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ENCYCLOPÆDIA BRITANNICA.

VOLUME XXXI (MOSAIC—PREVESA).

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PREFATORY ESSAY: THE INFLUENCE OF COMMERCE ON INTERNATIONAL CONFLICT.
FREDERICK GREENWOOD.

PREFATORY ESSAY.

THE INFLUENCE OF COMMERCE ON INTERNATIONAL CONFLICT.

By Frederick Greenwood.

TRADE is almost as old as the beginnings of human speech, and may be counted among the first and best uses to which speech was turned. When we think of the conditions amid which it arose in the still most fascinating guise of barter, what a pity it seems that there was no mind wise enough to understand what had happened, no fancy bright enough to catch and reflect the beauty of its promise! The practice began, we may suppose, in the village communities of the time as a neighbourly convenience, since every exchange of what was needed less for what was wanted more struck out the spark of pleased surprise which to this day makes the happiest bargains. A far greater pleasure was missed by those first bargainers for want of wit to comprehend it. Men were already men and far advanced from all other creatures, but yet were incapable of knowing what an immensity of change began with acquisition by barter, and too insensitive to feel or to care for the distance at which it placed them from the brutes, though by one remove alone. Its infancy being so purely innocent, in a world all rapine for both man and beast, the goodness that came in the train of its material advantage must have seemed to any high human intelligence the promise of a heaven-for-earth transformation. But no such intelligence existed to mark the change, dwell upon its meanings, mark its potentialities, and blamelessly commit the mistake that was made hundreds of thousands of years afterwards with no excuse whatever.

The earliest conditions of trade.

For, take any great intellect that we know of, suppose it at work at the time when acquisition by barter crept in upon acquisition by capture and robbery, and we see that such a mind might be pardoned for prophesying complete regeneration for mankind. If he saw in this simple innovation something that we might compare with another Speaking of the Word as in the Book of Genesis, still he might be pardoned. For he himself would have known no other dispensation on earth than that which included man in one order of life with the beasts, if not in one law of being, and he can have seen no such means of departure from that state as he discovered when mine became thine and thine became mine to the profit and pleasure of both. This was indeed to go upon new paths altogether, and thence toward others yet more remote from the dread domain of tooth and claw. Following upon the invention of barter, many undreamt-of kinds of good, as great as or far greater than itself, would have been apparent at once to a divining intelligence; and as the moral good which accompanies material advantage may be counted upon more surely than any other, and since barter was all innocence at the beginning and seemingly incapable of vice, prediction that mankind would be led to its utmost perfection by trade might have been uttered by the wisest in those days.

The truth, then, seems to be that wisdom was saved from disappointment in this momentous particular by having no existence. Trade prospered and no doubt did great things in ages impenetrably dark; but we must believe that before there was brain enough in any head to breed reasoned dreams of the future of mankind, trade had revealed its demerits and insufficiency. That, however, is to speak in the ordinary loose way. Like many other things that we accuse of degrading or otherwise damaging the mind of man, trade is in no way harmful of itself, but only as offering employment and satisfaction for some of the worst as well as the most wholesome cravings of human nature. Morally, it was at its best at first, or so it is reasonable to think; for we have actual observation to go by besides well-grounded conjecture. The earliest or almost the earliest conditions of trade have lasted here and there to our own time. The trappers of the Hudson's Bay Company found them in North America; they were little changed in the South Sea Islands when our traffic began there; so they remain in Africa among peoples and tribes in various stages of advancement from the man-brute borderland. And when we mark what barter is among such peoples, we must conclude that it has least guile where intelligence is most rudimentary. There we see where the fault lies if barter has achieved no such mission as, at its beginning, might have seemed worthy of Providential design, and was even thought capable of after ages of failure from its high possibilities as a civilizing agency. Yet its achievements for good (the acknowledgment is unnecessary, and yet must not be withheld) have been immensely great in every kind. Much as they have been exalted, they might still be praised without stint or antiphone if we could be sure that the set-off which must be placed against them in the sharpening of unbeneficent faculties, the stimulation of the lower passions and ambitions, is a dwindling and not a rising quantity. That, however, is much in doubt at present; and since at the same time all the political and social forces of the world are moving in unexampled volume and rapidity, the difference involved in the doubt is of such importance that it can hardly be exceeded.

Whoso looks forward to the influence of trade, now that it has become the one grand object of contention with Governments and peoples, naturally looks back also for what light the past may afford. The whole history can never be known. It would be a comparatively easy study if it began with Greece and Rome, or perhaps beyond them with Egypt and the great Semitic empires whose history enlarges at such a rate under the discovery of to-day. But the same inquiry makes out that this which was "the ancient world" of our grandfathers had other ancient worlds—empires and civilizations not unworthy of those high-sounding names, though now without intelligible record. How they were established, or, what is more to our purpose, how they were maintained, is unlikely to be ever known in particulars; but though their successors flourished more by trade than was lately believed, we must suppose that tribute and not trade was the main support of them all. As it was with the later civilizations of old, so no doubt it was with the earlier. All were built up, under the simple dispensation of the prime, by conquest, plunder, subjugation, and attained to increasing degrees of magnificence by tribute; though not without help from trade, nor, of course, from the arts that were fed from both. In substance this is the history of the ancient empires that we know most about (its reversal, the story of their fall), and the unended tale may be read, with certain differences for the better and some disguises not so much so, in the chronicles of the kingdoms of the modern world. Spain, Portugal, Holland, England herself but a century or two ago, became rich by exploitation which might almost as well be called tribute as trade in some cases, more than as well in others; yet trade was the common name for it, as now it is for ruthless and unashamed extortions of conquest in West Africa.

Looking back, then, it seems that trade, to speak of it in the larger, newer meaning of the word, has never been dissociated from aggression, for we can scarcely except such periods in the history of nations when they rested from conquest in the enjoyment of its gains. The tradition is unbroken, though it starts from before the Flood. It goes on from utter barbarism through one civilization to another, and through the darkness of the intervals between one and another. With but little change of circumstance, small softening of conditions, what it was at the beginning may be seen to-day in the Congo country. That, however, may be regarded as a strange and unexpected "survival"—an illustrative particular. The general statement is broad enough that arms and adventure were at the making of all the trade of the modern world; but still with this advantage to the spirit of conquest, that it took to itself a benign and profitable purpose, and this advantage to commerce, that it shared in the romance of outland enterprise and the glory of war by sea and land.

No people should be more sensibly aware of this ancient association than the English, one of whose most cherished recollections is the adventure of their great sea captains in "the Spanish main"; adventure which, though understood to be piratical, is not remembered for that, but for its splendid belligerency combined with its high commercial character. After that time the association of war and trade became more familiar; and yet it was in England, in the latest and most enlightened century of the Christian era, that trade was discovered to be the natural foe and destined subverter of war. And so recently as the fifth month of the second year of the present century there arose (was it from the New World?) the phantom of a reason for thinking that this strange thing might be true. But at the time of which we speak—the thirty years from 1840, or thereabout—trade had not yet produced its brood of monster millionaires, nor was there a dream of such a progeny to be proved absurd by the economic science of the day. Even as a fancy of that commerce-worshipping time, there was no conception of Finance as an organism great enough to supersede war, or to do so inasmuch as the old barbaric methods of conquest applied to the subversion of rival States, the wounding of their prestige, the reduction of their security, the transfer of their honours and their means of prospering. We to whom the phantom made its entirely unexpected first appearance are at liberty to interpret by it, if we please, the prophecy that commerce would banish war; but we may not do so as if any such fulfilment had been looked for. All that the phantom portends (if it is to be considered a portent) is the supersession of the tiger by the stoat, which is far below the meaning of our prophets—far below it and very different. The commercial enthusiasm of fifty years since predicted an internationalism of the peoples, brought about by a great extension of trade, the consequent discovery in practice of its true principles as they apply between nation and nation—above all, discovery of the fatal hostility of militarism to industrial progress, the sole means of advancement for the masses of mankind. Militarism retains them under the old dispensation with its universal "law of the beasts," Industrialism opens the only broad path of emergence from it; and the road had never stood so clear as at the time we speak of. Till then commerce had moved in slow and narrow ways, often obstructed and not seldom destroyed. Now, equipped to a wonder by Science, Invention, Discovery, all working together as if from a reserve of forces held back for thousands of years for its timely use, commerce made such play to such beneficent effect that it might well be supposed capable of more than its own advancement. The abolition of war, the institution of a reign of peace throughout the civilized world, was very much more; but it was accepted as probable by most thoughtful minds—of course we mean in England. Moderately stated, the expectation was that commerce, spreading rapidly from this the grand centre of its enterprise over all the civilized nations, would draw their peoples into a common interest. Better acquaintance with each other, which trade intercourse would procure and its amenities improve, must break down the absurd old race hatreds; they would disappear. That accomplished, it would be no longer easy for monarchs and their ministers to attempt their gambling ambitions, or to indulge or avenge their mere personal pride, by plunging their people into war. It would be the less easy to do so because the spread of commerce was the diffusion of enlightenment as to the truest interests of the nations; and while no people would henceforth be willing to cut the throats of another merely because they were foreigners, neither would it permit interruption of its new-found blessings by quarrels that ought to be settled in the wise merchant way: by arbitration.

Dreams of the extinction of war.

This was the argument of sobriety and the philosophical. Enthusiasm, of course, was far more eloquently and confidently prophetic, yet not as departing from the approved common sense of the day, or from the postulate on which in one shape or another its social philosophy rested almost entirely: to wit, that the most constant factor in human and therefore in national affairs is an intelligent appreciation of private interests. Grounded upon a dogma so safe and respectable as this, enthusiasm could ply the lyre without ever seeming to be visionary or romantic; and how much there was of it, how much of this enthusiasm even in unemotional and uncommercial persons, would seem exaggerated if told to men who were born in a later day.

No romance, only rejoicing perception of a thing assured; and yet what did these anticipations amount to? In effect, they were the anticipations which, according to our supposition, a keenly imaginative intelligence would have drawn from the first use of barter in a world where appetite and force were all the law; yet they never found common acceptance till fifty years ago. All the promise that barter brought into the world was visible from before the time when there was mind enough to comprehend it; the saving practice continued and spread for thousands of generations; and not till these generations of thinking men had passed away did the belief arise that commerce, the born antagonist of war, would overcome it forthwith. It can hardly be that so much confidence against so much experience was ever shown before; and we may also say, considering what the abolition of war signifies, and how much else would go with it, that never was so tremendous a revolution of the moral order contemplated with such matter-of-fact composure. The abolition of war was of course understood by the enthusiasts of commerce as an immense achievement; but it evidently figured in their minds as a vaster abolition of the corn-laws might, rather than as the victory it would be over passions, instincts, impulses continued through ages of inheritance from primeval man. That it would mark a great moral departure in every way was of course recognized and joyfully proclaimed; but the reward of the great achievement reserved for trade which occupied the foremost place in expectation was the unchecked advance of trade itself.

The domestic history of that time is so poorly recorded that the new generation hardly knows how much of explanation there is for hopes and forecasts so absurdly optimistic. It has been said above that sixty years ago it seemed as if Science, Invention, Discovery, were all working for commerce as if from a reserve of equipment held back for thousands of years for its use when the right hour had come. To most readers of the new volumes of the *Encyclopædia Britannica* this will seem a more or less acceptable flower of speech, meant to adorn and with no other meaning. But in the known history of the world there have been strange concatenations of change from unknown causes, sudden rushes to development as if by the operation of prepared forces biding their time and strangely hiding in concealment: it is hard to understand how they should have been concealed. Such occurrences, when they happen, naturally take the imagination of men, to their exaltation if fortunate; and our little flower of speech describes one of them without much aid from fancy. The reality is that though the human mind, and the practice of inquiry, and the direction of it by the more importunate needs and aspirations of mankind, have been the same and ever active from time immemorial, there never was such a display of invention and discovery of a certain order as that which suddenly began in the earlier half of the 19th century. It does seem as if these intellectual agencies, theretofore quiescent though not for want of instigation, had found their appointed time and hastened to heap their hoarded services on industry and trade. The present generation is so familiar with the achievements of science in mastering the secrets and harnessing the forces of Nature as to be almost *blasé* with them. But in their first days these achievements were veritable wonders—wonders in themselves, their novelty, their voluminous advance; and since by some new mystery all seemed addressed to the aggrandisement of trade, it is not very surprising that there should be an enthusiasm of commerce in which it was regarded as an instrument of Destiny. The beneficence of its aggrandisement—that could be seen far better then than now. Not long before the rise of Modern Invention, England had laboured year after year in the worst impoverishment of a most glorious but most exhausting war. There is a sense in which working men were right when they used to say that "war makes good for trade." But the time in which it seems to do so is short, as the wars that England was engaged in at the beginning of the last and the close of the preceding century were not; they were followed by many years of industrial lassitude; and this the people had to endure under a weight and a variety of taxation which the financier of to-day stares at incredulously. Even when trade had begun to revive, the general distress was great enough to break out from time to time in violent disturbance, which even after 1840 was sufficiently serious to alarm the Government. Such were the conditions in which the country stood when the released spirits of Invention and Discovery supplied commerce with their magic, easing its processes, enlarging its forces, multiplying its chances, shortening and smoothing every path that it came and went upon. Nor was there any tarrying of results. To other wonders was added the rapidity with which (the enormous first-advantages of free trade assisting) the whole country was filled with material prosperity and the knowledge of the way to more. In twenty years the world was so transformed that no saying was so common as that if one came from the dead he would not know it for the world he had left. No one who is able to cast back his mind from these times to those will lack excuse for the prodigious pride in itself which commerce then displayed, or wonder much at the extravagant elation of its dreams.

Unless some individual participants in the United States must be taken into account, the extravagance was entirely English; but for that there is the further excuse that England was the birthplace of the New Day, the first recipient and distributor of its bounties. Nowhere else in the world (it has been said before) could the gifts of Science, of Invention, have been put to such use and increase. The boast holds no longer, but in that day England had a population of artificers that could be equalled nowhere. A very pretty breed has been produced in the United States since that time, but in the "'thirties" and "'forties" of the last century there was a larger and readier supply of mechanical aptitude in the British islands than any other nation could furnish. The indispensable material to begin upon, coal and iron, lay ready to hand in matchless abundance, and the advantage of its possession was greatly increased by the coal and iron being found close together. Beyond the seas which bounded all this good fortune were many growing colonies, and one vast dependency with a swarming population all ready for the new traffic. Elsewhere the enterprise of the country and the excellence of its goods had founded markets half over the world, and the road to those markets was familiar to the largest and best protected mercantile marine that the world had ever known. From its geographical position (which one great canal has strengthened and another may impair) London remained the most convenient port of distribution then open to trade; and, lastly, there was no lack of capital. Though a comparatively poor country as measured by the standard of riches in these days, there was money enough in England for all the needs of enterprise, with a stronger backing of credit than any other could command. The possession of so complete and unique a series of advantages was of course fortuitous, but (we know the universal superstition of mankind) in relation with the other wonders of the time it had a look of destiny. It is the foible of every great nation to conceive itself, at one period or another, chosen to work out some mighty change for good, and if the dream was that commerce was to bring about a saving order of things, and to do so in the end by banishing war, it was a dream that England had more excuse for giving way to than her commercial power, potentiality, opportunity, supplied. This is true because the ascendancy of the England of that day was not commercial only. When the moral influences which she was to enlist for the extinction of war had yet to operate, England could all but ordain peace as the most commanding belligerent power in Europe. That was her position at the time of which we speak; and it completes the explanation and excuse of illusions that were to be destroyed as completely as was the unhappy town of St Pierre, by similar forces though not of the physical world, and with the accompaniment of similar reflections.

British ascendancy in 1840.

There was also some egotism to pardon in this dream of the commercial redemption of man, for at every view of it Britain figured as prophet, priest, pioneer, and the greatest gainer of all whether in goods or glory. But it would be a far blacker fault to suppose the forecast a romance of selfishness, and thoughtless to deny it a superficial plausibility. As we have said, the expectation that science-taught commerce would work miracles was not formed till marvels had been wrought. To the eyes of the generation that saw its rise its bounties were prodigies; and though we should wonder now if it did not spread widely and rapidly through the land, it was a new thing then that it did. And we have always to remember the times which that generation looked back upon. Of wars there had been enough, whether for the good they secure or the ill they bequeath. Poverty was universal. Material prosperity, though not the noblest thing on earth, had become the first thing needful for all the populations of Europe, for the people of Great Britain almost as much as any. When in such conditions the means of material prosperity were suddenly enlarged, as if by a providential awakening of faculties half dormant in the human mind, and when the new dispensation had shown the substantiality of its benefactions and their fruitfulness, the thought that the people would never let those benefactions go was bred in the air. That commerce would banish war was only another expression of the same thought, or rather the expression of its specific meaning; and, in the mood then prevalent, we can feel how captivating was the persuasion that influences making strongly for peace and good-will would extend and still extend with the expansion of international traffic. Nor was there any mistake as to the reality or the character of those influences. The mistake was in assuming their future predominance, in discarding the consideration that trade has other incitements than those which bring individuals or nations under the rule of interdependence. To be sure, rivalry with England for commercial supremacy was only thought of then by Englishmen as a pleasing impossibility, unless, indeed, for the United States in a hundred years or so. But the calculation that commerce would abolish war, what ground did it stand upon? It was that, convinced of the more substantial glories of peace, freed by trade intercourse from the barbaric prejudice of race, the European peoples would no longer allow the old wars for the lust of conquest and the pride of aggrandisement by subjugation. But that should have suggested two questions at least: firstly, whether in so doing the European peoples would contentedly resign all ambition to excel, whether they would not begin to think of striving with England for equality in the larger fields of the greatest good; and, secondly, what the difference is, in practice, between the contention of individuals for trade and the strife of nations. The usual resort in the one case is to "cut rates," in the other—— ?

There were many men in England, of course, who doubted that the victories of trade could include extinction of the Old Adam in Governments and peoples in the summary way that was looked for, if ever at all; but a certain association of the new cult with religion strengthened the natural inclination to silence in face of a joyfully confident and very large majority. Many of the best minds in the country, too, indulged the hope or permitted the belief, which soon found a creeping admittance into the regulation of public affairs. Confidence in immunity from attack, acting congenially upon the official negligence which may hope to figure largely in England's epitaph, had impoverished the Services; the Manchester idea covered the impoverishment with a spurious but hard-wearing moral sanction. Mr Gladstone's first budget was a product of the time in its heyday. It was framed in 1853,—"a large plan which," said his colleague Lord John Russell, "it rejoices me to be a party to"; and a boldly meritorious budget it was, with this peculiarity: it included a scheme for the extinction of income tax,—a scheme, however, which was to be carried out by a comprehensive rearrangement of the national finances extending over seven years! Seven years of unbroken peace were needed for working out the scheme; continued peace thereafter was necessary for its enjoyment; and therefore, to the foreknowledge of its author, the success of his plan would have been but a *succès pour rire* if it ran but for a year or two after completion. Confidence in the remoteness of war could hardly be more clearly shown than by the proposal of such a scheme on such conditions; but the whole significance of this illustration of the persuasions of the time is not seen till we remember that Mr Gladstone's confidence in his plan included confidence that the House of Commons and the public would make no difficulty of its essential premisses—as in fact they did not. That was done by war itself (the war in 1854) which even while the seven-year scheme was yet untried, had stalked across the horizon.

Subsequent course of international relations.

From the fact that Mr Gladstone's prepossessions on this great matter remained unshaken, since, indeed, they seem to have been little changed from first to last by the changing portents of his many years of life, he might be put out of court reasonably enough as a too exceptional witness. His views of the subject would have to be regarded as a biographical detail (though far from unimportant in the case of so great a political personage), and not as a strangely common error of mind strongly exemplified.[1] That, however, is what it was. If Mr Gladstone's policy and the conduct of it were largely determined by a conception of war as fast dying out under the influences of Industrialism and the "enlightenment of the age," he was supported in that idea by a widely diffused body of feeling which could not be turned from the logic of the Manchester revelation. Experience had no effect,

[1] On this point Mr Sydney Buxton, his friendly historian as Finance Minister, says: "He was, perhaps, too much inclined to believe that, as he said in 1862, 'we have sown our wild oats long ago,' and that the national debt would be never again appreciably increased."

observation went for nothing. The wars that began in the middle of the last century, as if provoked by the prophecy that there would be no more of them, were not only numerous enough to be convincing on that score, but offered strong evidence of little-changed and undiminished impulses to war. In the Crimean war the old-world motives were at work on all sides, and, when needed, in the old disguises: the Russian motives, territorial aggrandisement and the half-mysterious, often invincible stimulus of race; in Turkey, forces once the same, but now called to the defence and not the seizure of spoil; the Principalities, revolt against subjugation; France, dynastic considerations, very personal; England, protection of threatened interests and a menaced "position in the world." Half the battles in the "frankly pagan" days of antiquity, we might say nearly all, would come into one or other of these descriptions. The Austro-German war, a large-scale repetition of tribal conflict for ascendancy. The Italian war of Liberation names its own character—again the rebellion of a conquered people, marked by all the good and the bad characteristics of its predecessors "in the dark backward and abysm of time." Or then the Franco-German war; which in all that relates to motive, intention, machination, assembled so many precedents from barbarism as to prove an unweakened heredity. Had these wars been arranged to teach the lesson it could hardly have been better done. Apart from the miscalculated influences of commercial intercourse, the wars of the latter half of the 19th century might well have revealed a growing unwillingness, a restraint, fathered by wisdom and mothered by kindness; but if any change to that effect had been going on, it was little more appreciable by the senses, when the hour came for discovering it, than the meantime weather-wearing of the hills. Yet, despite all this positive evidence, belief in the antiquation of war as a working fact of the day maintained its existence.

It would have done so less vigorously, no doubt, but for certain principles of political economy from which false pictures of the future were drawn. In making these pictures you took the world as it was, saw it imbibe from ever-multiplying sources of information the true principles of international trade, and enjoyed the pleasure of each in finding out that the broadest principle of all is the easiest to follow. It is, of course, that every people should devote itself to the supply of such commodities as the natural resources and aptitudes of the country enable it to produce most cheaply—the surplus of these being exchanged for other commodities produced elsewhere under similar conditions. You saw that obedience as by compulsion followed the understanding of this first principle; it fulfilled itself by becoming known. At once, therefore, the nations were brought into a combination in which each secured its utmost profit to the advantage of the rest. At the same time, the comfort of each being dependent on the harmony of a now organic whole, a universal interest in the maintenance of peace is established. Viewed, then, under these conditions, what a picture did the working world present to the fancy of our island philosophers fifty years ago! Here stood England, incomparably rich in the means and appliances of factory work, machine work, engineering, mining. Busy and apt in all industrial arts, especially in those which the newly-employed agency of steam quickened and cheapened, her cities were fast becoming factories, while fleets of carrier ships were at hand to convey their products wheresoever on earth they were a want. England's part in the universal harmony was plainly appointed therefore; she could but call her labourers in from the fields and become manufacturer-in-chief for the rest of the world. Looking abroad upon this unadvanced remainder, there was France, confectioner of many articles of taste and luxury—wine-grower, too, for those who did not drink beer; France had always understood her *rôle*, and would go on with the production of her incomparably elegant superfluities. Elsewhere were broad cornlands, abundant and cheap grazing lands; here the people would address themselves with contented assiduity to their old-world employments, raising a commercial surplus of wheat, hides, tallow, bristles, for distribution from British ports. And so with many another scene of tranquil industry. An uncommercial Russia, a peasant Germany, numbers of what may be called country States, would become emulous in the production of food-stuffs and raw material, their rural lowliness being enriched and adorned by good things in exchange.

It may be that this bright vision of promise has not the embodiment of print in any of the political economy books. But its warrant is there; and since it was not the work of imagination so far as any one knew at the time, but a forecast from the teaching of a science impregnably logical, we can see how it may have served to counter the lessons of those 19th-century wars. The truth is, however, that while the logic of the political economists remains all that it was, the forecasts drawn from it ever go wrong, and none so completely as the more important and impressive of them. We have hitherto spoken of those that related to commerce and war as failures, as unconfirmed; in truth, they have been destroyed by violent disproof. The co-ordination, the interdependence of commercial exchange (what you can best supply for what we can best supply) has an almost æsthetic beauty as a principle; it was thought so obviously sound, and its advantages so equitable as well as great, that it must prevail wherever it was known; and no doubt its adoption in the spirit and meaning of its propounders would have been a powerful means to the extinction of war. But it was adopted nowhere. The nations are many, and in different conditions of existence; but none of them would consent to a system of international trade the first recommendations of which were the utmost economy of advantage and the promise of abating the most dreaded cause of misery and waste. Why? The explanation is suggested (not, of course, for the first time) in the foregoing paragraph. An uncommercial Russia had no idea of remaining so. A peasant Germany could not definitely resign itself to that order of existence, however much it might be solaced and dignified by music and books. If Industrialism is the only real hope of human advancement, as Mr Spencer preaches and as many governing men have believed without reasoning about it much, it is a social duty to open and keep open the means of employing all the industrial gifts, inclinations, aptitudes that exist in the community. If a great commerce gives strength to a nation and substantiality to its enterprise, then it is a national duty to strive for the possession of a great trade. There are no circumstances in which either duty can be properly neglected; and since their performance comes under the wholesome ordinance of competition, since also they may be carried far without trespass and farther yet without unfair aggression, it would even be absurd to subdue such duties to the eternally limiting scheme of the professors. But there is more in the facts than this. Were there no more, if, that is to say, these national duties not only could be but habitually were carried out within the bounds of contention proper to trade, every nation might make its own fair growth, the professional ideal might be left to its unfructuous loveliness, and yet there would be a happier likelihood of the decline of war. But in all such matters we have to reckon with the inveterate fact that the relation of nations to each other is not the relation of individuals in the same community. Probably there ought not to be any difference, but there is, and it is immensely great. As a consequence "the bounds of contention proper to trade" in the citizen's case widen into license when the contention for trade is international. And thereupon comes the fact that a great commerce is envied not only for such uses as capital stands for within the community, but as a mark of ascendancy and a means of success in other fields of contention far older and more honoured than the struggle for new markets. The pride of command, the glory of conquest—the strongest *collective* passion of tribes and nations from their beginning, if not the only one—must be served. A great trade affords the most effective service in the unending conflict of national ambition, and trade itself is in our day as closely associated with international conquest as tribute was in times of old. Extension of trade and expansion of empire mean the same thing in most European tongues. They cannot be uttered without calling up visions of the fleets and armies necessary for acquirement or protection; fleets and armies which become more numerous and powerful as the rivalry increases which is little else than war in abeyance.

These conditions, which apply equally to the European States inasmuch as they aspire to greater domination or fear to be dispossessed, must change entirely before it can be said that commerce and war are at variance. Change there has been of late, increasing at an accelerated pace year by year; but not in the expected direction. The rivalry intensifies among the European States as they rise to a nearer equality in power; the number of aspirants for empire has increased, making their claims good in the old way by building fleets and adding army corps to army corps. Yet more unexpectedly, a vigorous Eastern State has come into the "world-conflict" for trade and territory, with a retinue of ships and soldiery magnificently armed. Now, this is a nation which did maintain within itself, for hundreds of years till the other day, all the functions of a full and busy social life, even to the finish of the arts.

Immediately upon that surprise another and far greater nation drew out from its own little universe of self-content, to enter the field of Imperialism. Very much because the Americans are not Orientals, but Europeans even as Britons are, this is the more instructive case of the two. For though the conscious motive of the United States in entering upon the Spanish-American war was to stop a useless waste of life under relentless misrule, one result of that war was increase and acknowledgment of the desire, irrepressible though long-pent, to give America a place among the conquering peoples. It is idle to talk of it, impossible for all but a very few minds to think of it, as a vain desire. But, however it may be considered from the moral, prudential, psychological points of view, that the desire exists and prevails is much to the purpose of this discussion. Acknowledged by the world as a great because vastly capable country, America possessed all that could be won by industry untaxed and unchecked by militarism (as Mr Spencer would have it), and by the undistracted use of the highest commercial faculty. It did not suffice. Long before the war, there were many signs in America of a coming change. The conditions which made obedience to the curbing of national ambition more inviting than obedience to that ambition had passed away; and, as was said at the time, it was not in the unregenerate nature of things that a strong, numerous, capable, proud, and stirring people should be content for ever to confine themselves and their influence within the bounds of home government. But it would be superfluous here to go into motive; enough to state it. The question being whether the tendencies of civilization run toward the extinction of militarism by industrialism, two powerful nations which have hitherto held aloof from the struggle for empire march into the arena with horse, foot, and artillery, and thus make contribution to the answer. One is of the outer East, and not unlikely to bring another Eastern people after it, or even the whole race to which it belongs. The other is of the West; a nation which, having come to full growth upon a religion proscriptive of "world-policies," and having prospered beyond all dreaming as a self-contained industrial republic, decides that as a career it does not satisfy. To be complete, it must be a career of conflict and dominion; with enlargement of trade for business justification, but more looked to for a becoming share of "the glory that was Greece and the grandeur that was Rome." And so, with a right-about face, the American people turn from their entirely successful experiment in industrial monasticism, hasten to build fleets of warships, and launch forth upon the ancient ways of national emulation.

It must be agreed that if more impressive evidence of the tendency of change than this can be found, it must be very convincing; and there is such evidence. We come back to the old countries of Europe, and looking to the agencies of civilization which were to have worked with the amenities of trade to abolish militarism (a disagreeable word, but inclusive of intended meanings which "war" does not express), we find these agencies employed in bringing about an entirely different result. Nor is their working partial, unless in one particular the most unexpected where every expectation has been falsified. The civilizing influences of the time force militarism upon people and princes alike, but most upon the peoples. The pressure is felt, though unequally as yet, where empire is a possession and where it is an aspiration; and commerce and labour call eagerly upon militarism in the one case for the protection of trade acquired, in the other for the acquisition of trade desired.

War as a trade weapon.

The effect of these crowding civilizing agencies as they tell upon the "dim populations" of Europe is readily traced out. One of them is the closer intercourse of men by the "abolition of distance" between village and town, but more especially by "the effacement of the physical barriers between nation and nation"—these beneficent changes being the work of our railways, steamships, telegraphs. Another is the diffusion of education, and a printing press that cheapens the means of enlightenment so bountifully that every man may partake. For the dim populations these are the most effective civilizing influences, though no doubt there are others. And now what are their main results for the masses personally, practically, as citizens and industrials? The answer is that the extension of civilization means extension of the demand for the appliances, comforts, and luxuries of civilized life. The effacement of the physical barriers between nation and nation is more famous for enlarging acquaintance with these things, at least by sight and hearing, than for softening the hostilities of race by personal converse. The abolition of distance between village and town has the same effect, besides affording to villagers a readier means of seeing what it is to be a town artisan and not a peasant. And so the first employment of the commonest and most powerful agencies of civilization is to bring close to the eyes of poor men what others enjoy, to give them a taste for it as well as a sight of it, and to inform them at large on the subject by every print that finds its way into the hands of poverty. But the higher living so naturally coveted, and that certainly represents civilization however much else that better state may mean, is not obtainable by the wages of rural labour; and it is not labour alone that seeks the higher living which civilization commends and demands. Hence proceeds the enormously increased and increasing eagerness for trade, for factory profits, which has seized upon the European nations; although, as we remember, they were to have played a more philosophic and harmonious part in the commercial economy of the world. Hence, but with added cause, the raging desire for colonies which broke out not long since, the competition for an exclusive hold upon distant fields of enterprise, which is business beyond all doubt, and necessary business, but not of the kind that turns spears to pruning-hooks. We have said "with added cause," for where the wants of the people move them to discontent (civilization being a prolific creator of needs and appetites) Governments are taken with anxiety. They become eager for commercial empire as a provision of wealth and comfort on the one hand, as the prevention of social disorder on the other. Seeing how rapidly and adventurously the still exploitable portions of the earth are staked out for occupation, Governments and people are agreed that their purpose cannot be achieved by waving palm-branches from the doors of empty warehouses. No, but (in short) by the waving of the sword; by the use of it on occasion; by the maintenance of large armies to have and to hold; but especially by adding ship to ship, rediscovery being made that sea-power is the secret of empire, very much by the control of trade.

So far we have viewed the matter from the side of the nations which strive to acquire; the difference when we look to them that possess is only that between the offensive and defensive in warfare. Be his condition what it may, every intelligent Briton knows whether the wider diffusion of commerce and the more general interest in it abroad do or do not reduce England's obligations to stand well armed. He may doubt whether the great "world-movement" continued from the 19th century into the 20th is for trade for the sake of empire, or empire for the sake of trade; but he sees that in either case the upshot is that British commerce needs the sword of defence more and more. No doubt it needs other defence, such as firmer energies and a keener outlook upon business would supply; but this also is understood, though by no means as a substitute for the protection which the greatest navy ever seen is not too great to secure. This is for defence against a sudden blow, and is so vast a navy because the captivation—no, the necessity of commerce for other nations brings a sudden blow within probability. Nevertheless, up to the time when these pages are written, this which is a clear is not an animated conviction in the public mind. And yet, when the consequences are considered, failure in defence of a great and long-established commerce is far more serious than defeated endeavour to set up an empire of trade, or militarism, or any other. The difference is provided by the law under which the luxuries of to-day are the wants of to-morrow. A solace for poor communities (as for all poor folk), this unfailing compensatory law imposes on the rulers of England a far sharper responsibility than they have ever yet revealed a consciousness of. There is poverty enough in the country, Heaven knows; but take the mass of the population, excluding those who would be called rich by working men, and we shall see that many things which were the luxuries of a well-remembered generation have now become absolute needs. The trade of the country has been good so long, that a share of its benefits not at all too large, but larger than is commonly reckoned, has spread down through the multitudes of a newly-created "lower middle class" to the working population. And there we find many who not only know by sight, and hearing, and sensibility the sweetnesses and decencies which civilization requires, but, thanks to the wages supplied by an abundant commerce on the one hand, thanks to the cheapening of all manner of civilizing refinements on the other, have made imperative wants of them by habituation. If this is to be regretted we must be sorry for the better good which a nation draws from the enrichment of industry; for that better good is a common people in which the lower refinements and the higher decencies of life become sheer necessities. That, however, is by the way. Now, even a gradual attainment to such advantages is preferable to rapid acquisition; but being acquired, and having become constituent in the life and character of the people, what would it be to be stripped of them suddenly? We should listen to the truth that speaks in us when questions so momentous arise, and not be afraid to do so. Were the blow to fall which is a reasonable contingency if great fleets are not a foolish waste, it would be virtually (war is quick work at sea) a matter of a few weeks; the trade that feeds numberless factories would in that brief time depart; ransom under the name of indemnity would impose its intentional burden; and then the law of which we have spoken would fulfil its round. The needs that once were luxuries, and then became both the signs and the substantialities of social advancement, would be so many privations bitterly felt but not of the rousing kind. In other and perhaps more obvious ways they would be demoralizing privations, and of course an added quantity to those which were the common lot of the common people in the bad times at the beginning of the last century.

Drawn from the most grateful benefactions of trade, these are reasons for a vigorous alliance of commerce with armed Force; and the fuller the benefit the better the argument. There have been times, as we have said, when this combination under the British flag was little else than piratical; it had been so under other ensigns a hundred times before, is so now, and will be found at the same game as long as this world is made up of various races and nations at different removes from barbarism or at different stages of decadence. So long, therefore, it must also be a defensive combination, in which state it may not only play a natural but a humane and a righteous part. We have given some reasons for thinking so in England's case. Were there a better case, an empire more amply endowed with wealth and power more nobly employed and widely shared, it would make a better argument. Such an empire would perish under readier attack unless more formidably armed.

The benefactions of commerce have never been more loudly celebrated than in these days: they are as the beauty of Helen, with (perhaps) a more interested call to strife. But commerce has its vices, and they should have a greater share of attention. Domestic vices, as seen in the crowding of cities, the massing of misery, the physical degradation of the people, and in some other things that make for meanness, we do not concern ourselves with. The relation of commerce and war is our theme, and there are ways in which commerce works in that relation to extremely bad effect. One of them is by keeping up an incessantly reckless cry for new markets. It is a cry that naturally commends itself as a proof of energy and a sign of ever-conquering advance; there is too much evidence, consular and other, of a different explanation. Are the old markets filled before the cry for new ones is raised? That they are is assumed from the repetition of the demand; that they are not is proved by the one fact that within the last thirty years a newly-risen nation of traders has grown rich by gleaning in fields of enterprise where, it appears, British merchants were disappointed with the main crop. England's markets? England's markets abroad have been so numerous, so various, and so firmly held by virtue of first occupation, that they should have sufficed to this day by close thought and assiduity. Most of them wanted and would have repaid, as they have repaid later incursionists, the cultivation that a town shopkeeper spends on his town customers. Our commerce could not descend from the dignity of wholesale export to the *petits soins* which its rivals have introduced into the trade; would rather sweep up the first gains of an "unspoilt" market and pass on to others entirely new. "By disdain of small business, by contempt for the little cares that win small business, by a preposterous philistine habit of treating foreign tastes and preferences as whims that ought not to be humoured, British commerce shortens the harvest of its opportunities while ever reaching forth for more." Now this was well enough, no doubt, when many populous lands had been little visited, and when England's competitors for trade to far-off places were few and of small consideration. But all that was changed years ago; we have just been recounting the portentous how and why. All the greater nations are fighting together for new markets, oftener than not by their Governments sword in hand; and nearly all are animated by a fiery opinion that England has more than her share, to their injury. Notwithstanding this opinion England must hold her own and keep her high place. But it cannot be done with ease; and the "commercial interests" of the

The cry for new markets.

country should know that when in such conditions they clamour for new markets, the old ones being lazily or ineptly used, they do a grievously unpatriotic thing. The armed forces of the country may of course be called upon most properly to protect the commerce of the country, and perhaps to extend it; but not to extend it on such terms as these.

More serious in itself, and yet more serious because quite unchecked, is another vice: the recklessness of commerce in educating barbarism in the methods of war, and supplying the weapons it is taught the use of. The teaching is not always systematic or direct, but yet it goes as far where the taught are not savages or just emerging from savagery, but advanced from that state by many steps, and therefore more adept, and again on that account more dangerous pupils. The Abyssinians may be mentioned as in this category; much pains have been taken to bring the Abyssinians within the European system as a properly-equipped military people. And direct teaching goes farther yet in the case of the Chinese, who are not at all barbaric in the sense of being unformed and unpolished, but in the first place eminently capable, and in the next fixed in a civilization which is antagonistic in the highest degree to that of their instructors in warfare. Most of the commercial nations of Europe have competed for the privilege of imparting this instruction, which if ever it becomes effectual (as there is increasing reason to believe it will under the stimulus of hatred for its original teachers), will probably add to the armies of the world one of the most disturbing ever known. Yet it was but for the sake of a little trade (supply of war-material chiefly we may suppose, or the opening of doors to "concessions") that English, Germans, and others beside Russians, have played the part of drill-masters and gunnery instructors in China. No doubt this was done in belief that the Chinese were too inept and spiritless to turn their instruction to account. Europe had that excuse, such as it was—the excuse of a hazardous, unnatural calculation. But the error of politics and trade—yet of politics far less than trade, with its compelling cry for new markets—remained unabated when there was plentiful reason for suspecting it. As the commercial eagerness of Europe increased, it was accompanied by yet more heedless provocation of the spirit that detested it, and by further lessons to the Chinese in the feasibility of expelling their invaders. However, this is not a chapter on the "awakening" of China. The intention is only to recall the reckless induction of war in that much misunderstood country, and the culmination of the error when the European Powers felt themselves driven to the necessity of settling government at home on commercial empire abroad. In truly barbaric countries, as in nearly all parts of Africa, trade carries on with a like carelessness of the fact that its most positive civilizing process is the one that a Zulu or a Basuto, for example, is by nature, education, situation, most ready to profit by. No doubt he also acquires some of the amenities of civilization—those that fall away with such astonishing readiness from its white pioneers when their business lies in an india-rubber country. Much more lightly, however, do such graces sit upon the tribes of fighting-men who are being taught the Chinaman's lesson in more indirect ways. No doubt this cannot be avoided, but it might be hindered or delayed, whereas trade (which must be considered as an entity without regard to its eccentric members) seems to be quite indifferent on that point. Anything which, by observation, or experience, or provocation, or all three, may train these half-savage millions the sooner into formidable fighting-men is tolerable to trade, if in the meantime business is well served by it. This is no mere peccadillo, but a vice which, considering how rapidly the world narrows, and how much more speedily consequence follows upon cause, becomes signally unpatriotic.

The business conscience.

To these unpleasant portents others have been added so lately that their scope can hardly be measured. Tariff-wars are new, as intended by the Government of one state to defend its trade from subversion by another, or to force from another trade advantages. Commerce having risen to such importance in international rivalry, at the same time standing for so much between Governments and peoples, it may be that tariff-wars have been invented to stave off more dread "complications," upon which, indeed, tariff-wars seem to merge sometimes. In any case they witness to the command of trade in the world's affairs, and to its fertility in matter of direct quarrel. A sudden development of the American system of "combines" offers an entirely new view of a possible future, in which the financial machinery which obtains command of the whole stock of some indispensable commodity may find employment more august. State employment is intended: state employment in a scheme of war without bloodshed. A Government about to declare war arranges with an expert syndicate to obtain control of the whole supply of certain food-stuffs for a certain time, and pays in millions—as a Government about to declare war against a strong Power could well afford to do for such a purpose—to keep this food from the lips of the people to be attacked. Anticipated result, famine from the earliest possible moment without the usual preliminaries of slaughter and blockade; or a demonstrable certainty of famine, which, presented at the right moment, would compel submission on the one side, and confer triumph by mere cash transaction on the other. The plan is simple, almost certainly workable, and sure of commendation on grounds of humanity. And it has a particular interest for England, because it would fail against any but an island state, as England is, and one that is open to starvation in a similar degree.

Such being its limitations, there is almost as little likelihood that Finance will abolish war as that Commerce should; unless we admit the conjecture that a time will come when the great twin brethren will build for themselves a throne of dominion so mighty that to command its own peace will be the banishment of war. Meantime all previous conjecture has perished in disappointment and worse. For the influence of commerce was not the only trust of those who looked for the decline of war. Their expectation was that the characteristic intellectual agencies of the last century, the invention, the discovery, the high mechanical science which equipped trade so magnificently, would abet the suppression of war by direct operation. But that they stood for enlightenment, demonstrated the superiority of the arts of peace, added to the number of good things which war should take shame in destroying—such vague considerations as these seem to have been the only foundation of what was hoped from them. Yet there was some specific argument, as we have seen; and this too has given way. Nothing was reckoned upon more confidently for a great mixed crop of moral and material good than the bringing of the world together by the shortening of distances and the multiplying of means of communication. One unexpected consequence of these real blessings—the driving of Governments yet farther into militarism for the sake of trade—has been already noted. But there have been other results which, instead of reducing the need for armies and diminishing their cost, increase both. The bringing together of the various families of mankind has been accomplished with great success as to the material part. But as to the moral effect, it must be reckoned as much worse than nothing, according to evidence brought down to the second year of the new century. There were occasional bursts of fury between nation and nation in the less neighbourly days of old. In these times there are occasional bursts of fury as before; but, more remarkably, the intervals are filled with incessant bickerings among the peoples. The relations of the Governments remain what they were, with only one substantial difference: they are sometimes gravely embarrassed by these bickerings, which do not make for peace.

The shrinkage of the world.

But as the world is brought into an ever-narrowing compass, other consequences ensue which bear more directly upon militarism. Frontiers close in; and as distances diminish, as time contracts and movement becomes more rapid, larger armies must be kept in readiness to meet or forestall a foe. The facilities and appliances of war being what they are—thanks to the abounding mercies of science and invention—sudden conquest must be provided against; and since fifty thousand men may be rendered useless within a fortnight of the proclamation of hostilities, large reserves must be kept on a footing of instant readiness. Armies thus attain to more importance than they ever had before, do in fact become a more immediate and more costly necessity; and this they would be, it seems, if only because of the contraction of time, the closing of distances, the acceleration of movement. But modern armies must be large for another reason: the tremendous forces of destruction to which they are exposed compel provision of a corresponding "margin" for repair. These immensely destructive forces are among the most prodigal gifts of invention and science. If armies are so costly a necessity nowadays, it is not only because they must be more numerous, but because science and invention are tireless in providing ever more terrible and still more expensive engines of war. Hence the need of additional taxation, and therefore of additional trade, and therefore of increased competition for trade. The good genii of the 19th century have done great things for the material welfare of mankind, but what have they done for peace?

Peace has been little favoured by their labours indirectly—their direct labours have been assiduously addressed (no doubt with the best intentions) to enhancing the devastation and the waste of war. And their works continue.

When this unexpected outcome forced itself on attention, second thoughts discovered in it the very thing that would extinguish war most certainly and speedily. War would become so costly, above all it would become so dreadful, that it would not be endured. This remained a hopeful belief for some years, and it was not without reason. It was not without reason then. Since then war has been provided with far greater terrors, and once or twice it has made such havoc, in a space of time terrible in its brevity, as was never seen before under the sun. Yet humanity does endure the excess. There is no sign of its being shocked in the least. Invention is still at work upon improved means of ravage, and the State spends more and more on its productions amidst little complaint. For commerce prospers in reliance on war; war is everywhere pledged to commerce; and the old order reigneth still.

There is no more demonstrable truth in mundane affairs than this, and none, of course, that compares with it for importance. Should we not acknowledge it, then? To deny would be as reasonable in these days as to doubt that the original forces of Nature still operate by contention; and therefore it is not denied. But it is a truth that we conspire to cloak from ourselves and each other, not only because there is so much in it that disappoints and even appals, but also because it awakes in us a feeling of shame. And these are not bad reasons for silence, which would be blameless enough were it never allowed to obscure the facts, and if it were not accompanied by certain hypocrisies of a distinct, demoralizing character. But then it has those disadvantages, and to get rid of them would be a great reform. Now that would be done with sufficient completeness by quiet recognition that the international relations of mankind are what they are: that is to say, barely redeemed from barbarism, however well-gloved they may be in our day. Sincere endeavour has been made to bring them under the rules that govern civic communities, and not quite without success. In peace time, indeed, the success appears considerable; nevertheless, it is but superficial. Those relations are still rooted in the primal order of things, and at every disturbance show that they are. Now this is a time of great disturbance, and likely to last. Why, then, should we not acknowledge to ourselves the unregenerate character of international relations, and act *not* as if it were a merit to misunderstand them? To do this would be to clear away the doubts that hang upon the obligations of defence; or in case the offensive-defensive should be forced on us, we might then undertake it without resort to false and unworthy affectations of sacrifice to moral compulsion.

An illusion to be shed.

ENCYCLOPÆDIA BRITANNICA

NEW VOLUMES.

MOSAIC.

Mosaic.—The art of mosaic has never been deeply implanted in the artistic sensibilities of the north of Europe, nor has it been employed much either in France, or Germany, or England. It ceased to be generally adopted in Italy when fresco, oil, and tempera painting came into vogue. Gothic architecture is ill suited to its robust claims as a decorative art; and the incoming of fashion for the latest and least interesting development of classical architecture, "Palladian," divorced not only it, but mural painting also, from all architectural schemes. To be properly consequent and effective, buildings, ecclesiastical or public, should be constructed with the intention of being covered almost entirely by mosaics, which demand rich environment, marble or other colour; mosaic is essentially a colour medium. It is therefore scarcely surprising that when mural decoration became pre-eminently pictorial, and gestures and expression grew complicated, elaborate, and naturalistic, an art limited in its powers of presenting such manifestation of realistic design was relegated into the limbo of obscurity.

There are no instances of the use of mosaic in England after the Roman occupation. The Normans, who derived it from the Greeks and Saracens, and adopted it in Sicily, did not import it either to France or England. Although English churches, and French also, were highly decorated with polychromy from early times up to the 16th century, there is no evidence of mosaic ever having been used. The revival of a school of mosaicists in Rome during the 17th century, employed in the decoration of St Peter's, and here and there sparsely engaged in other churches, led to the idea which Wren would have carried into effect, namely, making use of mosaic for the cathedral of St Paul's in London; but his scheme, if it was ever really entertained, was not carried out, as we all know; and the art, which might have become the fashion in England, remained an exotic. Even late into the years of the 19th century mosaic decoration was regarded by classical purists as a barbarous art, and the glorious decorations in that material to be seen in Sicily, Italy, Greece, Asia Minor, and Russia were disregarded as works of high art. They were in many cases cut out to provide room for extravagant and vulgar designs in fresco or tempera, unmeaning, undecorative, and wholly abominable as decoration. Those Roman mosaics over the altars in St Peter's, being copies of celebrated oil pictures, while they cannot be denied excellence as such and marvellous dexterity, reveal the worst possible taste, for they attempt to represent adequately, in cubes, touches of the brush which were spontaneous, fluid, thick and thin, and as sensitive and spontaneous as the finger pressure on the violin string, so accurate that the least deviation from absolute position produces discord. The only service which such a misplacement of labour and of material can be said to have rendered, is, that when the original oil pictures have been destroyed by time, these inadequate copies of them will remain. In St Mark's in Venice Titian, Tintoretto, Veronese, and other oil painters of renown failed when they put into mosaics designs fitted only for easel pictures. Deeply indeed is it to be regretted that the mosaics (of which there still remain a few unrestored in St Mark's and in various churches in Italy and Sicily), designed and executed by Greeks, were cut out in the 16th century and later, to be supplanted by designs which, however good in themselves, are entirely ill adapted to the restricted conditions which are the strength and not the weakness of mosaic treatment when used in perfect justification of its capabilities.

These restrictions are many, and some are obvious. In the first place, mosaic is not suited for a small scale of design. It is true that in the Opera del Duomo in Florence there is a miniature mosaic (executed in the 12th century) of extraordinary beauty, which must have taken a lifetime to execute; but still this remains a curiosity, a bit of craftsmanship, rather than a great work of art. There is also a copy of Mr Holman Hunt's "Finding the Saviour in the Temple," executed for Clifton College by assistants in Messrs Powell's establishment in Whitefriars, London; it is admirably done, no doubt, but it is a long way behind the original, which is a design wholly ill adapted to mosaic. There are several other instances, notably one by Mr H. Holiday of "The Last Supper," where mosaic has been employed to translate a beautiful design, which would have been more satisfactorily executed either in oil or water colours. There are also several isolated figures in mosaic in cathedrals and churches of England, small in scale, of good workmanship, but failing *quâ* mosaic, because had they been done in oil or tempera colour their design would have been better justified. The primal and most obvious limitation is in matters of detail —detail as regards a multiplicity of forms, many gradations either of colour or tone and naturalistic accidents. In this respect good mosaic is like good *basso relievo;* it is accomplished by firmly pronounced outlines, unconfused masses, large planes unbroken up by small adjuncts, and generalized and conventionalized forms and simple colour. So all small curves, as well as small tints, should be eliminated, because it is not in the nature of the material to do them justice. One can scarcely conceive a choice less happy for mosaic than the centre group taken out of the upper portion of the Disputa fresco in the Vatican by Raphael, yet this florid piece of work, so facile in creation, was chosen to be executed on the eastern wall of the morning chapel in St Paul's. It is admirably copied as far as it goes, or rather as far as the material permitted, but hopelessly wanting in the spontaneity and charm of Raphael's delicate and sketchy work.

It is useless to illustrate the many similar mistakes that have been made. They were made in some of the earlier work in the choir of St Paul's. The best example of mosaic on a small scale is in Ravenna, the tomb of Galla Placidia; the best upon a large scale is the great Christ at the east end of the cathedral at Monreale. These two works absolutely justify the means to the end. Interesting are the designs made by Sir Edward Burne-Jones for the mosaics for the American church in Rome, but the execution and colour are alike monotonous. The cathedral of Chester contains a series of mosaic pictures designed by Mr Clayton. The Guards' chapel in St James's is adorned likewise by the same artist, under the direction of the late Sir Arthur Blomfield. In the chapel for the school at Giggleswick are mosaics designed by Mr Jackson, R.A., admirably and broadly treated in true mosaic character; these were executed *in situ* and not, according to the modern habit, upon paper, away from their environment and by a foreign firm. Those mosaic *pictures* which are placed in niches in the great gallery of South Kensington Museum are failures *quâ* mosaic, though the designs in many instances are fine, notably those by Lord Leighton and Mr Val Prinsep; but their execution is uninteresting, because the cubes are laid so flatly and so evenly that they suggest an oil picture *appliqué* upon a flat ground.

Messrs Powell have been employed on several occasions to decorate churches with mosaic. This firm has adopted the old style, and rejected the new one initiated by Dr Salviati of Venice. If we observe the surface of a fine Greek mosaic, such as that of Andrea Tafi in the Baptistery of Florence, or the few remains of unrestored mosaic in St Mark's, Venice, or indeed other works scattered over Italy, we shall see that it is rough, not smooth; that the cubes are irregular in shape; that there is always a space of the ground colour left, red or white, and visible between each cube. In modern mosaic, with rare exceptions, restoration or other, the cubes have been jammed up closely together, and the surface is as smooth as a piece of paper; thereby is engendered a mechanical and uninteresting surface, over which light plays with monotony, and hence that brilliant and scintillating effect so essentially the character of true mosaic is absent. The tendency in modern times has been to rival the smoothness and general appearance of an oil picture, which is the very antipodes of the nature and demands belonging to a material eminently structural and therefore eminently in harmony with building construction. This defect, and it is a grave one, is evident in the works in mosaic more or less recently set up in Paris, notably in the apse of the Pantheon, the east end of the Madeleine, and the vaulting of the great staircase of the Louvre. Those in the apse are finely designed, but scarcely look like mosaic, those in the Madeleine still less so, and the last not at all. These several mosaics were executed by the École Mosaique, long established in Paris, but they are far from interesting or satisfactory.

The artist who designs for this material must set aside all the principles he has learned to estimate in paint, either of oil or tempera. As an instance of a painter, pre-eminently delicate in his colour and tone, failing as a mosaic designer, we may quote Cimabue, whose beautiful designs in the cathedral at Pisa would have been far more effective had the artist painted them upon the wall with the medium in the requirements of which he was so great a master. The same criticism may apply to the mosaics in recent years set up on the west front of Santa Maria del Fiore in Florence. These look like oil pictures. One would never imagine, looking at the cartoons for them in the Opera del Duomo, that the artist had intended his designs for any other material than that in which they are executed—oil colour; so, when translated into another material, they retain their special elements of character, and look to be what indeed they are—copies in glass cubes of pictures. The very first principles which go to make a fine picture are just those which should be avoided in mosaic—elaborate modelling, delicate transitions of light and shade and picturesque effects of dark and light, materialistic resemblance indeed. The designer for mosaic should ever bear in mind his material, and in his designs for it he should accentuate those characteristics which belong essentially and specifically to mosaic and to *no other technique.* If he is a painter, he must forget his lessons in that art and take up with new ones—those which teach broad masses of colour obtained in lines. He will find that effects gained by a technique employed in oil colour look bald and ridiculous when translated into mosaic. Water-colour and pastel are by far the best media for cartoons to be copied in mosaic. We do not know how these were executed in ancient days; probably the design was drawn on the wall, and there were no cartoons. The master not only invented, but he was the master-workman also, and that is how it should be. The probability is that the custom of drawing the design upon the wall practised by the early Frescanti was the survival of a method adopted by the mosaicists, just as their method repeated that of Roman and Greek wall painters. Of course this direct method leads to a large style, a style harmonizing with environment, scale, &c.; the tendency is to draw large in a large building, to draw small in a small one. Anyhow, this is quite certain, that all the fine Byzantine and 13th-century mosaics, as well as wall paintings, were executed *in situ* and not away, as was the usual custom in England and elsewhere until recently. What foolishness it seems, when looked at directly and from a common-sense point of view, to design a wall decoration away from the building it is to adorn, then to send it to a foreign country to be set up in another material, unseen during its progress by its creator, and then, still invisible to him, to be applied to a wall! Who can wonder that such piecemeal work must, ninety-nine times out of a hundred, issue in failure?

Mr Harry Powell has permitted the writer to make use of some of his reflections upon the mosaicist's art in the following notes. The mosaicist should not separate the artistic from the technical details of his craft. He must study not only the decorative effect, form, colour, and spacing of his design, but the surface to be covered as well as the materials with which he builds.

Surface.—Good brick-work, the mortar joints slightly cut back, affords the best foundation for mosaic. The hollow and sharp-edged joints provide a key for the cement into which the cubes will be set, and they diminish the risk of sagging, a not uncommon event if the cement is not welded to the wall by being well pressed into the joints. If the mosaic is to be applied on stone, the stone must be notched and well roughened to provide support. Whether the surface is brick or stone, it must be well saturated with boiled oil to prevent suction, because if too much suction takes place the powder only of the cement will remain and the cubes will drop out.

Cement.—A cement suitable for mosaic is one which retains its tenacity, which can be applied in layers, which sets slowly, and which is not liable to change colour after long exposure. These conditions are best met by an oil cement. One consisting of equal weights of white oxide of zinc and carbonate of zinc, mixed with double boiled oil and containing small proportions of wax, gold size, and slaked lime gives good results. This cement can either be white or red, white where greyness of tone is desirable, red where a richer effect is desirable. It is generally mixed with a small portion of oxide of iron or oxide of manganese, which prevents the whiteness of the joints from rendering adjacent tints grey from a distance.

Atmospheric Corrosion.—As the atmosphere of modern towns is more corrosive than that of mediæval Venice or mediæval Rome, it is important that, in choosing the cement and the materials to be embedded in it, the mosaicist should be certain that they are impervious to atmospheric impurities.

Glass.—Although marble, mother-of-pearl, and other substances have been, and are still occasionally used, the predominant material in ancient as well as modern mosaics is glass. When prepared with due regard to the continuing proportions of its ingredients, glass is impervious to the action of ordinary acids, and is practically indestructible. It can be made to assume almost every shade and tint of colour (see GLASS). There are many kinds of glass, but for mosaic work either a potash-lead or a soda-lime glass is usually employed. Both of these glasses can be rendered opaque by mixing with the ingredients either oxide of tin or a mixture of felspar and fluorspar. The texture of a glass which owes its opacity to oxide of tin is dull and granular, and when the colouring agents are added the resultant colours are subdued in tone. Glass rendered opaque by the admixture of felspar and fluorspar has a bright, vitreous. easily cleaned surface, and readily develops brilliant colours.

Production of Colours.—Colours are obtained by mixing and melting with the ingredients of the opaque glass small proportions of certain metallic oxides. Oxide of chalk gives a purple blue; oxide of copper gives a peacock blue; oxide of copper with oxide of iron gives a green; oxide of copper mixed with oxide of iron and a strong reducing agent gives a red; oxide of chromium a green; oxide of nickel a purple; oxide of uranium a yellow; and oxide of manganese a violet, or a black, if a larger quantity of oxide is used. By continuing the oxides a practically unlimited palette may be readily obtained.

Manufacture of Glass Slabs.—The mixtures, in a state of powder, are shovelled into crucibles standing round the grate of a furnace, and when fusion is complete the viscous glass can be coiled upon the heated end of an iron rod and removed for use, very much in the way that thick treacle may be coiled round the bowl of a spoon. A mass of molten glass, thus collected, is allowed to fall upon a flat iron table, and is pressed into a slab about six inches square and half an inch thick. The slabs are removed to an oven, where they are allowed to cool slowly, and when cool are removed and broken by a hammer or a miniature guillotine into tesseræ or cubes. The fractured edge of the tesseræ is used for the surface of the mosaic.

Gold and Silver Slabs.—The tesseræ containing gold or silver leaf are as impervious to surface corrosions from the effects of atmosphere as the solid colours. The process of manufacturing a gold or silver slab for mosaic work is to spread the metallic leaf on a very thin tray of transparent glass, about five inches in diameter, and after it has been heated to press upon the surface of the leaf a mass of molten glass, so as to create cohesion between the molten glass and the glass tray through the pores of the metallic leaf. The slabs thus formed contain gold, silver, or platinum leaf hermetically imprisoned between two layers of glass. The slabs are cut up into tesseræ or cubes by means of a diamond or glasscutter's wheel. Only one surface can be used for mosaic work.

Tinted Metals.—By using coloured glass for the thin glass trays which form the surface of the metallic slabs a variety of tinted metallic effects are obtained. Moreover, if the glass which is to form the background is coloured, and if the slab after it has been cooled is strongly reheated, the leaf becomes sufficiently disintegrated to allow the colour of the background to show through, with the result that the colour effect of the metallic leaf is modified.

Palette and Tools.—The palette of the mosaic worker is a shallow box with many partitions, each division containing different-coloured tesseræ. The only tools required are clippers, for shaping the tesseræ, and a pointed awl for pricking through the cartoon into the cement the outlines of the design. Although the process and tools are simple, it requires prolonged training of mind, hand, eye, and fingers to enable a workman to create in mosaic a living representation as distinguished from a lifeless copy of the master craftsman's design.

Drawing Directly on the Wall.

Curved Surfaces.—If the mosaicist desires to draw his cartoon directly upon the wall, a necessary procedure where curved surfaces are presented, he goes to work in the following manner. He causes a model to be made to scale, of a dome, semi-dome, or spandrel, and upon it he draws his design with a brush in strong red pigment, having previously squared up the whole surface to scale. This done, he causes the dome, semi-dome, or spandrel to be covered over with thick brown paper. This being attached to the wall with white lead sufficient only to give temporary adhesion, the brown paper is squared up to the scale of the small sketch; each square being relatively numbered. The master then sets his pupils to work to draw mechanically and copy accurately from the small design on to the full-sized dome, semi-dome, or spandrel. This done, the master follows on, correcting with charcoal or brush until the whole design is developed in strong outline. Having made a slightly-coloured sketch, the master with the aid of his pupils proceeds to mix all the tints in water colour, adding colla di pesce or fish glue and a little honey to prevent cracking. He then applies every tint separately, keeping each distinct, and above all minding that the local colours of all half tints are different from the colour of all shadows. This done, he dips his brush in black and draws all the outlines, the thickness of which depends upon the distance which will intervene between his work and the spectator; in order that the black may not appear cold from a distance, he will add to one side of the line a red line, thicker or thinner than the black according to the effect he wishes to produce. It is sometimes effective to add upon the other side of the black line a green line, so that the purple effect of the black and red shall be modified.

Colour.—We now come to the great question of colour and how to obtain it simply, and so that from a distance a blurred and woolly effect is not obtained. There should be a marked and sharp definition between all tints; they should not be *fused*; they should look sharply defined as the squares upon a chessboard, and appear crude and brutal. The work which looks least refined near at hand looks most finished at a distance. Red and blue lines alternately laid, either more red or more blue as the purple is intended to tend towards red or blue, make the best purple. Green is best made with yellow and blue lines, the masses being separated by red lines, and the shadows of green should be red or blue: if red, they should be outlined with blue; if blue, with red. Red should be treated flatly, shaded with a deeper red, which should be of a warmer tone than the lights. Blue should be shaded with blue or red; and it is well to mix green tesseræ with the blue in the lights, and again green tesseræ with the blue or red shades to modify crudity. Pure white should be very sparingly used: it expands greatly at a distance. The best white is that which is of the tone of Naples yellow. Pure white in an atmosphere such as that of England comes to look blue and cold at a distance. Whenever it is necessary, however, to use pure white, either a yellow or pink line should be set on one side of it.

It is impossible to keep the *flesh* too simple. The local colour, *i.e.*, a red orange, is the staple colour. Features should be drawn in strong red or burnt sienna, or a rich brown. The outlines of limbs or the contours of faces should be made first with a green line, a little darker than the local tints, then a red line darker still, then a black or brown line. *White draperies* are capable of being treated with endless variety. Their shadows may be green, red, blue, grey, or yellow. If the white drapery is to take a neutral tone when seen from a distance, all of these tints should be employed, because when mixed those positive colours appear neutral when seen from afar.

Gold drapery has a fine effect. Bright gold expands to four times the width of the line, so that the lines of gold should be thin. It may be that the gold drapery is to appear greenish; when that is desirable the folds should be drawn in green outlined with red. All deep shades should be treated with red and hot browns. As gold expands so considerably, a larger interval should be left between the tesseræ than between any other colour, even white. Each tessera should have a thin space of the ground colour round it. The tesseræ should never be jammed: it is that which causes so many modern mosaics to look like oil-cloth or chromo-lithographs.

The Finished Cartoon.

The finished cartoon, having been coloured in lines, should look exactly like the finished mosaic as regards effect; and the master, in making his cartoon, should always bear in mind that he is designing for mosaic, and not making a finished picture. The cartoon, when complete, is taken off the wall and cut up in pieces. Each piece is then carefully traced. The space upon the wall corresponding to each section is then covered with cement, but only upon that portion of the space which can be worked in mosaic in a day. The mosaic worker then applies the portion of the tracing upon the wet cement, and with a sharp point he pricks through the paper upon the lines thereon drawn; on removing the tracing he will find indents within the surface of the cement, which give him his cue to all the forms. Setting up the coloured design by his side, he takes the tesseræ, which exactly correspond in colour and tone with those on the drawing, and begins his work, commencing from the outline and working inwards towards the centre, the lightest portion being left to the last. Here comes in the real test whether the craftsman is capable or the reverse. This is soon judged by the master, who will put the work in and out until he is satisfied with the result. Unless the master has himself gone through the drudgery of laying the cubes, he can be no teacher. He must be a craftsman as well as a designer, and must know by experience and practice in a very difficult craft what the material can do with ease and what it is not called upon to do by reason of its inherent limitations. If he has not so trained himself he is certain to pictorialize what he should conventionalize, and moreover he will set technical difficulties in the way which are impossible to overcome. He must aim at the greatest simplicity without dulness, at producing the greatest effect by the simplest means, and to do that he must *know his material or fail.*

From what has been said it is evident that all mosaic work should be executed under the eye of the master, and therefore it is ridiculous to send cartoons to Italy to be executed there, transported to England, placed *in situ*, under different conditions of light, under different environment, and under conditions possibly reversed. Mosaic will never take its place as a master craft in England or elsewhere until the master designer is also a craftsman. All mosaics should be executed upon the wall, and not elsewhere; and to be successful the master must give up almost the whole of his time, when he is not designing, to overlooking the work of his pupils, however capable they may be.

These are the principles which the author followed in the work at St Paul's. It is not for him to say anything for or against his own work. But of this he is certain, it was conducted upon a right basis, and not on the wrong and futile method previously employed in England. England can produce as good craftsmen as any other country can do; and if those who have the power would be patient with them, instruct them, encourage them, and work with them, English artists would produce as good work and be as good craftsmen as ever were seen in the best periods of Byzantine or mediæval mosaic designers and craftsmen. (W. B. RI.)

Moscow, a government of central Russia, bounded by Tver on the N.W., Vladimir and Ryazañ on the E., Tula and Kaluga on the S., and Smolensk on the W. Area, 12,859 square miles.

Its geology has been carefully studied, and it appears that in the Tertiary period the surface of this province was already continental; but during the Cretaceous period it was covered to some extent with the sea, which has left its traces in sands, clays, and shales, the organic remains of which testify to the littoral character of these deposits. Jurassic deposits are represented by their upper divisions only; the lower ones, as well as Triassic and Permian deposits, are wanting. The Carboniferous deposits are of a deep-sea origin, and are only represented by the upper division which lies upon Devonian deposits, discovered in an artesian well at Moscow at a depth of 1508 feet. The pendulum anomaly, mentioned already by Schweitzer, has been investigated. It appears in a zone 10 miles wide and about 95 miles long from west to east, and is positive (+10″·6) to the north of Moscow and negative (−2″·7) to the south. The prehistoric archæology of Moscow has been carefully studied. The site of the district has been inhabited since the Stone Age. Bronze implements are rare, and there are places where instruments of stone, bone, and iron are found together. The inhabitants who left the burial mounds in the 10th to 12th centuries seem to have been of Finnish origin, and were poorer, as a rule, than their contemporaries on the Volga.

At the census of 1897 the population was 2,433,356, out of whom 1,208,783 were women, and 1,099,604 lived in towns. In 1899 there were 1,072,600 acres under crops, and the total average annual crop of the period 1895–99 was 5,813,000 cwts. of all grain (rye 3,433,000 cwts., oats 1,985,000 cwts.). The importance of the Moscow government as a manufacturing centre is steadily increasing, and it now stands first in Russia with its aggregate annual production valued at £40,300,000 (in 1896), the next three provinces being St Petersburg (£31,700,000), Piotrków in Poland (£21,600,000), and Vladimir (£17,800,000). The chief factories are for cottons (£13,075,300; 81,936 workers in 299 factories), woollens (£5,607,600), silks (£244,300), clothing (£659,800), sugar refineries (£1,050,400), distilleries (£1,700,000), iron works (£540,000). There is besides a very great variety of smaller industries, such as those concerned in gold thread and gold brocades, gold and silver jewellery, bronze, perfumery, sweets, tobacco, tanneries, gutta-percha, furniture, carriages, wall-paper, &c. In 1894 there were in the secondary schools (excluding Moscow) 61,300 pupils. For primary education there were 913 schools, out of which 13 were of the ministry of education, 591 of the *zemstvo*, 213 of the clergy, and 96 private. The government is divided into 13 districts, the chief towns of which are—Moscow (*q.v.*), Bogorodsk (11,210 inhabitants), Bronnitsy (3837), Dmitroff (4550), Klin (5057), Kolomna (20,970), Mozhaisk (4839), Podolsk (3808), Ruza (2505), Serpukhoff (24,456), Vereya (3704), Volokolamsk (2899), and Zvenigorod (2110). (P. A. K.)

Moscow, the second capital of the Russian Empire and chief town of the government of same name, situated in 55° 45′ N., 37° 37′ E., on both banks of the river Moskva. Its population has been growing since 1870 at the rate of about 2½ per cent. per annum, and was in 1872, 601,969; (1882), 753,469; (1897), 988,614 (1,035,664 with the suburbs). The housing problem is of great importance, as it appears that no less than 7258 lodgings, *i.e.*, over 10 per cent. of the total (occupied by 59,000 persons), are underground. Thus while the average for the city is two occupants to each room, there were more than 10,000 lodgings which had more than four occupants to each room, representing one-fourth of the population. The average mortality is consequently high, namely 28 per 1000 (33 per 1000 if the children inmates of the Foundling House be included). In 1890 there were 9818 industrial establishments giving occupation to 122,445 workers, of whom 14 per cent. were children, 11 per cent. girls above fifteen years of age and women, and 75 per cent. were men and boys above fifteen years. There were besides 15,481 trade establishments, with 10,893 employés.

Moscow still continues the chief industrial centre of Russia, and it is estimated that the yearly returns of the industries alone exceeded, in 1895, £20,000,000. Their character is best seen from the following figures:—

	Number of Establishments.	Number of Workers.
Textiles	753	35,692
Clothing, shodding, laundries	3815	22,391
Metals	1076	10,915
Building	814	10,760
Articles of food	654	9911
Wooden goods	881	8261
Machinery	577	7756
Paper and tanneries	609	7522
Polygraphic trades	181	2497

The importance of Moscow as a centre for trade is steadily growing, and it is estimated that the yearly returns of 15,500 trade establishments amount to £200,000,000; while as a centre for railways the city plays so predominant a part in the traffic, that from one-sixth to one-seventh of all the goods shipped by the railways of European Russia (about 322,000,000 tons) loaded or unloaded at Moscow. No less than 501,000 tons of grain and flour, 26,000 tons of meat, 27,000 tons of fish, 226,000 tons of naphtha and its products, 100,000 tons of coal, and 870,000 tons of fuel wood are imported every year. As to the passenger traffic, it attains every year 6,300,000 passengers entering or leaving. The foreign imports are about 230,000 cwts. of tea, 90,000 cwts. of iron and steel goods, about 200,000 bottles and 330,000 gallons of wine, 55,000 cwts. of drugs, as well as raw cotton, raw wool, and silk. The exports are chiefly manufactured goods, sugar, drugs, &c. Tramways are rapidly developing, the tendency being to municipalize them. There were in 1893, 58 miles of tramways (over 43,000,000 passengers), but there has been considerable development since. The banks, including the mortgage banks, are the most important in Russia. The water-supply has been largely increased, a new supply having been brought from Mytishchi, calculated to yield every day 4,200,000 gallons, but this can be extended so as to provide in the future 9,500,000 gallons. A number of excellent free libraries (Turguéneff's, Ostrovsky's, Tchertkoff's, Galitzyn's) have been opened, the two latter containing valuable collections of books and MSS. The remarkable Tretiakoff gallery of pictures, chiefly of the Russian school (1278), has been given by its owner to the city. A polytechnic containing a museum, a large school of technical drawing, and various museums—technical, decorative art, domestic trades, educational, zoological, antique art, hygienic, municipal economy, and so on—have been opened, and the number of societies for scientific and various other purposes has greatly increased. Of philanthropic institutions, free hospitals, cheap lodgings, and the like there is a great number; they own property valued at £3,000,000, possess an aggregate capital of £4,566,860, and in 1897 gave aid to 437,500 persons. Besides, the municipal relief of the poor was entirely reorganized in 1894, partly on the Elberfeld system and partly on quite new and original lines. The movement for the maintenance and scientific restoration of old church architecture has been of value to some of the antiquities as well as to the revival of the 16th-century Moscow style of building (partly Florentine, or Italian altogether). Several buildings, such as a very handsome new Gostinoi Dvor, in lieu of the old one, have been built in that style, which fully corresponds to the style of the best parts of the Kremlin. A gorgeous monument in memory of Alexander II. has been erected. Moscow has always been a centre for the publication of very cheap books for the peasant class, which are carried about the villages by pedlars. Owing to the efforts of Count Tolstoy and others, a great improvement has been introduced into these publications, books and pictures of a high standard being now circulated at a trifling cost. The importance of the book trade is evident from the fact that during a single year eleven firms issued 3,945,000 copies of 396 of such books, to which about 1,500,000 copies of the Posrednik firm must be added. As to the pictures, about 1,700,000 copies of the best kinds and 4,000,000 of the plainest ones (sold in the villages at half a farthing apiece) are printed at Moscow, and coloured by peasant children in the neighbouring villages. Owing to special conditions of censorship, the periodical press is not so much developed as it is in St Petersburg. There are only 6 daily and 2 illustrated papers, 3 reviews, and 16 periodicals of a general character, while the number of official publications is 9. There are, moreover, 72 scientific and technical periodicals weekly, making a total of 108 periodical publications, as against 304 published in St Petersburg and 1561 in the provinces. (P. A. K.)

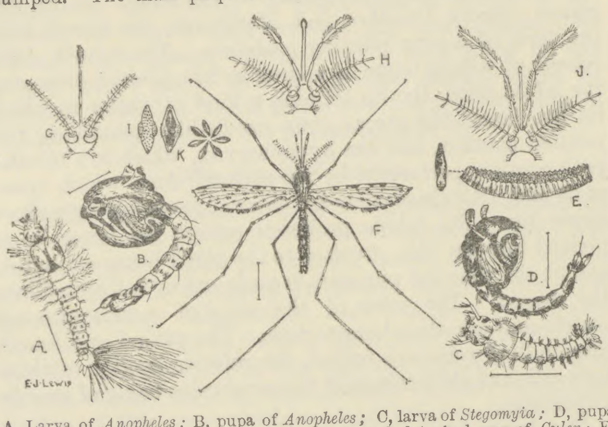
Mosquitoes.—The term "mosquito" is derived from the Spanish diminutive *mosca*—a little fly. A variety of insects comes under the name, the majority belonging to the dipterous family *Culicidæ*. Other insects called mosquitoes are the sand-flies (*Simulidæ*), certain midges belonging to the *Chironomidæ* of the genus *Ceratopogon*, and a few other blood-sucking diptera, such as *Phlebotomus*. True mosquitoes are *Culicidæ*. In that family the wing veins are covered with scales of varied form, and there are also scales on the head, body, and legs; another essential character is that the costal vein is carried right round the border of the wing. In all the genera, except *Corethra* and *Mochlonyx*, the mouth is in the form of a long piercing proboscis. The mouth parts consist of a long lower lip ending in two jointed processes, the labial palpi, the lip forming a kind of gutter in which lie five lancet-like pieces—two needle-like mandibles, two pointed maxillæ, and the hypopharynx, which is a tubular prolongation perforated by the salivary duct, which opens at its end. All these parts are covered above by the narrow upper lip. The whole proboscis except the lower lip is pierced into the skin previous to the blood being extracted, and at the time the puncture is made saliva is injected into the wound. The veins of the wing of a mosquito are scaled, and are also characteristic. The second and fourth longitudinal veins are forked, the relative lengths of these fork-cells and the position of the cross-veins being of specific importance.

The larvæ of mosquitoes are all aquatic, the majority living in still or slightly running fresh water, though some occur in brackish and a few in salt water. The pupæ are also aquatic, and are more or less active. In Europe and North America mosquitoes generally pass the winter as hibernating pregnant females; in tropical climates they go into a semi-hibernating condition during the dry season, when there is little water in which to deposit their eggs. There may be many broods in the year; Professor Howard has counted as many as twelve. Their reproductive powers are strongly developed; according to Ficalbi, one mother may be accountable for a progeny of 50 milliards in the fifth generation. Altitude has no effect upon the *Culicidæ;* some have been found in the Himalaya at 13,000 feet. Distribution takes place mainly by ships and trains, on which these pests are often abundant. The natural agencies of dispersal are very limited, as mosquitoes at once seek shelter from the wind, and the larvæ are seldom plentiful in running water.

In England mosquitoes are called gnats, and in parts of America gallinippers. Many species are undoubtedly normally phytophagous, but the majority of the females, and even a few of the males, are very sanguinary. These sanguinary *Culicidæ* form the true mosquitoes which cause such annoyance by their bites, as well as being carriers of disease. It has been said that blood is necessary for them to produce fertile eggs, but this is evidently erroneous. *Culicidæ* are found in all climates, and although in the tropics they are more troublesome than elsewhere, yet even within the Arctic circle they are often so abundant that they may completely cover the exposed parts of the body until, as described by Nansen whilst in Greenland, the hands look as if covered with rough woollen gloves. One genus at least, *Anopheles*, forms the intermediate host of the *Hæmamœbidæ*, the blood parasites that cause malaria, the gnats acting also as distributors of these germs from person to person. Another disease traced to them by Dr Patrick Manson, Dr Bancroft, and others is filariasis, in which *Culex panoplites* and *Anopheles* are employed (see NEMATODA). Other complaints, such as yellow fever and elephantiasis, are also connected with these insects.

The family *Culicidæ* embraces the following genera:—*Megarrhinus* (Desv), *Anopheles* (Meig), *Cycloleppteron* (Theo), *Psorophora* (Desv), *Mucidus* (Theo), *Stegomyia* (Theo), *Culex* (L.), *Eretmapodites*, *Panoplites*, and *Deinokerites* (Theo), *Tæniorhynchus* (Arri), *Ædes* (Meig), *Hæmagogus* (Will), *Ædeomyia* and *Wyeomyia* (Theo), *Uranotæmia* (Arri), *Trichoprosopon* (Theo), *Sabethes* (Desv), and the two non-piercing-mouthed genera, *Corethra* and *Mochlonyx*.

Those genera which cause most annoyance are *Anopheles*, *Stegomyia*, *Culex*, and *Panoplites* (see Fig.). *Anopheles* are nearly all blood-suckers in the female sex, both sexes having long palpi. Most of them have spotted wings, and when stationary remain with their proboscis and their body in a straight line; they can thus be distinguished from *Culex*, which, when settled, carry the proboscis bent at an angle to the rest of the body and the thorax humped. The male palpi are swollen at the ends, which is not



A, Larva of *Anopheles*; B, pupa of *Anopheles*; C, larva of *Stegomyia*; D, pupa of *Culex*; E, egg-float and further enlarged detached egg of *Culex*; F, female *Anopheles costalis*, Loew; G, head of ♀ *Culex*; H, head of ♂ *Anopheles*; J, head of ♂ *Culex*; K, eggs of *Anopheles*.

usually the case in *Culex* or *Stegomyia*. The larvæ live in all kinds of places, but show a decided preference for small surfaces of water, such as temporary roadside puddles; they cannot live in rapidly-running water, but a few exist in salt waters. They lie almost horizontally in the water, and are grey, green, or brown in colour; there is no respiratory siphon, and on the anal segment are four leaf-like plates. Head, thorax, and abdomen have tufts of many-branched hairs. Their food consists mainly of green algæ and other small water animals, including their own species, and plants. The pupæ have two truncated air-tubes on the thorax, and move about freely in the water. Fifty-five species of *Anopheles* are known, of which nine come from Africa, twenty-three from Asia, five from both North and South America, six from Europe, four from Australia, and four from the West Indies. They seem to be most abundant in India, the Malay Peninsula, West and Central Africa. It is in *Anopheles* alone that Patrick Manson, Ross, Grassi, and others have shown that the malarial parasite can develop. Only certain species (*A. funestus*, *costalis*, *maculipennis*, &c.) seem to act as intermediate hosts, and the probability is that all *Anopheles* do not do so. The malarial parasites are injected into the blood with the mosquito saliva.

Culex is the largest genus of the family, and contains probably more than 200 species; at present some 140 only are known in the restricted genus. The palpi are short in the female, long in the male; the head is covered with narrow-curved and forked-upright scales, the scutellum with narrow-curved scales only. The larvæ live in a variety of places, those of the household mosquitoes usually in water-butts and cisterns, and small receptacles of rain-water; some even in cesspools. A few live in the sea (*C. marinus*, Theo, &c.), others in salt marshes (*C. nemorosus*, variety *salinus*, Fic.). *Culex* larvæ differ from *Anopheles* in having a long respiratory siphon, and in the head being much broader than the rest of the body. When at the surface they hang head downwards, the siphon resting against the water-film; they are very active, and move by a series of jerks. The pupæ have two siphons on the thorax, but they are more cylindrical, and not truncated as in *Anopheles*. Some mosquitoes of this genus have a wide distribution; *Culex fatigans* (Wied) occurs all over tropical, sub-tropical, and warm temperate countries. Members of this genus act as the intermediate hosts of *Filaria Bancroftii*, and also of the *Proteosoma* or blood-parasites of birds (Ross), but so far all experiments with human malaria have failed with them. Some of the most vicious mosquitoes are contained in the genus *Stegomyia*, which is separated from *Culex* on account of the flat head, scales, and scutellar scales. The larvæ apparently have a much shorter and thicker siphon than in *Culex*. One species, *S. fasciata* (Fabr), is almost cosmopolitan, this little black-and-white mosquito being one of the commonest species of the family. Members of other genera also bite, and, as we have said, are connected with certain diseases in man. Those of the genus *Panoplites*, characterized by their broad wing-scales, cause severe irritation, the saliva being distinctly acid; most of these are riverside pests. In the genus *Ædes* both male and female have short palpi. The allied genera are *Ædeomyia*, with broad wing-scales; *Hæmagogus*, with five-jointed palpi; *Sabethes*, with the feet provided with paddle-like tufts in the male sex; and *Uranotænia*, small mosquitoes with very small fork-cells and usually some brilliant scales. The genera *Trichoprosopon* and *Limatus* (Theo) are distinguished by the presence of scales and chætæ on the metanotum, seen in no other Culicidæ. They thus differ from *Wysomyia*, which has only chætæ. (F. V. T.)

Moss, a seaport town of Norway, county of Smaalenene, on the east shore of Christiania Fjord, 37 miles by rail south of Christiania. Here was signed, on 14th August 1814, the convention which united Norway to Sweden. The town was almost destroyed by a fire in 1858, but was promptly rebuilt. The little river Mosse affords motive power for saw-mills, flour mills, iron works, and factories for wood-pulp, rice-busking, bottles and glass, preserves, a distillery, &c. The trade, of the annual value of £300,000 to £400,000, consists chiefly in the export of timber, ice, wood-pulp, grain and flour, and spirits, and in the import of grain and flour (mostly rye from the Black Sea ports), limestone and coal. The port, which affords 13 to 22 feet of water beside the quays, was cleared by 220 vessels of 77,200 tons burden in 1899. Population (1875), 5117; (1891), 8051; (1900), 8941.

Mossamedes, a town of Portuguese West Africa, capital of the district of Mossamedes, on the south side of Little Fish Bay (Bay of Mossamedes or Angra do Negro). It is regularly built, and defended by the fort of São Fernando. It serves as a sanatorium for the province of Angola. Population, 5000. The district of MOSSAMEDES is watered by the rivers Kubango, Kunene, and Kwando, and exports spirits, cotton, india-rubber, coffee, wax, hides, gums, ivory, fish, orchil, and cattle. In 1901 the district was divided—the coast district or Mossamedes, and the inland district or Huilla. The trade increased from £57,000 in 1886 to £146,667 in 1899. Fish is the principal export.

Mossley, municipal borough (1885) and market town in the Prestwich parliamentary division of Lancashire, England, 10 miles east-north-east of Manchester, on the river Tame and the London and North-Western Railway. The new church of St George's has been completed. A mansion which cost £80,000 has been sold to the corporation for the nominal sum of £4000, and is used as the town hall. There are foundries, mill-works, woollen factories, and large cotton-spinning mills. Population (1881), 13,850; (1891), 14,162; (1901), 13,452.

Mostaganem, a town of Algeria, in the department of Oran, chief town of the arrondissement, 44 miles east-north-east of Oran, on a plateau 278 feet high, half a mile from the Mediterranean coast. It has been made the head of a railway line connecting the coast with Tiaret. The surrounding country, laid out in vineyards and orchards, is one of the healthiest and most fertile of the colony. There are seventeen European villages in the district, and in the town are tanneries and peltries. An active trade is carried on in wool, skins, figs, and raisins. Noted Mussulman schools attract numerous students. Wholly an artificial creation, begun in 1888 and not yet finished, the port, notwithstanding the heavy outlay it has cost, promises but mediocre results. The tonnage averages about 70,000 a year. Population (1881), 13,420; (1891), 14,975; (1900), 17,353.

Mostar, the chief town of Herzegovina, Austria-Hungary, and the seat of a Roman Catholic and a Greek bishopric, situated on the Narenta river, and on the railway from Sarajevo to Metkovic, 81 miles south-west of Sarajevo and 27 north of Metkovic. A Government tobacco factory has been established. The Narenta is crossed by an iron bridge, built in 1881, the remarkable old bridge (built by the Turks in 1566, probably on the site of an old Roman bridge) being now used only by foot-passengers. Population (including the garrison), about 14,500.

Mosul.—1. A viláyet of Asiatic Turkey, of which the greater part lies to the east of the Tigris. It is divided into three sanjaks, Mosul, Shehrizor, and Suleimanieh, and has an area of 29,000 square miles. Population, 295,000 (Moslems 245,000, Yezidis 15,000, Christians 30,000, and Jews 5000). The climate is very hot, but healthy. The soil, naturally fertile, is little cultivated. 2. The capital of a viláyet and sanjak of the same name, situated on the right bank of the Tigris. It is now of little industrial or commercial importance, but remains the collecting and distributing centre for the north Mesopotamian desert and Kúrdistán. The exports and most of the imports pass through Baghdad. Mosul is the meeting point of roads from Aleppo, Diarbekr, Bitlis, north and west Persia, and Baghdad, and it is on the projected line of railway from Constantinople to the Persian Gulf. The population amounts to 40,000 (Moslems 31,500, Christians 7000, Jews 1500). The town is the seat of British, French, and Russian consulates.

PARRY. *Six Months in a Syrian Monastery.* 1895.—SACHAU. *Am Euphrat und Tigris.* Berlin, 1899.—VON OPPENHEIM. *Vom Mittelmeer zum Persischen Golf.* Berlin, 1900. (C. W. W.)

Motala, a modern town of Sweden, county of Östergötland, on the east side of Lake Wetter, on the Göta canal and the river Motala, at its exit from the lake, 42 miles west from Norrköping. It was only founded in 1880. Two miles east of the town are the Motala ironworks (1822), the largest in Sweden, with branches in Norrköping, Gothenburg, and other towns, in which iron war-ships, railway locomotives, iron bridges, machinery, &c., are built. Population (1900), 3047.

Motherwell, a police burgh and important railway junction of Lanarkshire, Scotland, near the Clyde, $12\frac{1}{2}$ miles south-east by east of Glasgow by rail. A distinctive modern industry is bridge-building, which is carried on in three large establishments. Among modern erections are a town hall, a new post office, and a hospital. A theatre is about to be built. Electric lighting has been introduced, and it is proposed to spend £120,000 on an additional gravitation water scheme. A park was presented to the town in commemoration of Queen Victoria's jubilee. United Free, Baptist, and Episcopal churches have been erected, also a secondary and technical school. There is, too, a Roman Catholic secondary and technical school. Motherwell has been subject for many years to considerable damage to buildings from the working of the mineral field on which the town is built. Population (1881), 12,904; (1891), 18,736; (1901), 30,243.

Motion, Laws of.—Before the time of Galileo (1564–1642) hardly any attention had been paid to a scientific study of the motions of terrestrial bodies. With regard to celestial bodies, however, the case was different. The regularity of their diurnal revolutions could not escape notice, and a good deal was known more than 2000 years ago about the motions of the sun and moon and planets among the stars. For the statement of the motions of these bodies uniform motion in a circle was employed as a fundamental type, combinations of motions of this type being constructed to fit the observations. This procedure did not afford any law connecting the motions of different bodies. Copernicus (1473–1543) employed the same system, and greatly simplified the application of it, especially by regarding the earth as rotating and the sun as the centre of the solar system. Kepler (1571–1630) was led by his study of the planetary motions to reject this method of statement as inadequate, and it is in fact incapable of giving a complete representation of the motions in question. In 1609 and 1619 Kepler published his new laws of planetary motion, which were subsequently shown by Newton to agree with the results obtained by experiment for the motion of terrestrial bodies.

Acceleration of gravity.

The earliest recorded systematic experiments as to the motion of falling bodies were made by Galileo at Pisa in the latter years of the 16th century. Bodies of different substances were employed, and slight differences in their behaviour accounted for by the resistance of the air. The result obtained was that any body allowed to fall from rest would, in a vacuum, move relatively to the earth with constant acceleration; that is to say, would move in a straight line, in such a manner that its velocity would increase by equal amounts in any two equal times. This result is very nearly correct, the deviations being so small as to be almost beyond the reach of direct measurement. It has since been discovered, however, that the magnitude of the acceleration in question is not exactly the same at different places on the earth, the range of variation amounting to about $\frac{1}{2}$ per cent. Galileo proceeded to measure the motion of a body on a smooth, fixed, inclined plane, and found that the law of constant acceleration along the line of slope of the plane still held, the acceleration decreasing in magnitude as the angle of inclination was reduced; and he inferred that a body, moving on a smooth horizontal plane, would move with uniform velocity in a straight line if the resistance of the air, and friction due to contact with the plane, could be eliminated. He went on to deal with the case of projectiles, and was led to the conclusion that the motion in this case could be regarded as the result of superposing a horizontal motion with uniform velocity and a vertical motion with constant acceleration, identical with that of a merely falling body; the inference being that the path of a projectile would be a parabola except for deviations attributed to contact with the air, and that in a vacuum this path would be accurately followed. The method of superposition of two motions may be illustrated by such examples as that of a body dropped from the mast of a ship moving at uniform speed; and in this case it is found that the body falls relatively to the ship as if the latter were at rest, and alights at the foot of the mast, having consequently pursued a parabolic path relatively to the earth.

The importance of these results, limited though their scope was, can hardly be overrated. They had practically the effect of suggesting an entirely new view of the subject, namely, that a body uninfluenced by other matter might be expected to move, relatively to some base or other, with uniform velocity in a straight line; and that, when it does not move in this way, its acceleration is the feature of its motion which the surrounding conditions determine. The acceleration of a falling body is naturally attributed to the presence of the earth; and, though the body approaches the earth in the course of its fall, it is easily recognized that the conditions under which it moves are only very slightly affected by this approach. Moreover, Galileo recognized, to some extent at any rate, the principle of simple superposition of velocities and accelerations, due to different sets of circumstances, when these are superposed (see MECHANICS, *Ency. Brit.* vol. xv.). The results thus obtained apply to the motion of a small body, the rotation of which is disregarded; and, our first notions being derived from this case, the motion of any system is dealt with by regarding it as built up of small portions. Such portions, small enough for the position and motion of each to be sufficiently specified by those of a point, are called "particles." Other forms of experiment can readily be arranged to test, with regard to terrestrial motions, the correspondence of constant acceleration to constant conditions, and the principle of superposition.

The period immediately succeeding that of Galileo's work and teaching was not very fruitful in results. Descartes helped to generalize and establish the notion of the fundamental character of uniform motion in a straight line, but otherwise his speculations did not point in the direction of sound progress in dynamics; and the next substantial advance that was made in the principles of the subject was due to Huygens (1629–95). He attained correct views as to the character of centrifugal force in connexion with Galileo's theory; and, when the fact of the variation of gravity (Galileo's acceleration) in different latitudes first became known from the results of pendulum experiments, he at once perceived the possibility of connecting such a variation with the fact of the earth's diurnal rotation relatively to the stars. He made experiments, simultaneously with Wallis and Wren, on the collision of hard spherical bodies, and his statement of the results (1669) included a clear enunciation of the conservation of linear momentum, as demonstrated for these cases of collision, and apparently correct in certain other cases, mass being estimated by weight. But Huygens's most important contribution to the subject was his investigation, published in 1673, of the motion of a rigid pendulum of any form. This is the earliest example of a theoretical investigation of the rotation of rigid bodies. It involved the adoption of a point of view as to the relation between the motions of bodies of different forms, which practically amounted to a perception of the principle of energy as applied to the case in question.

Centrifugal force.

We owe to Newton (1642–1727) the consolidation of the views which were current in his time into one coherent and universal system, sometimes called the Galileo-Newton theory, but commonly known as the "laws of motion"; and the demonstration of the fact that the motions of the celestial bodies could be included in this theory by means of the law of universal gravitation. A full account of his results was first published in the *Principia* in 1687. (For Newton's formal statement of laws of motion see *Ency. Brit.* vol. xv. p. 676; this should be read in conjunction with the introduction and explanations given in the *Principia.*)

Galileo-Newton theory.

Such statements as that a body moves in a straight line, and that it has a certain velocity, have no meaning unless the base, relative to which the motion is to be reckoned, is defined. Accordingly, in the extension of Galileo's results for the purpose of a universal theory the establishment of a suitable base of reference is the first step to be taken. Newton assumed the possibility of choosing a base such that relatively to it the motion of any particle would have only such divergence from uniform velocity in a straight line as could be expressed by laws of acceleration dependent on its relation to other bodies. He used the term "absolute motion" for motion relative to such a base. Many writers on the subject distinguish such a base as "fixed." It is sometimes convenient to apply to the base in question a name of a more specific character. The name "Newtonian base" will serve this purpose. Assuming such a base to exist, Newton admitted at the outset the difficulty of identifying it, but pointed out that the key to the situation might be found in the identification of forces; that is to say, in the mutual character of laws of acceleration. In this connexion he took an important step by distinguishing clearly the character of "mass" as a universal property of bodies distinct from weight.

There can be no doubt that the development of correct views as to mass was closely connected with the results of experiments with regard to the collision of hard bodies. Suppose two small spherical bodies which can be regarded as particles to be brought into collision, so that the velocity of each, relative to any base which is unaffected by the collision, is suddenly changed. The additions of velocity which the two bodies receive respectively, relative to such a base, are in opposite directions, and if the bodies are alike their magnitudes are equal. If the bodies though of the same substance are of different sizes, the magnitudes of the additions of velocity are found to be inversely proportional to the volumes of the two bodies. But if the bodies are of different substances, say one of iron and the other of gold, the ratio of these magnitudes is found to depend upon something else besides bulk. A given volume of gold is found to count for this purpose for about two and a half times as much as the same volume of iron. This is expressed by saying that the density of gold is about two and a half times that of iron. In fact, experiments upon the changes of velocity of bodies, due to a mutual influence between them, bring to light a property of bodies which may be specified by a quantity proportional to their volumes in the case of bodies which are perceived by other tests to be of one homogeneous substance, but otherwise involving also another factor.

The product of the volume and density of a body measures what is called its "mass." The mass of a body is often loosely defined as the measure of the quantity of matter in it. This definition correctly indicates that the mass of any portion of matter is equal to the sum of the masses of its parts, and that the masses of bodies alike in other respects are equal, but gives no test for comparison of the masses of bodies of different substances; this test is supplied only by a comparison of motions. When, as in the case of contact, a mutual relation is perceived between the motions of two particles, the changes of velocity, or when gradual changes of velocity are in question, the accelerations, are in opposite directions, and the ratio of their magnitudes determines the ratio of the masses of the particles, the motion being reckoned relative to any base which is unaffected by the change. It is found that this gives a consistent result; that is to say, if by an experiment with two particles A and B we get the ratio of their masses, and by an experiment with B and a third particle C we get the ratio of the masses of B and C, and thus the ratio of the masses of A and C, we should get the same ratio by a direct experiment with A and C. For the numerical measure of mass that of some standard body is chosen as a unit, and the masses of other bodies are obtained by comparison with this. Masses of terrestrial bodies are generally compared by weighing; this is found by experiment to give a correct result, but it is applicable only in the neighbourhood of the earth. Familiar cases can readily be found of the perception of the mass of bodies, independently of their tendency to fall towards the earth. The mass of any portion of matter is found to be permanent under chemical and other changes, and this fact adds to its importance as a physical quantity. Minute variations may possibly occur, but none has been established.

The Galileo-Newton theory of motion is that, relative to a suitably chosen base, and with suitable assignments of mass, all accelerations of particles are made up of mutual, so called, actions between pairs of particles, whereby the two particles forming the pair have accelerations in opposite directions in the line joining them, of magnitudes inversely proportional to their masses. Thus the product of mass and magnitude of acceleration is the same for each. The mutual action between two particles is otherwise expressed by saying that a force acts upon each of them, in the line joining it to the other, each force being measured by the product of mass and acceleration; so that pairs of forces are equal and opposite. Thus the total acceleration of any particle is that given by the superposition of the accelerations due to the several forces which act upon it. An equivalent operation is to compound the several forces acting on a particle by the parallelogram law (see MECHANICS) into what may be called the resultant force, the total acceleration of the particle being the same as if this alone acted.

Application of the theory.

To apply and verify the theory, we depend on being able to identify and classify forces. They are recognized by their reciprocal character, and it is found possible to establish permanent laws connecting the forces in any system with its configuration and other recognizable characteristics. A generalization of Galileo's results takes the form that under constant conditions of this character force is constant, and that the superposition of two sets of conditions, if their independence can be secured, results in superposition of the forces associated with them separately. The association of forces with the conditions of their occurrence causes some confusion of nomenclature. It is possible to regard specified physical conditions or a certain configuration, such as strain in a case of contact, as providing a definition of force of a certain type; to deduce other types by reference to their neutralizing effect; and to regard the expression in terms of acceleration as an experimental result. Such a course is sometimes followed, and within a limited range of application to terrestrial mechanics it is a natural procedure; but for the purpose of a universal theory it is difficult to maintain this point of view consistently, and the definition of force in terms of motion is usually adopted by modern writers as being logically the more convenient. Particular laws of force may be suggested by a study of the simplest cases in which they are manifested, and from them results may be obtained by calculation as to the motions of systems of any given structure. Such results may be tested by direct observation. For the calculation of the motion of any body which is known to be perfectly rigid, no knowledge of the forces between particles composing the body is needed, beyond the fact that they neutralize any tendency to change of shape.

Gravitation.

Newton's law of gravitation affords the most notable example of the process of verification of a law of force, and incidentally of the Galileo-Newton theory. As a law of acceleration of the planets relatively to the sun, its approximate agreement with Kepler's third law of planetary motion follows readily from a consideration of the character of the acceleration of a point moving uniformly in a circle. Newton tells us that this agreement led him to adopt the law of the inverse square of the distance about 1665–66, before Huygens's results as to circular motion had been published. At the same time he thought of the possibility of terrestrial gravity extending to the moon, and made a calculation with regard to it. Some years later he succeeded in showing that Kepler's elliptic orbit for planetary motion agreed with the assumed law of attraction; he also completed the co-ordination with terrestrial gravity by his investigation of the attractions of homogeneous spherical bodies. Finally, he made substantial progress with more exact calculations of the motions of the solar system, especially for the case of the moon. The work of translating the law of gravitation into the form of astronomical tables, and the comparison of these with observations, has been in progress ever since. It has involved great labour and refinement of calculation, and is not yet completed. The verification is sufficiently exact to establish the law of gravitation, as providing a statement of the motions of the bodies in question which is correct to a high degree of accuracy. In the meantime some confirmation of the law has been obtained from terrestrial experiments, and observations of double stars tend to indicate for it a wider if not universal range. It should be noticed that the verification was begun without any data as to the masses of the celestial bodies, these being selected and adjusted to fit the observations. It may be mentioned that another factor has been introduced into the problem of the motions of these bodies by the recognition of the effects of their imperfect rigidity.

The case of electromagnetic forces between two conductors carrying electric currents affords an example of a statement of motion in terms of force of a highly artificial kind. It can only be contrived by means of complicated mathematical analysis, and the question of its correspondence with any actual division of the conductors into particles is a difficult one. In this connexion a statement in terms of force is apt to be displaced by more direct and more comprehensive methods, and the attention of physicists is chiefly directed to the intervention of the ether. In fact, the study of this part of the subject leads us to look upon the universal statement of motion in terms of force as really only a provisional one, to be employed in default of more intimate knowledge of the connexions between material systems. It is worth noting that there are indications of this having been Newton's own opinion.

Newtonian base.

The Newtonian base deserves some further consideration. It is defined by the property that relative to it all accelerations of particles correspond to forces. This test involves only changes of velocity, and so does not distinguish between two bases, each of which moves relatively to the other with uniform velocity without rotation. The establishment of a true Newtonian base presumes knowledge of the motions of all bodies. But practically we are always dealing with limited systems, so any actual determination must always be regarded as to some extent provisional. In the treatment of the relative motions of a limited system, we may use a confessedly provisional base, though it may be necessary to introduce corrections, either exact or approximate, to take account either of the existence of bodies outside the system, or of the rotation of the base employed relative to a more correct one. Such corrections may be made by the device of applying additional unpaired, or what we may call external, forces to particles of the system. These have only to take account of differences of accelerations of the several particles. The earth, which is commonly employed as a base for terrestrial motions, is not a very close approximation to being a Newtonian base. Differences of acceleration due to the sun and moon are not important for terrestrial systems on a small scale, and can usually be ignored, but their effect (in combination with the rotation of the earth) is very apparent in the case of the ocean tides. A much more sensible defect is due to the earth having a diurnal rotation relative to a Newtonian base, and this is never wholly ignored. Take a base attached to the centre of the earth, but without this diurnal rotation. A small body hanging by a string, at rest relatively to the earth, moves relatively to this base uniformly in a circle; that is to say, with constant acceleration directed towards the earth's axis. What is done is to divide gravitation into two components; one of these then corresponds to this acceleration, and the other one is what is called the "weight" of the body. Weight is in fact the force which corresponds to the Galileo acceleration with which the body would begin to move relatively to the earth if the string were cut. Another way of stating the same thing is to say that we introduce, as a correction for the earth's rotation, a force called "centrifugal force" which, combined with gravitation, gives the weight of the body. It is not, however, a true force in the sense of corresponding to any mutual relation between two portions of matter. The effect of centrifugal force is to make the weight of a body at the equator about ·35 per cent. less than the value it would have if due to gravitation alone. This represents about two-thirds of the total variation of Galileo's acceleration between the equator and the poles, the balance being due to the ellipticity of the figure of the earth. In the case of a body moving relatively to the earth, the introduction of centrifugal force only partially corrects the effect of the earth's rotation. Newton called attention to the fact that a falling body moves in a curve, diverging slightly from the plumb-line vertical. The divergence in a fall of 100 feet in the latitude of Greenwich is about one-eleventh of an inch. Foucault's pendulum is another example of motion relative to the earth which exhibits the fact that the earth is not a Newtonian base.

For the study of the relative motions of the solar system, a provisional base established for that system by itself, bodies outside it being disregarded, is a very good one. No correction for any defect in it has been found necessary; moreover, no rotation of the base relative to the directions of the stars without proper motion has been detected. This is not inconsistent with the law of gravitation, for such estimates as have been made of planetary perturbations due to stars give results which are insignificant in comparison with quantities at present measurable. Our knowledge of motions of the stars and of the solar system relative to them is rather scanty, but is not inconsistent with the view that the theory may be applicable throughout the whole extent of the known universe. It is natural to suppose that the Newtonian base has a relation to the ether, which is the vehicle of electrical and optical phenomena, but this is a question which has not yet emerged from the region of speculation.

Measurement of time.

For the measurement of motion it must be presumed that we have a method of measuring time. The question of the standard to be employed for the scientific measurement of time accordingly demands attention. Galileo measured time for the purpose of his experiments by the flow of water through a small hole under approximately constant conditions, which was of course a very old method. He had, however, some years before, when he was a medical student, noticed the apparent regularity of successive swings of a pendulum, and devised an instrument for measuring, by means of a pendulum, such short periods of time as sufficed for testing the pulse of a patient. The use of the pendulum clock in its present form appears to date from the construction of such a clock by Huygens in 1657. Newton dealt with the question at the beginning of the *Principia*, distinguishing what he called "absolute time" from such measures of time as would be afforded by any particular examples of motion; but he did not give any clear definition. The selection of a standard may be regarded as a matter of arbitrary choice; that is to say, it would be possible to use any continuous time-measurer, and to adapt all scientific results to it. It is of the utmost importance, however, to make, if possible, such a choice of a standard as shall render it unnecessary to date all results which have any relation to time. Such a choice is practically made. It can be put into the form of a definition by saying that two periods of time are equal in which two physical operations, of whatever character, take place, which are identical in all respects except as regards lapse of time. The validity of this definition depends on the assumption that operations of different kinds all agree in giving the same measure of time, such allowances as experience dictates being made for changing conditions. This assumption has successfully stood all tests to which it has been subjected. All clocks are constructed on the basis of this method of measurement; that is to say, on the plan of counting the repetitions of some operation, adopted solely on the ground of its being capable of continual repetition with a certain degree of accuracy, and possibly also of automatic compensation for changing conditions. Practically clocks are regulated by reference to the diurnal rotation of the earth relatively to the stars, which affords a measurement on the repetition principle, agreeing with other methods, but more accurate than that given by any existing clock. We have, however, good reasons for regarding it as not absolutely perfect, and there are some astronomical data the tendency of which is to confirm this view.

Theory of energy.

The most important extension of the principles of the subject since Newton's time is to be found in the development of the theory of energy, the chief value of which lies in the fact that it has supplied a measurable link connecting the motions of systems, the structure of which can be directly observed, with physical and chemical phenomena having to do with motions which cannot be traced in detail. The importance of a study of the changes of the *vis viva* depending on squares of velocities, or what is now called the "kinetic energy" of a system, was recognized in Newton's time, especially by Leibnitz; and it was perceived (at any rate for special cases) that an increase in this quantity in the course of any motion of the system was otherwise expressible by what we now call the "work" done by the forces. The mathematical treatment of the subject from this point of view by Lagrange (1736–1813) and others has afforded the most important statements of the theory of the motion of a system that are available for practical use. But it is to the physicists of the 19th century, and especially to Joule, whose experimental results were published in 1843–49, that we practically owe the most notable advance that has been made in the development of the subject, namely, the establishment of the principle of the conservation of energy (see ENERGETICS, *Ency. Brit.* vol. xxviii.; also ENERGY, vol. viii.). The energy of a system is the measure of its capacity for doing work, on the assumption of suitable connexions with other systems. When the motion of a body is checked by a spring, its kinetic energy being destroyed, the spring, if perfectly elastic, is capable of restoring the motion; but if it is checked by friction no such restoration can be immediately effected. It has, however, been shown that, just as the compressed spring has a capacity for doing work by virtue of its configuration, so in the case of the friction there is a physical effect produced, namely the raising of the temperature of the bodies in contact, which is the mark of a capacity (in the sense in which the word is used) for doing the same amount of work. Electrical and chemical effects afford similar examples. Here we get the link with physics and chemistry alluded to above, which is obtained by the recognition of new forms of energy, interchangeable with what may be called mechanical energy or that associated with sensible motions and changes of configuration.

Having identified forms of energy other than mechanical, we can attempt to apply to physics and chemistry, or, as we may say, to molecular systems and the ether, not only the principle of conservation of energy, but also other relations connecting changes of energy of various types with the characteristics of a system. In this way the 19th century saw the first steps taken towards the carrying out of work which Newton bequeathed to his successors in the concluding sentences of the *Principia*.

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(W. H. M.)

MOTOR VEHICLES.

I. LIGHT VEHICLES.

MOTOR-CAR is a term primarily employed in America to denote the car or carriage containing the electromotor used for propelling an electric tramcar or train of carriages on rails, but of late years more usually applied in Great Britain to light automobile or mechanically-propelled carriages running on common roads. On the Continent of Europe and in the United States the usual expression for these vehicles is "automobile"; the term "autocar" has also been employed.

The first practical steam carriage was made by Richard Trevethick in 1802 (Fig. 1), though Cugnot had produced a rudimentary

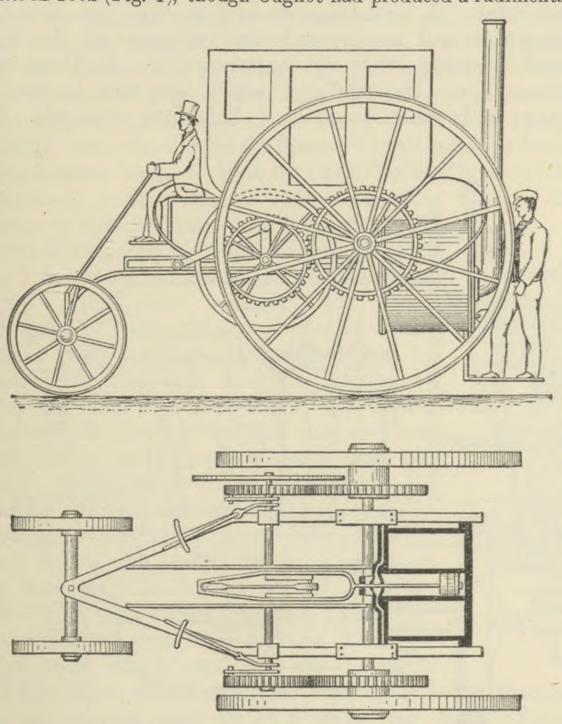


FIG. 1.—Trevethick's Steam Carriage: Side View and Plan.

one in France in 1769; but very little was done in this direction until 1824, from which date a number of these vehicles were constructed and used with considerable success, taking the form of stage coaches propelled by steam, and weighing some 3 or 4 tons unloaded. Among the most successful of steam-carriage designers at this time were James, Gurney, Dance, Hancock, Maceroni and Squire, Somers and Ogle, Church, Hill, and Scott-Russell, all of whose vehicles proved practicable to some extent. Some of these ran regular passenger services, notably between Cheltenham and Gloucester, attaining average speeds of 10 to 14 miles per hour; but great opposition was met with owing to the narrow prejudice of those whose interests related to horse-haulage, and every obstruction was offered in the shape of prohibitive tolls and legislative enactments. The result was that steam carriages were driven off the roads in favour of railways, although the select committee of the House of Commons appointed in 1831 to inquire into the subject reported completely in favour of their adoption (as did also that of 1873). In 1861 the first Locomotives on Highways Act was passed, but the crushing blow came in 1865, when the Legislature prescribed (1) that the number of persons required to drive the locomotive should be increased to three; (2) that a man should precede with a red flag; (3) that the maximum limit of speed should be reduced to 4 miles per hour; and (4) that they should be forbidden ever to blow off steam, &c. These restrictions were confirmed rather than relieved by the 1878 Act. Although these Acts were created to deal with heavy traction, the famous 1881 appeal in the Court of Queen's Bench placed every type of self-propelled vehicle, from a traction engine down to Bateman's steam tricycle, under their narrow limitations.

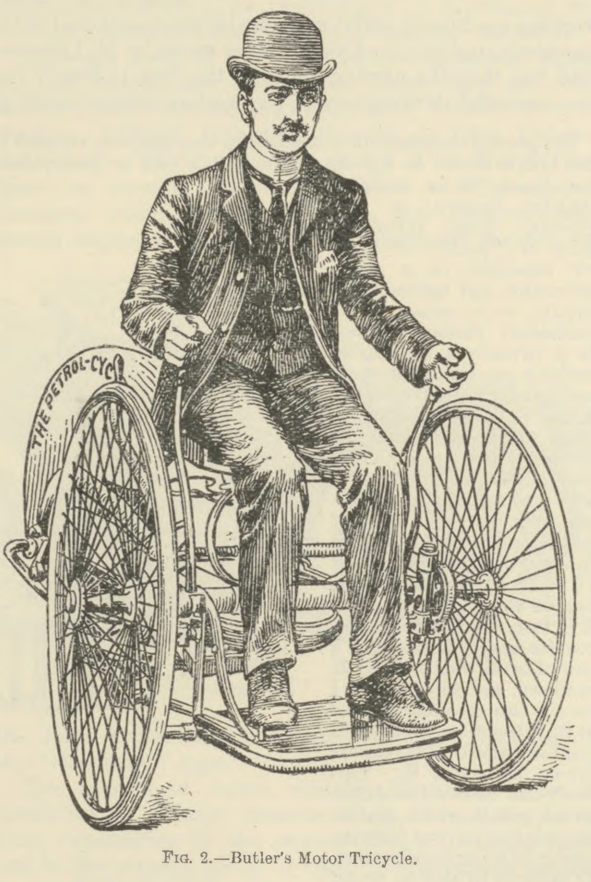


FIG. 2.—Butler's Motor Tricycle.

This resulted in the development of the heavy traction engine, and light motor vehicles were little more heard of in Great Britain. There were a few exceptions, however, notably the steam vehicles of Rickett (1860), Carrett (1861), Tangye (1862), Yarrow (1862), Holt (1866), Todd (1870), Perkins (1870), Mackenzie (1875), and Blackburn (1878), and some electrical carriages made by Elwell (1884), Ward (1886), and Volk (1888). An important departure was that of Butler, who constructed in 1885 what is believed to be the first vehicle (a tricycle) propelled by an internal combustion engine in England (Fig. 2); he used the vapour of benzoline exploded electrically. Later, Roots successfully employed heavy oil, as did Knight. The chief prohibitory clauses of the Acts were repealed in 1896, when public interest revived, and Great Britain, in spite of its early exploits in mechanical traction, found that it was completely left behind by other countries, such as France, Germany, and America, whose engineers had been handicapped by no such restrictions.

France has undoubtedly led in the development of the light automobile vehicle, though it is right to mention that the most successful vehicles used there derive their power from a petroleum spirit motor invented by a German, Herr Gottlieb Daimler, who made numerous vehicles, commencing with a bicycle fitted with this motor (Fig. 3) in 1885. He disposed of his French patents to the firm of MM. Panhard and Levassor, who were well-known makers of wood-working machinery, and it may here be mentioned that to the ingenious application of the Daimler motor by M. Levassor, who was then the moving spirit of the firm, is largely due the successful development of the modern motor industry.

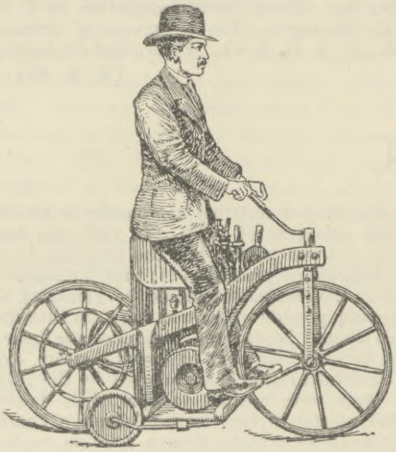


FIG. 3.—Early Daimler Motor Bicycle.

The general arrangement of mechanism that has been adopted by this firm is shown in Fig. 4. The motor, a two- or four-cylinder "equipoise," is a modified Daimler, known as the Phœnix, using petroleum spirit or "petrol" of sp.g 0·7 vaporized in a spray carburator and ignited electrically, or by means of incandescent platinum tubes It is virtually a gas engine working on the Otto cycle and making its own gas from petrol. It is situated in front, and transmits its power by means of a friction cone A, working into the fly-wheel, to one of the changeable spur wheels B^1 B^2 B^3 B^4 on the square shaft C, thence to one of the fixed spur wheels D^1 D^2 D^3 D^4 on the second-motion shaft E. This shaft E in turn drives a transverse counter-shaft I through a pair of bevel wheels F and H as shown, and counter-shaft I carries two sprocket pinions at its extremities, from which the back wheels of the car are driven by chains K. This shaft also carries the differential gear G, which enables its ends to revolve at different speeds for going round corners. In order to be able to propel the carriage backwards, a reversing motion is introduced consisting of two intermediate spur wheels RR^1 carried on a separate shaft L. When it is desired to go astern the sleeve carrying the spur wheels B^1 B^2 B^3 B^4 is moved along the shaft C into a position such that the wheel B^1 engages with R, and R^1 with the spur wheel D^1; this causes the shaft E—and consequently the back wheels of the car—to rotate in the opposite direction. The four pairs of spur wheels (which run in oil) allow of four ratios of gearing which are interchangeable whilst running, according to the power required, the friction clutch being relieved by the foot at each change of gear. There is also a pedal for regulating the speed of the motor, and a powerful foot-brake, acting on the counter-shaft, besides two band brakes on the back wheels actuated by a lever. The steering is effected by a wheel with worm gear, and the carriage can be steered at high speed with one hand. These vehicles are nearly always fitted with pneumatic tyres, and many have ball or roller bearings, and electrical as well as tube ignition.

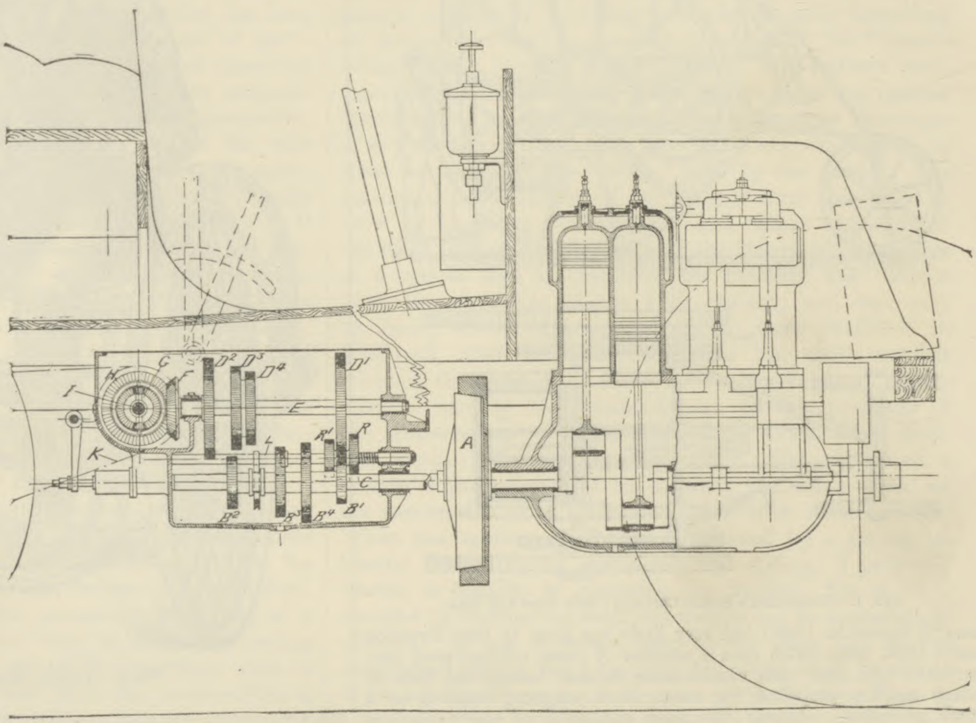


FIG. 4.—Mechanism of Panhard and Levassor Motor Cars.

A great impulse was given to the French industry by the organization by the *Petit Journal* of a trial run of automobile vehicles from Paris to Rouen in 1894. This was followed next year by a race from Paris to Bordeaux and back, in which £2500 in prizes was awarded, mostly to MM. Panhard and Levassor, and MM. Peugeot Frères. The first carriage was driven by M. Levassor, and performed the journey of 744 miles in one trip, without a break-down, and at a mean velocity of 15 miles per hour. A still more important race was held in 1896, the course being from Paris to Marseilles and back. It was organized by the Automobile Club of France, a society founded in that year upon the initiative of the count de Dion and baron de Zuylen, for the furtherance and encouragement of automobile locomotion: its membership grew in three and a half years to some 2000, and it is now one of the leading institutions in France. The race was 1060 miles in length, and was run under most adverse conditions of weather; the winning carriage by Panhard and Levassor nevertheless made an average speed of 15·85 miles per hour, and was followed by two others of the same house, while the Delahaye and Peugeot carriages did good work. A prominent feature of this race was the remarkable and unexpected performances of the new petrol tricycles (Fig. 5) constructed by de Dion and Bouton, some thousands of which are now in use in France and other countries. This firm were also the builders of three steam vehicles which attempted the race, but did not get through. This and the Paris–Bordeaux race in fact established the triumph of petrol (*i.e.*, petroleum spirit) for long distances over steam, which only seems to have gained first place on two occasions, viz., the Concours du *Petit Journal* in 1894, and the Marseilles–Nice–Turbie race in January 1897, when a de Dion brake covered the rough and hilly route of 145 miles in $7\frac{3}{4}$ hours. This vehicle, however, was very heavy, and no successful attempt seems to have been made in France to construct a light steam vehicle except

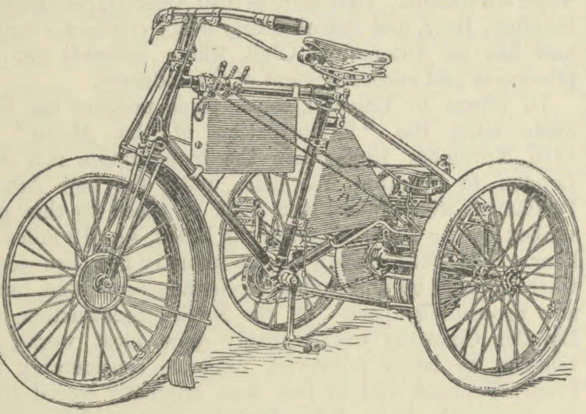


FIG. 5.—De Dion and Bouton Petrol Tricycle.

by M. Serpollet, whose "flash" generators are extensively used on tramways.

The speeds attained continued to increase. In 1897 the Paris–Dieppe and Paris–Trouville races showed an average of 26 miles per hour. In the Paris–Amsterdam race (1898), Charron, on an 8-h.p. Panhard carriage, kept up a mean speed of 28 miles an hour, and in 1899 he won the Paris to Bordeaux race on a 12-h.p. vehicle of the same make, covering the 350 miles in 11 hours 43 minutes without a stop. In the same year was held the longest motor race up to the present time (August 1902)—viz., the "Tour de France," 1440 miles in length, the distance being covered by Chevalier de Knyff (16-h.p. Panhard) in 42 hours 33 minutes running time. Other races of that year were the Paris–St Malo (200 miles), won by Antony's 16-h.p. Mors in 7 hours 32 minutes; the Paris–Ostend (204 miles), the winning cars being Girardot's Panhard and Levegh's Mors (tie); Paris–Boulogne (143 miles), won by Girardot's Panhard; and the Bordeaux–Biarritz, won by Levegh's 16-h.p. Mors. In 1900 de Knyff in the Pau–Bayonne race attained a mean speed of 43·4 miles per hour, the distance being 208 miles. He used a Panhard machine of 20 h.p. similar to Fig. 6, but fitted with a "racing" body; and during one part of the race he is said to have done $34\frac{1}{2}$ miles in $33\frac{1}{2}$ minutes. The most important race of this year, however, was that from Paris to Toulouse and back, which was won by Levegh's 24-h.p. Mors, the distance of 836 miles being traversed at an average rate of 42·7 miles per hour. Levegh in the same year was also credited with an average of 51 miles an hour from Bordeaux to Périgueux; the distance, however, was short, viz., 72 miles.

In 1901 the racing season in France was characterized by two important events, namely, the Paris–Bordeaux and the international race from Paris to Berlin, for which prizes were offered by the German emperor, President Loubet, and the king of the Belgians. The first of these races was won by Fournier on a Mors vehicle of about 60 horse-power. Fournier made an average speed of 53 miles an hour to Bordeaux—a distance (after deducting the neutralized sections) of 328 miles, his fastest-timed piece being $17\frac{1}{2}$ miles in 15 minutes; and from Paris to Berlin he covered a distance of 686 miles at a mean velocity of over 44 miles per hour, excluding 63 miles of "controls," or towns and villages through which each competitor has to follow a cyclist at 6 or 8 miles an hour in order to ensure the safety of the public and effectually prevent any attempt at racing through crowded places. The latter event was one which put the vehicles to an extremely severe test, owing to the roughness of the road throughout the greater portion of the journey. In 1902 the French Government commenced making strenuous efforts to encourage amongst agriculturists the manufacture of denaturalized alcohol as a substitute for petroleum spirit, and to this end a race—known as the "Circuit du Nord"—was organized by the Minister of Agriculture, in which the fuel used had to contain at least 50 per cent. of common vegetable alcohol. The course was $571\frac{1}{2}$ miles in length, and was covered by Farman, the winner, on a Panhard machine in about 12 hours. The big event of the year, however, was the race from Paris to Vienna, which was won by Renault's 16-h.p. "voiturette." Deducting the Swiss portion of the route (which was neutralized), the distance was 615 miles, which was accomplished in 15 hours 48 minutes—running time. Seventy-seven per cent. of the starters arrived at Vienna; and, considering the dangerous character of the route—its many steep and tortuous descents—this and the race from Paris to Berlin afford striking illustrations of the advance that has been made in the perfecting of the mechanical road carriage since the commencement of this new industry.

Although most of the big races have been won by the cars of Panhard and Levassor, or Mors, there are other makers whose vehicles are widely used, notably Peugeot, Dietrich, Richard, Delahaye, Renault, de Dion, Darracq, and others. The transmission system of the Peugeot and Mors is virtually the same as that of Panhard and Levassor, while Dietrich, Richard, and Delahaye have mostly employed belt-driving and horizontal engines, and

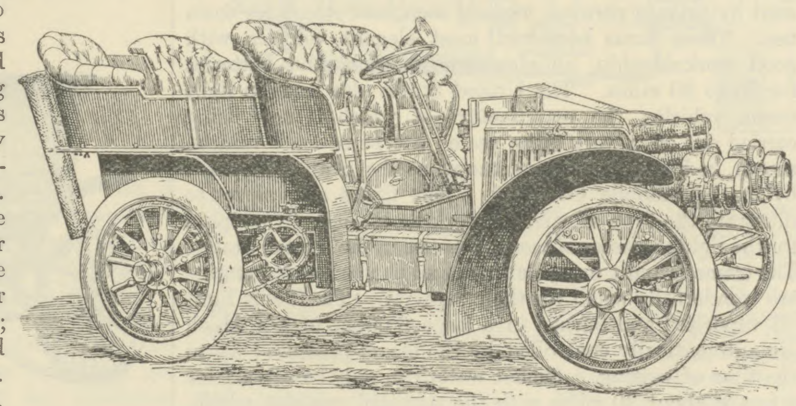


FIG. 6.—Panhard Car.

the three firms last named are makers of light cars of the "voiturette" type.

The success of motor vehicles in France may be attributed in a large measure to the demonstration of their capabilities by the organization of frequent races, and to the support given to these by the various authorities and the public, who at once saw the advantages of the new means of locomotion. Whatever may be said to the contrary, these races and the experience thereby gained have undoubtedly brought out the weak points, have induced makers to construct machines of the very best material and workmanship, and have enabled them to produce a wonderful combination of speed, durability, lightness, and strength—a state of perfection that would otherwise scarcely be existent. Hence the importance attached to these periodical contests in the preceding remarks.

In America the first important developments in automobiles were inaugurated by the *Times-Herald* contest in November 1895, in which the tractive power and consumption of fuel were considered. There was deep snow on the ground, and the results achieved were hardly successful, though the Mueller and Duryea cars figured prominently. The latter, together with the Winton (which represented America in the Gordon Bennett Cup race of 1900), are amongst the best-known vehicles propelled by gasolene in the United States. Duryea employs a well-balanced engine, and the speed changing is effected by clutches, the spur wheels remaining always engaged. To

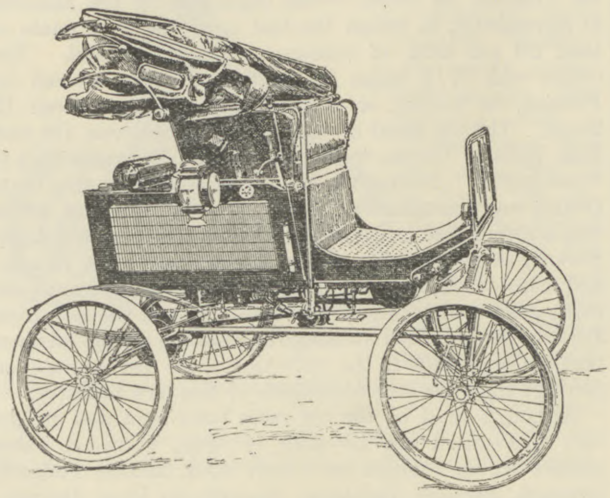


Fig. 7.—"Locomobile" Steam Carriage.

America is due the first place in regard to electrical carriages, the Columbia of the Pope Manufacturing Company, the Riker, the Woods, and similar vehicles being extensively used by private persons, medical men, and others for town use. These firms construct most elegant vehicles with good workmanship, noiseless transmission, and batteries for 30 to 60 miles. The United States also leads in light steam vehicles, the manufacture of which is now being carried out on a very large scale; a type of such vehicle, shown in Fig. 7, and once known as the Stanley, is built by the Locomobile Company. This figure also serves to illustrate the type of carriage work most generally adopted for the lighter classes of motor vehicles in the United States. The frame is built on cycle lines, and the boiler and engine are wonderfully small for their capacity. The fuel is light oil vaporized and burned in a large number of jets which are automatically controlled by the steam pressure; up to the time of writing, sufficient water can only be carried for a run of about 30 miles with the standard vehicles, which, however, have found much favour owing to their low price and quiet running.

As regards other countries, Germany holds an important position, having produced the two great exponents of petrol motors—Gottlieb Daimler and Carl Benz. It is believed that M. Lenoir, a Frenchman, constructed in 1862 the first vehicle propelled by an internal combustion engine, but he apparently did not follow up his invention as did Herr Benz, who constructed his first carriage in 1885, since when some 2500 of these cars—a type of which is shown in Fig. 8—have been turned out at the Rheinische Gasmotoren-Fabrik of Mannheim. This firm uses horizontal cylinders, electric ignition, and principally belt-driving. The late Herr Daimler, whose work has already been alluded to, was the founder of the Daimler Motoren Gesellschaft of Cannstadt, which constructed vehicles under his patents with the transmission formerly by belts, but now on the lines adopted by Panhard and Levassor. Their latest production is a racing machine of 35 h.p. known as the Mercedes, which won laurels at the Nice races of 1901 and 1902. It is fitted with magneto-electric ignition, and a 4-cylinder motor cooled by an air-fan in addition to the water circulation. Germany, as also America, Switzerland, Belgium, Italy, and indeed nearly every civilized country, now has its Automobile Club, whose interests are the protection and encouragement of the industry.

To return to England, considerable progress has been made since the "Emancipation of the Motor" on 14th November 1896, when the inauguration run from London to Brighton was held, under the new Act of Parliament which raised the limit of speed to that prescribed by the Local Government Board, *i.e.*, 12 miles an hour. The pure growth of the industry has been somewhat impeded by unscrupulous company promotion, but is now proceeding apace. Of the British constructors, the Daimler Company has probably done most work; its vehicles, as lately improved, resemble considerably the French Panhard, and in fact were originally copied from it. Sectional views of the Daimler motor (12 h.p. 1902 type) are shown in Figs. 9 and 10. The Motor Manufacturing Company builds similar vehicles, using the Daimler and Iden motors, whilst Napier was the first in England to construct powerful machines for the Continental races, and one of his vehicles won for Great Britain in 1902 the international automobile race held annually for the Gordon Bennett Cup. The Napier car is also of the Panhard type, but with a modified motor, heavier gear, and other improvements. The Wolseley Tool and Motor Car Company have a type of their own, and their carriages are of substantial design and workmanship and are low in price. In addition to the constructors named above, there are numerous smaller firms engaged on motor cycles of the de Dion system

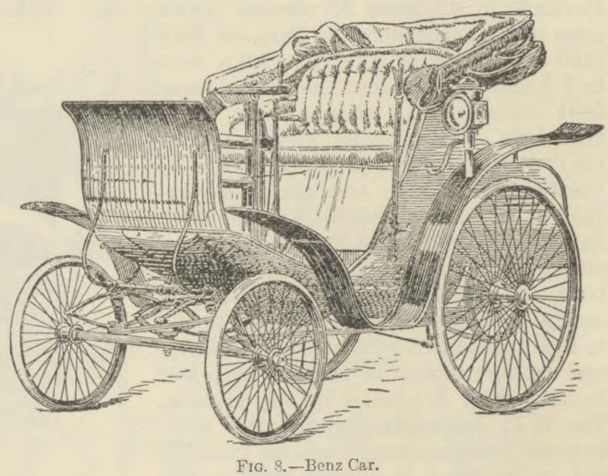
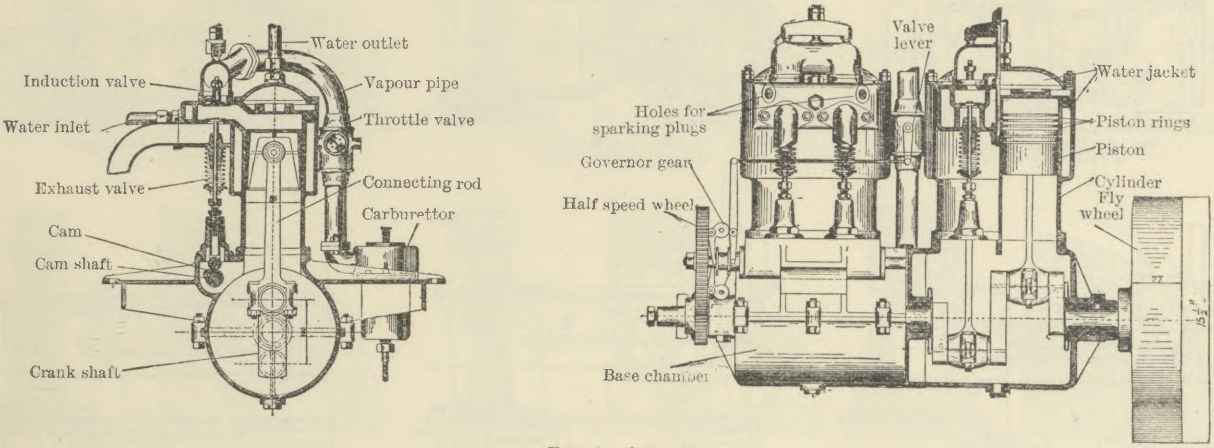


Fig. 8.—Benz Car.

and on light cars of the "voiturette" class. The Automobile Club of Great Britain and Ireland, amongst whose members are many leading sportsmen and scientific men, has its headquarters in London, with numerous branches at other important centres. It has done much to protect the interests of automobilism in Great Britain; and its frequent tours and competitions have helped to popularize the motor vehicle and to educate the public as to its capabilities. The most important of these events was probably the thousand miles trial of 1900, which was the first serious test of motor cars in the United Kingdom; the gold medal for this event was awarded to a French car—that of the Hon. C. S. Rolls, built by Panhard and Levassor of Paris. Similar tests have been repeated annually. It is probable that the revived industry in Great Britain will assume before long as large proportions as it has taken in France, where it developed with an unprecedented rapidity, £2,400,000 worth of motor vehicles having, it is estimated, been turned out there during 1897, 1898, and 1899. The big makers are so full of work that some require a year for the execution of orders, and premiums of 50 to 100 per cent. have been paid for immediate delivery, whilst upwards of £2000 has several times been realized for high-powered vehicles that have won important races. The French nation, however, has taken the matter up purely from a sporting standpoint, and has rushed into it with an impetuosity hardly characteristic of the Briton, with whom the new means of locomotion is likely to come into favour slowly but steadily.

The three commonest methods of propulsion that have been employed up to the present are steam, oil, and electricity. Of these steam appears to be the most suitable for heavy loads, having a great range and elasticity of power; oil or spirit for light carriages, enabling long distances at high speed to be conveniently covered without stoppages; whilst electricity—the "ideal" motive power—is at present a luxury to be employed only for towns and short distances, until a light battery is discovered having a far greater capacity than is at present possible. The mechanical difficulties that have been encountered in the development of the light motor vehicle are very many, and the chief disadvantages hitherto prominent have been noise, vibration, and uncertainty of action, all of which, as one may notice in the modern vehicles, have now been greatly reduced, although it is still essential for an owner to have a mechanical instinct—or to employ a competent man—for the efficient working of his car. For their advantages, apart from heavy transport (dealt with below), much may be said. The capabilities of the modern automobile, the extraordinary control, freedom from vibration when in motion, and the exhilarating effect of gliding swiftly and smoothly through the air, are points of which the ordinary individual is totally ignorant; hence the reason why a first ride in a good vehicle usually converts the most prejudiced person. A good motor-car has a large field of use and enjoyment, though the public should be cautioned against the purchase of cheap and inferior productions, many of which are on the market and which cause much disappointment. A motor carriage has a scope of work far beyond the capabilities of a horsed vehicle. It can cover long distances, is under absolute control, and can therefore travel at very high speeds with perfect safety. It greatly



FIGS. 9 and 10.

economizes space when among street traffic, and would, if generally employed, render the streets far more sanitary, as well as reduce the wear on the roads; it costs nothing for fuel when not in use, and but a penny a mile on an average when running.

A word of warning to the novice may not be out of place. The possessor of an autocar should not let enthusiasm and the ever-increasing thirst for speed get the better of prudence, and should show due consideration for nervous horses, and users of the road generally, remembering that in England a pedestrian has as much legal right to the road as any vehicle. In this way each automobilist will do his part in the popularization of the mechanical road carriage, which has been brought to its present state of perfection by an amount of ingenuity and art realized by few, and which is destined in the near future to play an important part in the civilization of the world.

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II. HEAVY VEHICLES.

Until the close of the 18th century, the common road constituted the only means by which goods could be transported upon land from one part of the country to another. The marvellous development in the carriage of goods by land since about 1830 is due to the introduction and gradual perfection of the railway system, the essential features of which are a hard steel wheel rolling upon a hard smooth track, and the substitution of mechanical for animal traction. Railways now constitute the great arterial systems of communication by land all over the world, and it is no wonder that their rapid development, which has absorbed in the United Kingdom alone a capital of over one thousand million pounds, has led to the comparative neglect of the application of mechanical power upon roads. It is true that traction engines have now been brought to a high state of efficiency, and are being increasingly employed both at home and abroad, but when it is remembered that the vast and ever-growing tonnage carried upon railways must fall very far short of that carried upon roads, it will be seen how limited is the field

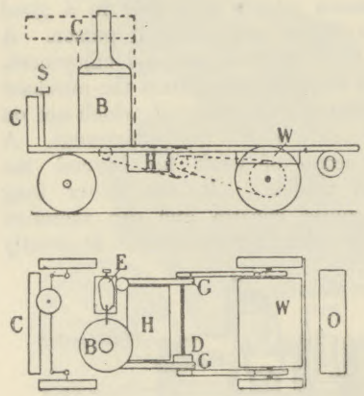


FIG. 1.—Coulthard-Leyland.

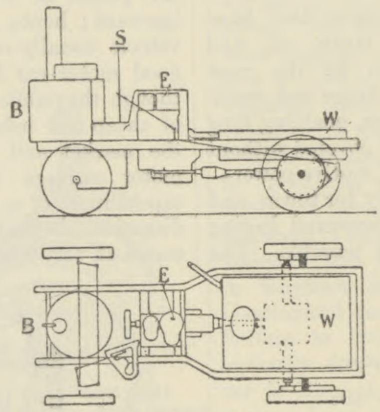


FIG. 2.—Bayley.

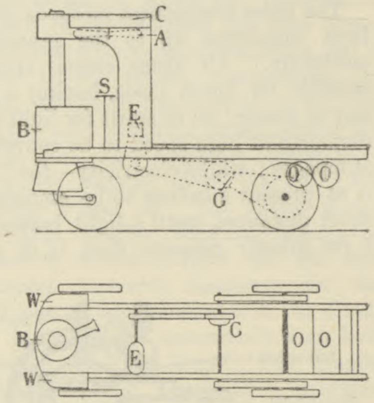


FIG. 3.—Clarkson-Capel.

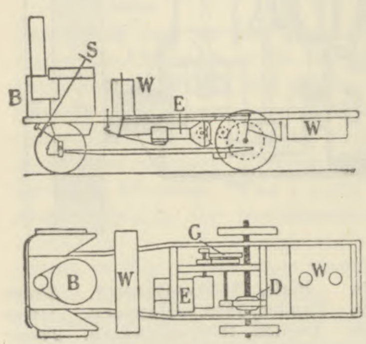


FIG. 4.—Thornycroft.

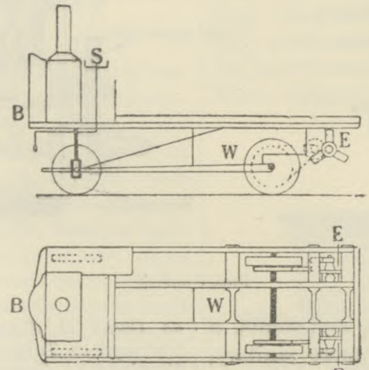


FIG. 5.—Simpson-Bibby.

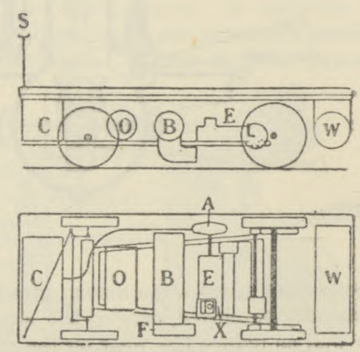


FIG. 6.—Musker.

TYPES OF HEAVY MOTOR VEHICLES.

A, Air-fan; B, boiler; C, condenser; D, differential gear; E, engine; G, gearing; H, hot-water tank; O, oil-tank; S, steering; W, water-tank; X, auxiliary engine.

which is covered by this type of engine. With the exception of the traction engine itself, it cannot be said that there has ever been the same serious attempt to introduce mechanical propulsion for the conveyance of goods that has been shown in the previous section of this article to have taken place since about 1840 in connexion with passenger and pleasure vehicles. But it was to be expected that sooner or later the natural course of events would lead to the introduction of improved and more speedy means of conveyance of goods upon roads, and there is every reason for thinking that during the present century there will be a development in this direction bearing at any rate some proportion to the development of railways during the century that is past.

In the first place, it may be remarked that railways themselves are dependent upon the use of roads for the distribution of goods, railway companies being, in many of the great cities, the largest owners of horses and waggons; all the railway system would, therefore, derive much benefit from improved means of road transit. But further, there is a vast field for development in the conveyance of goods which could not be dealt with at all by railways, and in the opinion of those best fitted to judge, country and agricultural districts might be largely opened up if a more rapid and efficient mode of conveyance upon roads became established, while it is almost certain that up to distances of 40 or 50 miles motor vehicles can even now compete successfully with the railways for the carriage of goods in the great industrial centres. The general feeling that the progress in mechanically propelled vehicles which might be so advantageous to the country at large was made absolutely impossible by legislative restrictions led to the passing of the Locomotives on Highways Act in 1896, which has doubtless been the direct cause of the production and successful introduction in Great Britain of a number of heavy motor vehicles, capable of carrying loads up to 6 and 8 tons.

Before proceeding to describe these vehicles, it may be noted that the regulations of the Local Government Board respecting motor vehicles issued in accordance with the foregoing Act, as far as heavy motor vehicles are concerned, deal chiefly with restrictions of weight and speed. If the weight of the vehicle is between $1\frac{1}{2}$ and 2 tons, the limit of speed is 8 miles an hour, whereas when the weight exceeds 2 tons, the limit of speed is placed at 5 miles an hour. It is in the direction of the tare limit, or weight when unladen, that the greatest difficulties have been found by manufacturers. The extreme tare limit is placed at 3 tons—with a trailer weighing 1 ton—and the construction of a vehicle for heavy traffic which will carry a paying load, and which when unladen shall, with its motive power and accessories, weigh only 3 tons, has not only involved the application of the greatest ingenuity and skill, but has necessitated the use in many cases of an expensive metal like aluminium for casings and other parts of the motor. Even with the greatest mechanical skill in construction and design, it is questionable if the full benefits of the self-propelled vehicle can be realized with the 3-ton tare limit in connexion with the hauling of goods to and from docks, and in the great manufacturing centres. Energetic steps are being taken to obtain a modification of this limit, which will probably be successful if the proper protection of the road surface can be secured with the heavy loads which could then be carried.

Concerning the actual results which have been obtained, a summary is given on p. 21 of the trials of heavy motor vehicles held in the years 1898, 1899, and 1901, under the auspices of the Liverpool Self-Propelled Traffic Association, although it must be remembered that their practical success must really depend upon a lengthened experience of working, so as to enable a comparison to be made with horse traction. Such facts as are already available from the experience of the engineers of the city of Liverpool, of the Mersey Docks and Harbour Board, of the Lancashire and Yorkshire Railway, and of private firms, were collected in a paper on "Road Locomotion," read before the Institution of Mechanical Engineers on 26th April 1900, which paper has been freely drawn upon in the preparation of this article.

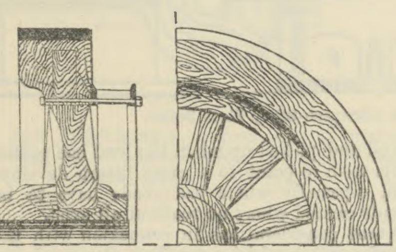


Fig. 7.—Simpson-Bibby.

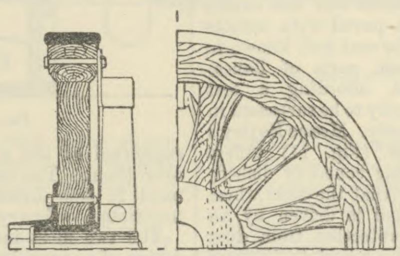


Fig. 8.—Thornycroft.

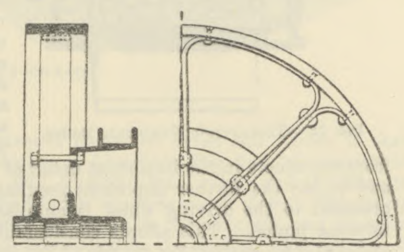


Fig. 9.—Coulthard.

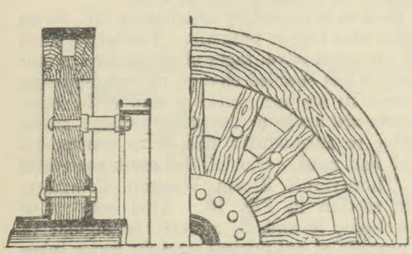


Fig. 10.—Leyland.

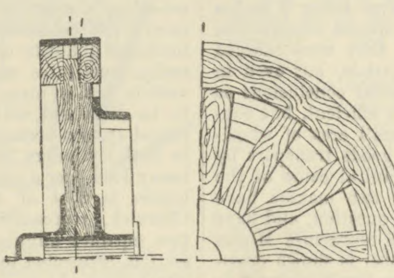


Fig. 11.—Bayley.

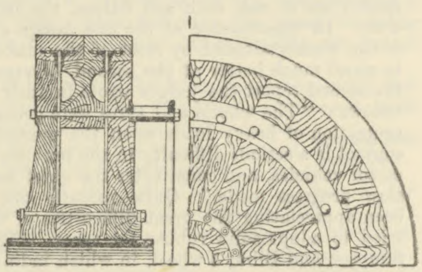


Fig. 12.—Simpson-Bibby.

Driving Wheels for Heavy Motor Vehicles.

In the United Kingdom it may be said that steam is the only power which has been introduced up to the present time for the mechanical propulsion of vehicles for heavy traffic. It does not by any means follow, however, that this will permanently be the case, and both oil engines and electricity have been used with a certain amount of success, while in America compressed air for such purposes is being given a trial. The following descriptive account is limited, however, to steam motor vehicles, which in the first place will be briefly dealt with from the point of view of their general arrangement and construction.

General construction.

Figs. 1 to 6 represent by skeleton diagrams the plan and elevation of these vehicles, a uniform system of lettering being adopted. A glance at these will show the very varied methods in which makers have distributed the essential features. All the boilers are placed in the front and above the car, except in the Musker system (Fig. 6), in which a horizontal boiler with a special fan or draught for the burner is employed, and is placed transversely under the middle of the car, no funnel being required (see also Fig. 26). The next important feature of difference between the systems is in the position of the engines. In the Thornycroft and Lifu systems (Fig. 4, see also Figs. 22 and 23) they are placed horizontally in the middle of the waggon, and the main driving wheel is driven by means of toothed gearing. This is also the case in the Musker system. The Coulthard-Leyland (Fig. 1; see also Figs. 24 and 25) and Clarkson-Capel systems (Fig. 3) all have vertical engines from which the motion is transmitted to the main driving wheel by means of chain gearing operating through a counter-shaft. In the Bayley system (Fig. 2) the engine is also vertical, but transmits the motion by means of a horizontal shaft placed longitudinally with the waggon; by bevelled gearing this drives a counter-shaft which in turn drives the main driving wheel by a pinion and spur wheel. In the Simpson-Bibby system (Fig. 5; also Fig. 27) the arrangement is neat and ingenious. A pair of small three-cylinder engines work separately and independently the two main driving wheels, the use of separate engines obviating the necessity for a jack-in-the-box or differential gearing. Another important feature of difference between the various systems is to be found in the fact that the Musker, Leyland, Coulthard and Clarkson-Capel all use condensers, the location of which can be seen by an inspection of the various diagrams, whereas in the others the effect of superheating the steam is relied on in order to avoid the emission of visible vapour. This latter device acts very well in hot dry weather, but when the atmosphere is cold and moist a cloud of steam is undoubtedly formed, the machine thus failing to comply with the provision of the Act which requires that no *visible* vapour be emitted by light locomotives except from temporary or accidental causes.

Wheels.

When it is remembered that the load has to be concentrated upon the point of contact of the periphery of four wheels, which have also to transmit tractive force from the motor, it is no wonder that they have hitherto been almost entirely made with iron tyres. At the first Liverpool trials of heavy motor vehicles great trouble was experienced with most of the wheels, which had been made in the best possible manner for ordinary vehicular traffic, and in almost all cases they showed signs of the severe stresses and shocks to which they had been subjected, so much so that some of them utterly broke down in consequence. Figs. 7 to 12 illustrate some of the wheels which have been specially designed by the makers of motor vehicles, and show in each case the arrangements for driving, which form a vital part of the design. Messrs Coulthard used a wheel entirely of iron (Fig. 9), which seemed to give very satisfactory results at the Liverpool trials, where it must be noted that part of the 40 miles run was over a road paved with cobbles of the sort well known in certain parts of Lancashire, affording a test scarcely to be surpassed in severity. Messrs Bayley's wheel (Fig. 11) differs from the others in the important detail of being coned or dished, and it has the further important peculiarity that the spur wheel attached to the driving wheel is annular, and is driven by an internal pinion. This affords considerable protection from dust and dirt, and enables the outside of the annular wheel to be used very effectively as a brake wheel encircled by a band brake. The spokes are of oak with ash felloes, the iron tyre being 5 inches wide. In consequence of the new design and special construction of the wheels adopted by most of the makers, they were enabled to stand much better at the second Liverpool trials, but even in the second report the judges wrote in their special conclusions as follows: "The wheels and tyres were generally efficient, but concentration of heavy loads upon the present small area of wheel-contact is a serious difficulty in the problem of goods transport by motor vehicles, and constitutes the chief mechanical cause of the slow progress made." Quite recently one or two makers have been appreciating the great difficulties of this question, and have tried to adopt solid rubber for tyres. Fig. 12 represents Messrs Simpson and Bibby's wheel, in which india-rubber is shown cross-hatched in section, and from which satisfactory results appear to have been obtained.

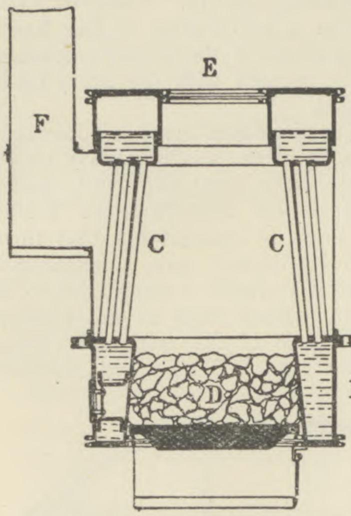


Fig. 13.—Thornycroft Water-tube Boiler.

It is important to notice that while high speeds up to 70 miles an hour and above have been obtained by means of pneumatic tyres with motor vehicles weighing in some cases more than a ton, the limit of speed at which a heavy motor vehicle on iron tyres can run with any great load without rapidly destroying the vehicle must apparently be placed at something like 5 miles an hour. The development of heavy motor traffic is greatly retarded by the difficulties which are encountered in the matter of speed upon bad roads, and even upon good roads during the winter time, while upon the best of roads in dry weather it is scarcely possible to carry more than a total possible load of 15 tons upon four wheels of a motor waggon. Inasmuch as a motor waggon carries its own power and is a very expensive machine, it is necessary for its commercial success that it should carry the greatest possible load at the highest possible speed consistent with the safety of the public and the efficiency of the motor; for these reasons attention has been turned to some contrivance or other that will replace the ordinary wheel. This is a time-honoured problem which all attempts have hitherto failed to solve, but the recent trials of the Diplock walking machine—called by the inventor the "Pedrail"—give promise of a successful result. In this invention supports carrying rollers are placed on the ground, and the motor or traction engine may be said to be rolled over them, so that a rail fixed to the waggon moves along while the wheels themselves are temporarily supported on the ground and picked up when the load has passed over them. The results seem to point to a great future development in this direction, especially where bad roads have to be negotiated, or heavy loads carried where no roads at all exist.

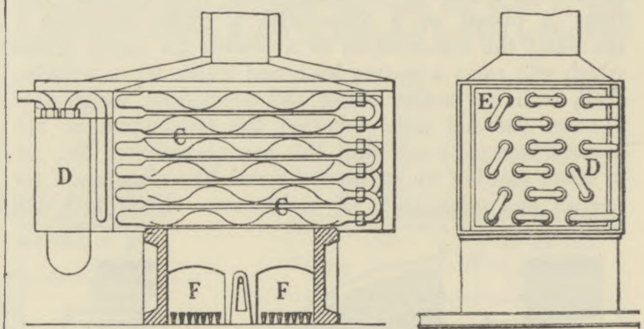


Fig. 15.—Simpson-Bibby Flash Boiler.

Boilers.

The two most important considerations in connexion with the design of a steam boiler for motor vehicles are, first, it must be as light as possible consistent with high pressure, and secondly, it must be capable of being forced so as to meet a sudden demand, such as is caused by climbing a hill, for an increased quantity of steam at a higher pressure. The latter point really constitutes one of the great advantages of steam for a motor vehicle, and in many designs has enabled change of speed-gearing to be dispensed with, since in engines working under the compound system arrangements are made to use high-pressure steam in both cylinders in order to surmount a hill or to transport a heavy load over a piece of bad road. One of the most successful boilers is that of the Thornycroft Steam Waggon Company, Chiswick, represented in section in Fig. 13. This consists of two separate annular portions, A and B, almost rectangular in section, connected by a number of cylindrical straight water tubes which form the walls of a slightly tapered hollow cone CC. The furnace D is contained in the hollow of the lower annulus B, being fed through the opening in the upper annulus A, through the cover E, which can be removed for the purpose. The flame has to find its way on all sides through the narrow spaces left between the water tubes, the products of combustion escaping by means of the funnel F. The de Dion boiler, shown in Fig. 14, is better known in France than in the United Kingdom, but at the Liverpool trials on the Bayley waggon it proved itself a very efficient steam generator. It consists, like the Thornycroft, of a double annulus of rectangular section, connected by water tubes, the essential difference between the two boilers being that one annulus M is much smaller than the other, and is partly contained in it; the water tubes connected with them, instead of being vertical as in the Thornycroft, are slightly inclined from the horizontal. The furnace N, as in the case of the Thornycroft, is fed through a

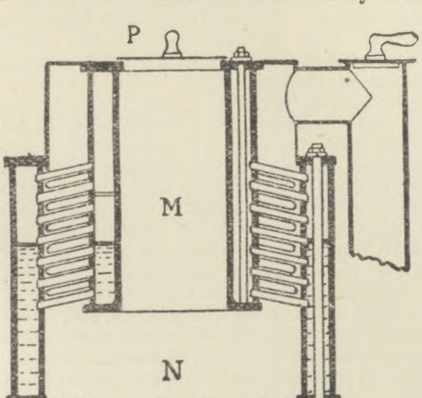


Fig. 14.—De Dion Water-tube Boiler.

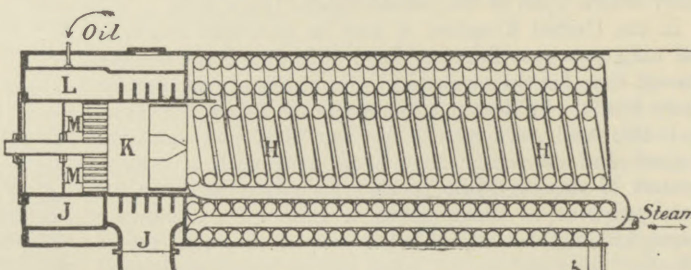


Fig. 16.—Musker Boiler and Burner.

cover P. It is obvious that the heating surface is disposed to the best advantage, as is shown by the results obtained.

The two foregoing boilers are of the water-tube type, but some motor waggons employ flash boilers. In this type of boiler a small quantity of water is injected at each stroke of the engine into a heated coil of metal, or series of tubes, to be flashed into steam and superheated. M. Serpollet has for some years been engaged in perfecting such a boiler, while in Great Britain Messrs Simpson

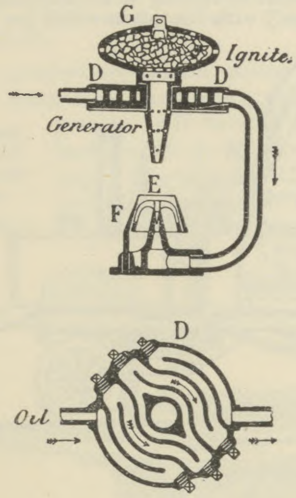


Fig. 17.—Lifu Burner.

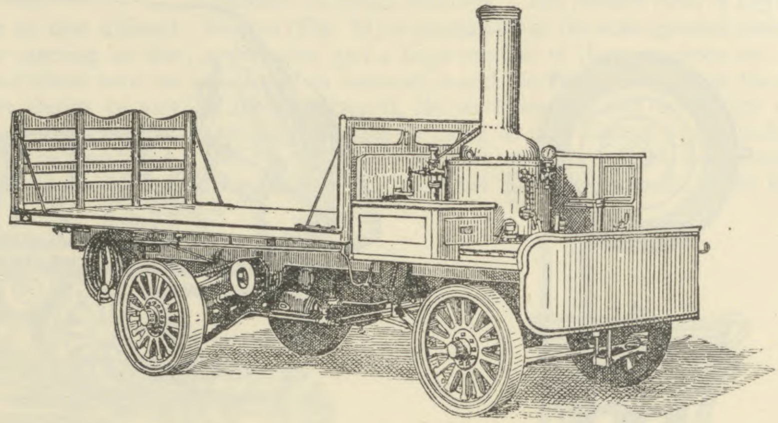


Fig. 25.—Coulthard 5-ton Lorry.

and Bibby have a very strong and effective flash boiler, shown in Fig. 15. This consists of a series of indented heavy steel tubes C, connected outside the furnace by a Haythorn joint. The

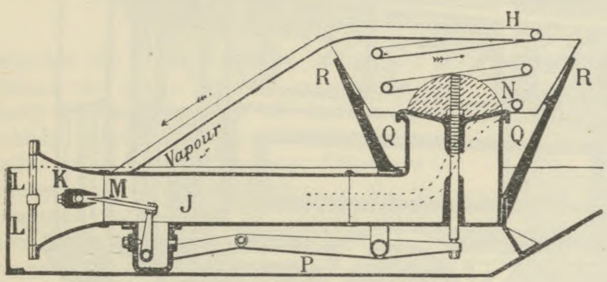


Fig. 18.—Clarkson-Capel Burner.

indentations alternate about 168 times in the generator, and any fluid passing round them must encounter an amount of baffling that exposes it in the most effective way to the action of the heating surface. The steam is made to pass through a drum D, which is found necessary to prevent the superheated steam having too high a temperature. The boiler is heated by a coal furnace FF, and in about 40 minutes from lighting the fire steam is generated.

One of the newest forms of combined boiler and burner is that of Messrs C. and A. Musker of Liverpool (Fig. 16). It consists of three cylindrical coils, HH, of strong steel tubes, and the flame is made to circulate in the annular space between them. The point at which the water enters is shown in the diagram, and likewise that at which the steam is supplied to the engine. The weight of this boiler and contents, independently of the burner, is only 4 cwts., and it is capable of developing 30 h.p., representing a weight of 15 lb per h.p. This indicates the great steaming capacity of this type of boiler, and its suitability for motor vehicles.

It will be noted that in some of the foregoing boilers solid fuel is used, while for the Musker boiler liquid fuel is employed, as it is also in the Lifu, Serpollet, and other steam systems. It cannot be said that at present it is more economical, but with an efficient burner it is certainly more convenient. Some at least of the difficulties in the way of the construction of a burner using heavy petroleum seem to have been successfully overcome in the systems above mentioned. The essential feature of all these burners is a heated surface over which the liquid fuel is allowed to pass, so as to become heated and vaporized; the vapour then issues from a suitable jet burning in air under the boiler. The number of burners for liquid fuel which have been invented in recent years is very great, and the figures given merely represent types of those in operation with motor vehicles. An important distinction must

Liquid fuel burners.

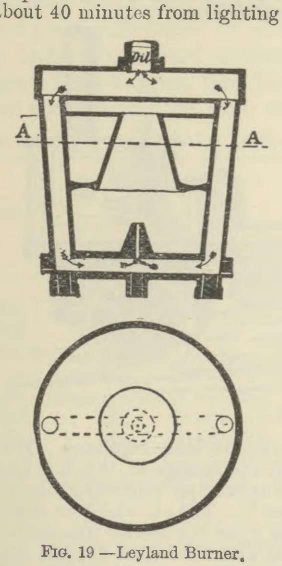


Fig. 19.—Leyland Burner.

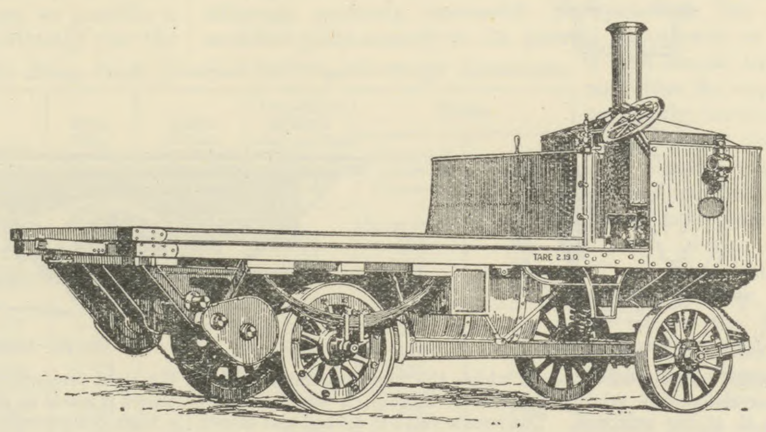


Fig. 27.—Simpson-Bibby 5-ton Lorry.

be made between burners for light and heavy oil, for with a light spirit vaporization, although necessarily effected on the same principle, is a far less difficult matter, and probably does not involve the same risk of carbonizing the petroleum.

The Lifu burner (Fig. 17) consists of a casting D, in the tortuous passages of which the petroleum is made to circulate; it thus becomes thoroughly vaporized, since the casting is placed in the body of the flame which issues at E. F is an air cone which allows the proper proportion of air to mix with the vapour issuing from the needle-valve, which is shown in section and is self-regulating. A peculiar feature of the contrivance is an igniter G, filled with fire-brick which is maintained in a red-hot condition by the flame, so that in the event of the flame being extinguished suddenly, it is immediately relighted from the hot fire-clay. In order to ensure perfect combustion, arrangements are made for regulating the supply of air in both the Clarkson-Capel and Musker burners. In the former, which is shown in Fig. 18, this is in a sense done automatically. The air can be regulated in quantity by altering the amount of opening of the diaphragm at LL. It mixes there thoroughly with the vapour which has been

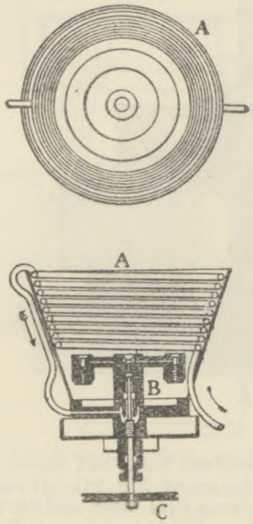


Fig. 20.—Longuemare Burner.

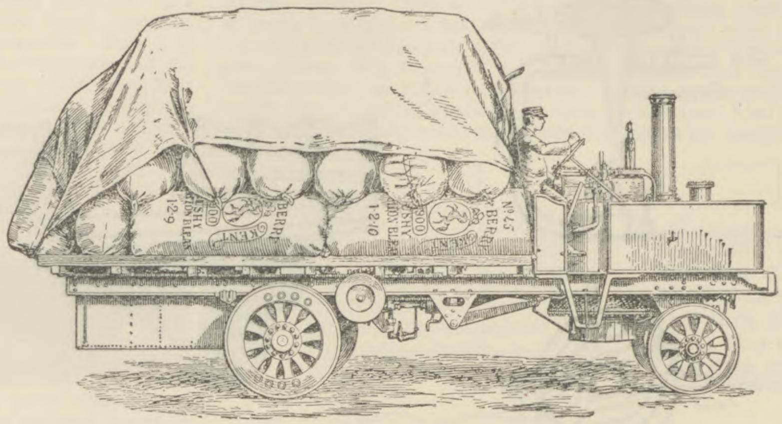


Fig. 22.—Thornycroft 7-ton Lorry.

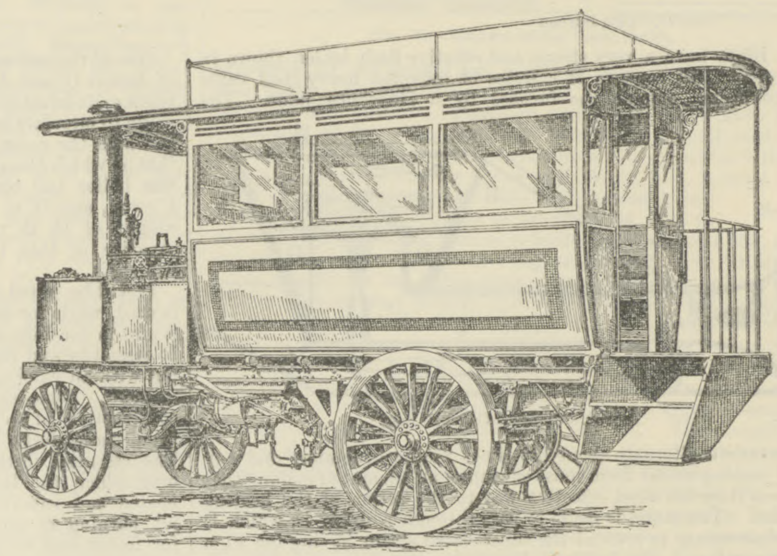


Fig. 23.—Thornycroft Steam Motor Omnibus.

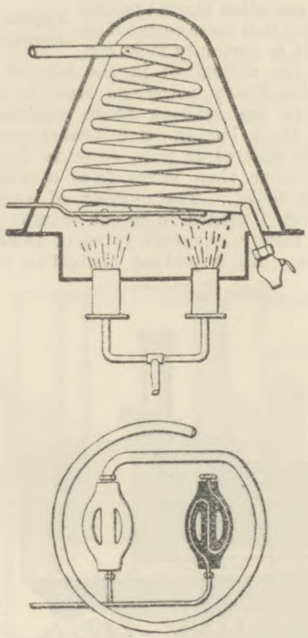


Fig. 21.—Tangye Burner.

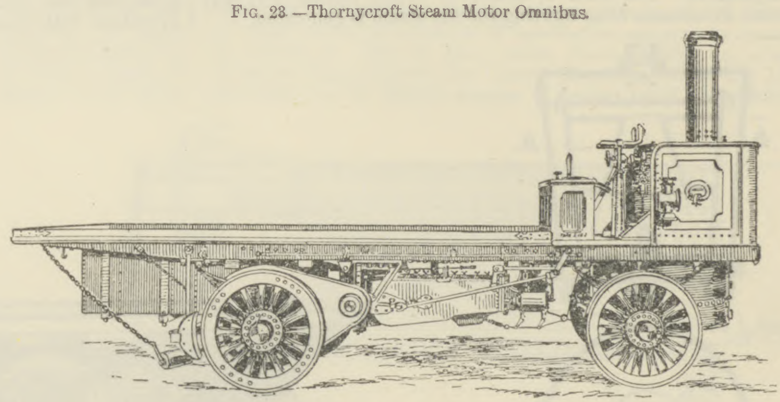


Fig. 24.—Leyland 5-ton Lorry.

generated in the coil H, round which the flame circulates. This vapour enters the mixing chamber J through a small needle-valve M, at the orifice K. The needle-valve is opened and closed by a lever P, which at the same time raises and lowers the larger valve N, so as to regulate the outflow of combined mixture of oil and air underneath at QQ, the flame being baffled on the inside of a hollow nickel cone. The whole arrangement worked very satisfactorily in the Liverpool heavy motor trials. For the burner of Messrs Musker, which is shown attached to the boiler in Fig. 16, the air is supplied by a fan driven by the same auxiliary engine which supplies both the water for the boiler and the oil for the burner, the right proportion being thus automatically regulated. The air passes inwards as shown, through the passage JJ, which is kept at a high temperature by means of cylindrical projecting ribs which form part of the ignition chamber K. The oil, which is admitted by drops at the point L, falling upon the heated iron surface, is vaporized and immediately mixed with the heated air, the mixing being further ensured by causing the vapour and the air to pass through a number of holes in a perforated block M. Ignition takes place in the ignition chamber K. The Leyland burner is shown in section in Fig. 19. The Longuemare burner, shown in plan and elevation, Fig. 20, is largely used in France; it consists of a row of coils through which the spirit is brought and afterwards passed down a pipe B, through a needle-valve regulated by a wheel C, which can be operated by the driver. The Tangye burner (Fig. 21) will be easily understood from a reference to the sectional plan, while the elevation shows the way in which the flame vaporizes the liquid fuel. The coil, boiler, and casing are also shown.

General view of different types.

In general appearance motor waggons at first differed very much from each other, each maker starting at the problem as it were *ab initio*, and there were no traditions to go upon or to fetter design in any way. Hence it was that the questions whether protection for the driver should be employed, whether an air-cooled condenser should be adopted, whether the boiler should be in front of or behind the driver, or even underneath the body of the car, were all matters upon which different makers held different opinions, and this led to great differences in the general external appearance of the first waggons designed by the various makers. But very quickly a remarkable tendency became visible to conform to one particular type, viz., that which was first adopted in the Lifu system, and which is illustrated by Figs. 22, 24, and 27. In these waggons there is a workmanlike funnel and casing for the boiler, behind which the driver sits without any attempt at weather protection, a precaution which may be said to have been found practically futile on a motor waggon; the engines and boiler are carried underneath the frame, as in the original Lifu waggon, thus leaving as large as possible a space for carrying the load, which comes directly over the driving wheels. These general features are well shown in the Thornycroft waggon (Fig. 22), and there is no waggon better known or which stands higher in the matter either of design or workmanship. Fig. 22 shows the Thornycroft 7-ton lorry, and Fig. 23 shows the Thornycroft system adapted to a steam omnibus. The present form of Leyland waggon (Fig. 24) is practically of the same general external appearance, and a large number of these waggons are now employed in Lancashire and elsewhere; and, as in the case of the Thornycroft, the workmanship and design are such as to enable them to carry at the highest legal limits of speed a full load without any very rapid deterioration, over some of the roughest Lancashire roads. The same may be said of the Coulthard, which is shown in Fig. 25, although in the illustration the waggon is shown which, although perfectly successful in operation, has been modified quite recently in its general appearance, so that it now almost exactly resembles the waggons previously mentioned. Fig. 26 shows the oil-fired Musker waggon, the general details of which have been previously given. Fig. 27 is the Simpson and Bibby lorry. Fig. 28 shows the Mann 5-ton lorry, which is interesting from the fact that, like the Foden motor waggon, it employs a horizontal type of boiler. Both the Foden and the Mann lorry have given excellent results in practice, the former

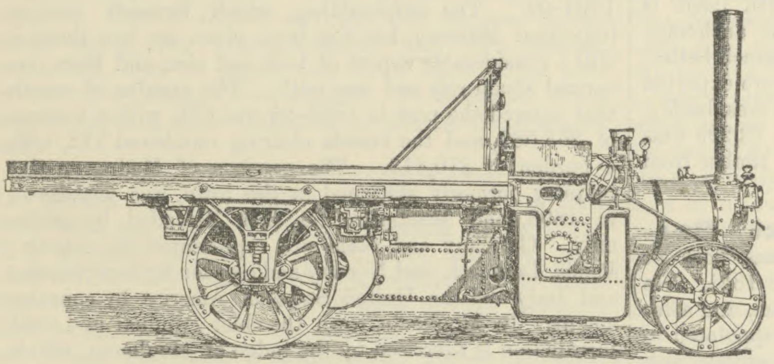


FIG. 28.—Mann 5-ton Lorry.

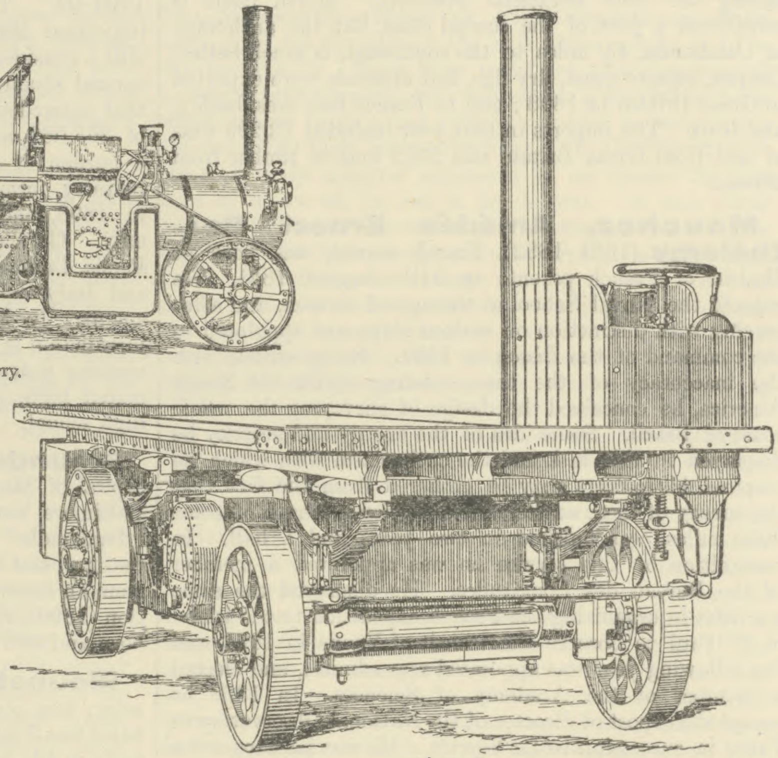


FIG. 26.—Musker Oil-fired Lorry.

Abstract of Results of Trials of Motor Vehicles for Heavy Traffic (Liverpool Self-Propelled Traffic Association).

Year.	Vehicle.	Tare.	Freight.	Mean total moving Weight.	Ratio of mean Dead Weight to Freight.	Proportion of mean total moving Weight on Driving Wheels.	Boiler. Average of observed Pressures.	Boiler. Heating Surface.
		Tons.	Tons.	Tons.			℔ per sq. in.	Square feet.
1898	Thornycroft (4-wheeler) .	2·83	2·53	5·91	1·29	0·77	152	65
1899	do. do.	3·00	3·73	7·24	0·96	0·68	147	83
1901	do. do.	3·80	4·42	9·18	1·06	...	175	83
1898	Thornycroft (6 wheeler) .	3·85	4·73	9·25	0·93	0·46	125	65
1899	do. (8-wheeler) .	3·90	6·65	11·28	0·71	0·54	176	83
1901	do. (4-wheeler) .	6·40	6·33	14·03	1·21	...	210	132
1898	Leyland (liquid fuel) .	2·86	4·06	7·29	0·78	...	178	110
1899	do. do.	2·85	4·44	7·64	0·71	0·62	167	110
1901	do. (coke) . .	2·98	4·81	8·63	0·78	...	212	76
1898	Lifu	2·39	2·20	4·94	1·21	0·77	207	80
1899	Clarkson . . .	3·00	3·35	6·68	1·00	0·51	193	80
1898	De Dion (French Trials)	4·72	3·25	8·60	1·65	0·60	(?)	56
1899	Bayley	2·97	3·67	7·13	0·95	0·67	174	70

behaving remarkably well at the War Office trials in 1901, under the severe tests to which it was subjected by the military experts.

The table on the previous page gives the chief data of the heavy motors which competed in the various trials conducted by the Self-Propelled Traffic Association at Liverpool. Full information and details of the motors, also their respective consumption of fuel, water, &c., will be found in the three volumes of Reports.

(H. S. H.-S.)

Motril, a town of Spain, in the province of Granada, one mile from the coast. Its population was 17,108 in 1897. The sugar-cane and beetroot grown in the district both contribute to the increasing prosperity of the sugar factories. Alcohol, flour, soap, iron, and cotton stuffs are among the other industrial products. Motril itself is considered a port of the second class, but the anchorage at Calahonda, 4½ miles to the south-east, is much better. Grapes, esparto grass, dry figs, and almonds were exported to Great Britain in 1898; and to France zinc ores, barley, and fruit. The imports in that year included 12,299 tons of coal from Great Britain and 2518 tons of timber from Russia.

Mouchez, Amédée Ernest Barthélemy (1821–1892), French savant, was born at Madrid of French parents on 24th August 1821. He entered the Naval School at the age of sixteen, and after serving with distinction on various ships was appointed to the command of the *Bisson* in 1856. Being struck with the inaccuracy of the then existing charts of South America, he conceived the design of surveying the whole coast of Brazil. Some idea of the energy and activity he displayed in this task and the enthusiasm with which he inspired his officers may be gathered from the fact that the survey of these coasts, extending for a length of some 3000 miles, was finished in two years and a half. In recognition of this service he was appointed a member of the Bureau des Longitudes. He displayed the same qualities in organizing the French expedition to the island of St Paul to observe the transit of Venus in 1874, and the following year was appointed rear-admiral, and elected a member of the Academy of Sciences. In 1878 he accepted the post of director of the National Observatory at Paris, in succession to Le Verrier. He was perhaps not a great astronomer in the sense that the term is applied to his predecessor, but he found here ample scope for the exercise of his great administrative abilities. During the fourteen years of his directorship the usefulness of this famous institution was largely extended. The grounds of the Observatory were enlarged, and two powerful instruments of a novel kind were installed; a new spectroscopic department was established, and the gigantic task of re-observing all Lalande's stars was completed. Under his direction twenty-one volumes of the *Annales* were published, as well as the first two volumes of the great catalogue, in which he rendered accessible to astronomers the observations which had been accumulating at the Paris Observatory for more than half a century. He founded the *Bulletin Astronomique*, the School of Astronomy at the Paris Observatory, and the observatory of Montsouris, where naval and military officers, explorers, and others are instructed in such astronomical observations as are necessary in their various callings. It is, however, as author of the great scheme for an international photographic survey of the heavens that Mouchez will be chiefly remembered. The advances which had been made at the Paris Observatory and elsewhere in stellar photography suggested to him the magnificent idea of constructing, by the international co-operation of astronomers, a complete photographic chart of the celestial vault, which, containing more than fifty million stars, would hand down to future ages a faithful picture of the state of the heavens at the end of the 19th century. At three great congresses presided over by Mouchez, and attended by representative astronomers from all the leading observatories of the world, the initial difficulties inseparable from such a vast scheme were overcome; and although he did not live to see the completion of his splendid project, he had the satisfaction before his death of knowing that its ultimate success was assured. His death occurred very suddenly at his country seat at Wissous, near Antony, on 25th June 1892. (A. A. R*.)

Moulmein (or Maulme'n), the headquarters of the Amherst district and Tenasserim division of Lower Burma. The population—53,107 in 1881—was only 55,785 in 1898–99. The shipbuilding, which formerly was an important industry, has now been given up, but there is still a considerable export of teak and rice, and there are several steam rice and saw mills. The number of vessels that entered the port in 1898–99 was 674, with a tonnage of 263,089, and the vessels clearing numbered 712, with a burden of 270,413. The garrison of Madras native infantry, formerly stationed in the town, was withdrawn in 1898, and Moulmein was then defended by police only. Germany and Siam are represented by consuls; Persia, Denmark, and Norway and Sweden by vice-consuls; and Italy and the United States of America by consular agents. In Moulmein town the chief criminal and civil jurisdiction is exercised by the judge of Moulmein, who is sessions judge and district judge. There is an amalgamated high, normal, and practising school, as well as a high school.

Moundsville, a city of West Virginia, U.S.A., capital of Marshall county, on the Ohio river, and on the Baltimore and Ohio and Ohio River railways, in the "Panhandle" of the state. It contains the state penitentiary, and has varied manufactures. It derives its name from an interesting Indian mound in the vicinity. Population (1890), 2688; (1900), 5362, of whom 130 were foreign-born and 468 were negroes.

Mounet-Sully, Jean (1841–——), French actor, was born at Bergerac, 27th February 1841. His name was Jean Sully Mounet, but he adopted the above form early in life and has been always known by it. After a struggle against the prejudices of his parents, he entered the Conservatoire at the age of twenty-one, and a few years later took the first prize for tragedy. In 1868 he made his *début* at the Odéon, without attracting much attention. His career was interrupted by the Franco-Prussian war, and the liking he developed for soldiering had almost decided him to give up the stage when he was offered the opportunity of playing the part of Oreste in *Andromaque* at the Comédie Française in July 1872. His striking presence and voice and the passionate vigour of his acting made an immediate impression, and the eventual result was his election as "sociétaire" in January 1874. He became one of the mainstays of the Comédie Française, and distinguished himself in a large variety of tragic and romantic parts. Perhaps his most famous impersonation was that of Œdipus in a version of Sophocles' drama. This was first performed in the ruined amphitheatre at Orange on the occasion of a fête in 1888. Other prominent parts in his repertory were those of Achille in *Iphigénie*, Hippolyte in *Phèdre*, Hernani, Ruy Blas, Hamlet, Francis I. in *Le Roi s'Amuse*, Didier in *Marion Delorme*, &c. He was created Chevalier of the Légion d'Honneur in 1889, and is the author of a play entitled *La Buveuse de Larmes*.

Mountaineering.—Mountaineering is the art of moving about safely in mountain regions, avoiding the dangers incidental to them, and attaining high points difficult of access. It consists of two main divisions, rock-craft and snow-craft. Rock-craft consists in the intelligent selection of a line of route and in gymnastic skill to follow the line chosen. In snow-craft the choice of route is the result of a full understanding of the behaviour of snow under a multitude of varying conditions; it depends largely upon experience, and much less upon gymnastic skill. The dangers which the craft of climbing has been developed to avoid are of two main kinds, the danger of things falling on the traveller and the danger of his falling himself. The things that may fall are rocks, ice, and snow; the traveller may fall from rocks, ice, or snow, or into crevasses in ice or snow. There are also dangers from weather. Thus in all there are eight chief dangers: falling rocks, falling ice, snow-avalanches, falls from difficult rocks, falls from ice slopes, falls down snow slopes, falls into crevasses, dangers from weather. To select and follow a route avoiding these dangers is to exercise the climber's craft.

Falling Rocks.—Every rock mountain is falling to pieces, the process being specially rapid above the snow-line. Rock-faces are constantly swept by falling stones, which it is generally possible to dodge. Few accidents have occurred in such places. Falling rocks tend to form furrows in a mountain face, and these furrows (*couloirs*) have to be ascended with caution, their sides being often safe when the middle is stone-swept. Stones fall more frequently on some days than on others, according to the recent weather. Local experience is a valuable help on such a question. The direction of the dip of rock strata often determines whether a particular face is safe or dangerous; the character of the rock must also be considered. Where stones fall frequently débris will be found below, whilst on snow slopes falling stones cut furrows visible from a great distance. In planning an ascent of a new peak such traces must be looked for. In some mountain ranges (Himalaya, Alps of New Zealand) falling stones are more frequent than in the Swiss Alps. When falling stones get mixed in considerable quantity with slushy snow or water a mud avalanche is formed (common in the Himalaya). Mud avalanches keep to recognized tracks and move slowly, but advance to great distances and overwhelm large areas of land. It is necessary to avoid camping in their possible line of fall.

Falling Ice.—The places where ice may fall can always be determined beforehand. It falls in the broken parts of glaciers (*seracs*) and from overhanging cornices formed on the crests of narrow ridges. Large icicles are often formed on steep rock-faces, and these fall frequently in fine weather following cold and stormy days. They have to be avoided like falling stones. Seracs are slow in formation, and slow in arriving (by glacier motion) at a condition of unstable equilibrium. They generally fall in or just after the hottest part of the day, and their débris seldom goes far. It is generally possible to estimate the stability of a serac within reasonable limits. A skilful and experienced ice-man will usually devise a safe route through a most intricate ice-fall, but such places should be avoided in the afternoon of a hot day. Hanging glaciers (*i.e.*, glaciers perched on steep slopes) often discharge themselves over steep rock-faces, the snout breaking off at intervals. They can always be detected by their débris below. Their track should be avoided. In the early summer falls of ice are less common than in the autumn, when the winter snow has melted away and deprived seracs of its support.

Snow Avalanches.—These mainly occur on steep slopes when the snow is in bad condition, early in the year, or after a recent fresh fall. Days when snow is in bad condition are easily recognized; on such days it may be inadvisable to traverse snow-slopes which at another time may be as safe as a high-road. Beds of snow collected on rock ledges in bad weather fall off when a thaw comes, and are dangerous to rock-climbers. Snow that has recently fallen upon ice slopes is always liable to slip off bodily. Such falling masses generally make the lower part of their descent by couloirs. Snow avalanches never fall in unexpected places, but have their easily recognizable routes, which can be avoided in times of danger by experienced mountaineers.

Falls from Rocks.—The skill of a rock-climber is shown by his choice of hand-hold and foot-hold, and his adhesion to those he has chosen. A man who knows the limit of his powers and selects his grip accordingly may be stopped by a difficulty, but will not fall. Much depends on a correct estimate of the firmness of the rock where weight is to be thrown upon it. Many loose rocks are quite firm enough to bear a man's weight, but experience is needed to know which can be trusted, and skill is required in transferring the weight to them without jerking. On all difficult rocks the rope is the greatest safeguard for all except the first man in the ascent, the last in the descent. In such places a party of three or four men roped together, with a distance of 15 to 20 feet between one and another, will be able to hold up one of their number (except the top man) if one only moves at a time and the others are firmly placed and keep the rope tight between them, so that a falling individual may be arrested before his velocity has been accelerated. In very difficult places help may be obtained by throwing a loose rope round a projection above, and pulling on it; this method is specially valuable in a difficult descent. The rope usually employed is a strong Manila cord called Alpine Club rope, but some prefer a thinner rope used double. On rotten rocks the rope must be handled with special care, lest it should start loose stones on to the heads of those below. Similar care must be given to hand-holds and foot-holds, for the same reason. When a horizontal traverse has to be made across very difficult rocks, a dangerous situation may arise unless at both ends of the traverse there be firm positions. Even then the end men gain little from the rope. Mutual assistance on hard rocks takes all manner of forms: two or even three men climbing on one another's shoulders, or using for foot-hold an ice-axe propped up by others. The great principle is that of co-operation, all the members of the party climbing with reference to the others, and not as independent units; each when moving must know what the man in front and the man behind are doing. Help may sometimes be obtained by fastening iron or wooden pegs into cracks, and hitching a rope over. The greatest danger on difficult rocks is to be roped to a careless companion. After bad weather steep rocks are often found covered with a veneer of ice (*verglas*), which may even render them inaccessible. Climbing-irons (crampons, *steigeisen*) are useful on such occasions.

Ice Slopes.—Climbing-irons are also most useful on ice or hard snow, as by them step-cutting can sometimes be avoided, and the footing at all times rendered more secure. True ice slopes are rare in Europe, though common in tropical mountains, where newly-fallen snow quickly thaws on the surface and becomes sodden below, so that the next night's frost turns the whole into a mass of solid ice. An ice slope can only be surmounted by step-cutting. For this an ice-axe is needed, the common form being a small pick-axe on the end of a pole as long as from the elbow of a man to the ground. This pole is used also as a walking-stick, and is furnished with a spike at the foot. A great deal has been written about how to cut steps, which need not be repeated here. There is much to be learned in practice, and a wide difference between a quick and a slow step-cutter. One of the chief uses of a guide is to save his employer this labour. Special care must be taken not to slip on an ice slope, and to use the rope carefully, as the best ice-step remains slippery.

Snow slopes are very common, and usually easy to ascend. At the foot of a snow or ice slope is generally a big crevasse, called a *bergschrund*, where the final slope of the mountain rises from a snow-field or glacier. Such *bergschrunds* are generally too wide to be strided, and must be crossed by a snow bridge, which needs careful testing and a painstaking use of the rope. A steep snow slope in bad condition may be dangerous, as the whole body of snow may start as an avalanche. Such slopes are less dangerous if ascended directly than obliquely, for an oblique or horizontal track cuts them across and facilitates movement of the mass. New snow lying on ice is specially dangerous. Experience is needful for deciding on the advisability of advancing over snow in doubtful condition. Snow on rocks is usually rotten unless it be thick; snow on snow is likely to be sound. A day or two of fine weather will usually bring new snow into sound condition. Snow cannot lie at a very steep angle, though it often deceives the eye as to its slope. Snow slopes seldom exceed 40°. Ice slopes may be much steeper. Snow slopes in early morning are usually hard and safe, but the same in the afternoon are quite soft and possibly dangerous; hence the advantage of an early start.

Crevasses.—These are the slits or deep chasms formed in the substance of a glacier as it passes over an uneven bed. They may be open or hidden. In the lower part of a glacier the crevasses are open. Above the snow-line they are frequently hidden by arched-over accumulations of winter snow. The detection of hidden crevasses requires care and experience. After a fresh fall of snow they can only be detected by sounding with the pole of the ice-axe, or by looking to right and left where the open extension of a partially hidden crevasse may be obvious. A master of snow-craft hardly ever falls into a crevasse, a novice is liable to frequent falls. The safeguard against accident is the rope, and no one should ever cross a snow-covered glacier unless roped to one, or better to two companions.

Weather.—Many of the dangers resulting from bad weather have been referred to above. Storms seldom destroy mountaineers by mere cold or exposure, unless they sit down and lose vitality by inaction, but there have been cases of men blown from exposed positions to destruction. Many climbers have been struck by lightning, but few, if any, killed at high elevations. The main group of dangers caused by bad weather centre round the change it effects in the condition of snow and rock, making ascents suddenly perilous which before were easy, and so altering the aspect of things as to make it hard to find the way or retrace a route. The two extremes to be avoided are sitting still and making frantic haste. The worst of all remedies is alcohol; the best, food, patience, and a dogged will. In storm the man who is wont to rely on a compass has great advantage over a merely empirical follower of his eyes. In large snow-fields it is, of course, easier to go wrong than on rocks, but a trained intelligence is the best companion and surest guide.

History.—The craft of climbing is essentially a modern invention. Devised for sport, it has become an important adjunct to geographical exploration, for it bears to mountain-travel the relation that navigation bears to sea-travel. Till relatively recent times a mysterious dread of mountains lingered in the minds even of educated people; horror was the impression derived from mountain scenery by 18th-century travellers. The substitution of admiration for horror was the work of the 19th century. The chief Alpine passes were crossed in Roman and even prehistoric times. The first recorded mountain ascent after Old Testament times is Trajan's ascent of Etna to see the sun rise. The Roche Melon (11,600 feet) was climbed in 1358. Peter III. of Aragon climbed Canigou in the Pyrenees in the last quarter of the 13th century. In 1339 Petrarch climbed Mount Ventoux near Vaucluse. In 1492 Charles VIII. of France reached the top of Mount Aiguille. The Humanists of the 16th century adopted a new attitude towards mountains, but the disturbed state of Europe nipped in the bud the nascent mountaineering of the Zürich school. Leonardo da Vinci climbed to a snow-field in the neighbourhood of the Val Sesia and made scientific observations. Conrad Gesner and Josias Simler of Zürich visited and described mountains, and made regular ascents. The use of axe and rope were locally invented at this time. No mountain expeditions of note are recorded in the 17th century. In 1739 the Titlis was climbed—the first true snow-mountain. Pococke and Windham's historic visit to Chamounix was made in 1741, and set the fashion of visiting the glaciers. The first attempt to ascend Mont Blanc was made in 1775 by a party of natives. In 1786 Dr Michel Paccard and Jacques Balmat gained the summit for the first time. De Saussure followed next year. The Jungfrau was climbed in 1811, the Finsteraarhorn in 1812, and the Zermatt Breithorn in 1813. Thenceforward tourists showed a tendency to climb, and the body of Alpine guides began to come into existence in consequence. Systematic mountaineering, as a sport, is usually dated from Mr Justice Wills's ascent of the Wetterhorn in 1854. The first ascent of Monte Rosa was made in 1855. The Alpine Club was founded in London in 1857, and soon imitated in most European countries. Mr Whymper's ascent of the Matterhorn in 1865 marks the close of the main period of Alpine conquest, during which the craft of climbing was invented and perfected, the body of professional guides formed, and their traditions fixed. Passing to other ranges, the exploration of the Pyrenees was concurrent with that of the Alps. The Caucasus followed, mainly owing to the initiative of Mr D. W. Freshfield; it was first visited by exploring climbers in 1868, and most of its great peaks were climbed by 1888. Trained climbers turned their attention to the mountains of North America in 1888, when the Rev. W. S. Green made an expedition to the Selkirks. From that time exploration has gone on apace, and many English and American climbing parties have surveyed most of the highest groups of snow-peaks. The exploration of the highest Andes was begun in 1879–80, when Mr Whymper climbed Chimborazo and explored the mountains of Ecuador. The Cordillera between Chile and Argentina was attacked by Dr Güssfeldt in 1883, who ascended Maipo (17,752 feet) and attempted Aconcagua (23,080). That peak was first climbed by the Fitzgerald expedition in 1897. The Andes of Bolivia were explored by Sir Martin Conway in 1898. Chilian and Argentine expeditions revealed the structure of the southern Cordillera in the years 1885–98. Sir Martin Conway visited the mountains of Tierra del Fuego in 1898. The Alps of New Zealand were first attacked in 1882 by the Rev. W. S. Green, and shortly afterwards a New Zealand Alpine Club was founded, and by their activities the exploration of the range was pushed forward. In 1895 Mr E. A. Fitzgerald made an important journey in this range. Of the high African peaks, Kilimanjaro was climbed in 1889 by Dr Meyer, Mount Kenia in 1899 by Mr Mackinder, and a peak of Ruwenzori by Mr Moore in 1900. The Asiatic mountains have as yet been little climbed, though those that lie within the British empire have been surveyed. In 1892 Sir Martin Conway explored the Karakoram Himalayas, and climbed a peak of 23,000 feet. In 1895 Mr A. F. Mummery made a fatal attempt to ascend Nanga Parbat, whilst in 1899 Mr D. W. Freshfield took an expedition to the snowy regions of Sikkim. A body of Gurkha sepoys has now been trained as expert mountaineers by Major the Hon. C. G. Bruce, and a good deal of exploration has been accomplished by them. The only mountains of the northern polar region that have been explored are those of Spitsbergen by Sir Martin Conway's expeditions in 1896 and 1897, and the peaks in the north of Norway and the Lofotens by various Alpine Club and Norwegian parties. The great mountains of the south polar region have not yet been attempted. (W. M. C.)

Mount Carmel, a borough of Northumberland county, Pennsylvania, U.S.A. It is at the head of Shamokin creek, in the anthracite coal region, in the eastern part of the state, at an altitude of 1054 feet. It is on the Lehigh Valley, the Northern Central, and the Philadelphia and Reading railways. Its chief business consists of mining, handling, and shipping anthracite coal. Population (1880), 2378; (1890), 8254; (1900), 13,179, of whom 3772 were foreign-born.

Mount Clemens, a city of Michigan, U.S.A., capital of Macomb county, on the Clinton river near its mouth, and on the Grand Trunk Railway, in the south-eastern part of the state, at an altitude of 603 feet. It is noted for its mineral springs, which are said to possess remarkable curative properties, and which draw to it a large transient population. Population (1880), 3057; (1900), 6576—1194 foreign-born and 18 negroes.

Mount Desert, an island off the coast of Maine, U.S.A., a part of Hancock county of that state. It has an area of about 100 square miles, and is mountainous, rising to an extreme altitude, in Green Mountain, of 1527 feet. It contains many lakes and ponds, and is deeply penetrated by arms of the sea, affording a great variety of picturesque scenery. It is a popular seaside resort in summer, being reached by a line of the Maine Central Railroad and ferry, or by steamers from Portland and Boston. The chief points on the island frequented by visitors are Bar Harbour (far the most important), Seal Harbour, North-East Harbour, South-West Harbour, and Somesville, at the head of Somes Sound. Population (1890), 5337; (1900), 7989, increased in the season by 10,000 to 20,000 visitors.

Mount Morgan, gold-mining town and municipality (1890), Queensland, Australia, in the county of Raglan, 28 miles south-south-west of Rockhampton, to which a railway was opened in 1898, and believed to be on the richest gold site in Australia. The output in 1900 amounted to nearly £790,000, and during that year about 2000 persons were employed. Machinery is replacing manual labour to a considerable extent. Population (1891), 3514; (1901), 9609.

Mount Vernon, a city of Illinois, U.S.A., capital of Jefferson county, towards the southern part of the state, at the intersection of four railways, and at an altitude of 472 feet. The surrounding country is a rich farming region, for which it acts as a collecting and distributing point. Population (1890), 3233; (1900), 5216, of whom 111 were foreign-born and 190 negroes.

Mount Vernon, a city of Indiana, U.S.A., capital of Posey county, on the Ohio river, at the intersection of the Louisville and Nashville and the Evansville and Terre Haute railways, in the south-western part of the state. Population (1890), 4705; (1900), 5132, of whom 262 were foreign-born and 892 negroes.

Mount Vernon, a city of Westchester county, New York, U.S.A., on the Bronx river, and the New York Central and Hudson River, and the New York, New Haven and Hartford railways, in the south-eastern part of the state. It is a suburb of New York City, being distant but 13 miles. It was incorporated as a village in 1853, and chartered as a city in 1892. Population (1890), 10,830; (1900), 20,346, of whom 5265 were foreign-born and 516 negroes. The death-rate in 1900 was 19·4.

Mount Vernon, a city of Ohio, U.S.A., capital of Knox county, on the Kokosing river, and the Baltimore and Ohio and the Cleveland, Akron and Columbus railways, north-east of the centre of the state, at an altitude of 991 feet. It has manufactures of furniture, carriages and waggons, and locomotives, besides flour-mills and machine-shops. Population (1890), 6027; (1900), 6633, of whom 359 were foreign-born and 239 negroes.

Mouscron, a town of Belgium, in the province of West Flanders, 35 miles south of Bruges, with a station at the junction of the lines from Courtrai and Tournai to Lille (France). Its numerous industries include cotton and wool weaving, dyeing, and oil-refining. Population (1890), 13,764; (1900), 18,909.

Mozambique. See East Africa, Portuguese.

Mozyr, a district town of Russia, government and 241 miles south-east of Minsk, on the railway from Brest to Bryansk, and on the Pripet river. Coal has been found near the town, which is an *entrepôt* for goods shipped on the Pripet. Population (1897), 12,251.

Much Wenlock. See Wenlock.

Mudania, the ancient *Myrlea*, a town of Asia Minor, on the south coast of the Sea of Marmora, and the port of Brúsa. It is connected with Brúsa by a railway and a carriage road, and with Constantinople by a line of steamers. Olive oil is produced in large quantities. The population numbers 4800, almost wholly Greek.

Muhamrah (Mohammerah), a town of Persia, in the province of Arabistan, 30° 26′ N., 48° 11′ E., on the Haffár canal, which joins the Karun with the Shatt el Arab, and flows into the latter 40 miles above its mouth at Fao and about 20 miles below Basrah. It has post and telegraph offices, and a population of about 5000. With the opening of the Karun river, as far as Ahvaz, to international navigation in 1889, Muhamrah acquired greater importance, and its customs, which until then were leased to the governor for £1500 per annum, rose considerably, and now pay £8000. A British vice-consul was appointed in 1890. The following table shows the value of the exports and imports and the amount of shipping at intervals since 1890:—

Year.	Exports.	Imports.	Shipping.			
			Total.		British.	
	£	£	Entered, tons.	Cleared, tons.	Entered, tons.	Cleared, tons.
1890	58,096	146,141	...	...	...	...
1895	98,193	138,006	111,623	89,432	103,805	...
1899	131,706	207,892	105,480	86,252	97,765	...
1900	164,078	281,854	121,427	91,909	112,946	86,202

Nearly one-half of the exports was specie.

Until 1847, when it definitely became Persian territory in accordance with Art. II. of the treaty of Erzerum, Muhamrah was alternately claimed and occupied by Persia and Turkey, its ruler, an Arab sheikh, helping either Power as he found it convenient. Since then the governor of the town and adjoining district has been a sheikh of the K'ab, or Chaab, Arabs of the powerful tribe of the Shi'ah branch of Islam. At the close of the Anglo-Persian campaign in 1857 Muhamrah was taken by a British force.

Muir, Sir William (1819-——), Arabic scholar, was born at Glasgow, and educated at Kilmarnock Academy and at Glasgow and Edinburgh Universities.

In 1837 he entered the Bengal Civil Service, and there held several important appointments. He served as secretary to the Governor of the North-West Provinces, and as a member of the Agra revenue board, and during the Mutiny he was in charge of the Intelligence Department there. In 1868 he became Lieutenant-Governor of the North-West Provinces. In 1874 he was appointed financial member of the Council of the Governor-General of India, and retired in 1876, when he became a member of the Council of India. In 1867 the Order of the Star of India had been conferred on him in recognition of his public services. He had always taken an interest in educational matters, and it was chiefly through his exertions that the large central college at Allahabad, known as Muir's College, was built and endowed. In 1885 he was elected Principal of Edinburgh University in succession to Sir Alexander Grant. Sir William Muir is a good Arabic scholar, and has made a careful study of the history of the time of Mahomet and the following period. His chief books are a *Life of Mahomet and History of Islam to the Era of the Hegira*, a work of great historic value; *Annals of the Early Caliphate*, an admirable account of the period of early Saracenic conquests; *The Caliphate*, an abridgment and continuation of the *Annals*, which brings the record down to the fall of the Caliphate on the onset of the Mongols; *The Coran: its Composition and Teaching*; and *The Mohammedan Controversy*, a reprint of five essays published at intervals between 1885 and 1887. In 1881 he delivered the Rede lecture at Cambridge on *The Early Caliphate and Rise of Islam*. His interests are chiefly with the Arabs, and he has less sympathy with the other developments of Islam.

Muirkirk, a mining and manufacturing town of Ayrshire, Scotland, near the river Ayr, 25¾ miles east by north of Ayr by rail. It is one of the chief seats of the iron industry, and there are coal-mines and lime-kilns. There are parish council chambers and an institute, with library and recreation rooms. In the neighbourhood are four monuments to Covenanting martyrs, including Cameron of Aird's Moss and Brown of Priesthill; also Druidical remains and a Roman camp. Population (1891), 3329; (1901), 5670.

Mukden (Chinese, *Shingking*), capital of Manchuria, on the Hun-ho, 110 miles north-east of Newchwang, with a population of 250,000. It is a centre for trade and also for missionary enterprise, and has become of greater importance in consequence of the Russian encroachments and of the projection of new railways. It was formerly the headquarters of the Manchu dynasty, and their tombs lie within its confines.

Mülhausen, a town of Germany, in Alsace-Lorraine, district of Upper Alsace, 21 miles by rail north-west of Basel. It is the centre of the cotton industries of Alsace, though it also has numerous other industries. The museum of the Industrial Society (1882) contains a collection of Romano-Celtic antiquities and a historical museum and picture gallery. Of recent years the operatives have gradually moved farther out into the suburbs, leaving the model houses of the "artisans' town" to be occupied by small tradesmen. In addition to a zoological garden, the town has a new chemical school. Population (1885), 69,759; (1900), 89,012.

Mülheim, two towns of Prussia, in the Rhine province. 1. On the Rhine, 3 miles north-north-east of Cologne, with numerous manufactures. Population (1885), 24,975; (1900), 45,085. 2. On the Ruhr, 5 miles east of Duisburg. It also is a place of industrial activity, and has a large trade in coal. On the opposite bank of the river is the old castle of Broich. The "small" Evangelical church dates from 1879–81. Population (1885), 24,465; (1900), 38,292.

Mull, an island of Argyllshire, Scotland, the third of the Hebrides in size, separated from the mainland on the south-east by the Firth of Lorn and on the north-east by the Sound of Mull. A large stretch of grazing ground about Ben More was converted by the late duke of Argyll into a deer forest. Tobermory, which is a police burgh (population, 1019 in 1901) and the only town, has regular steamer communication with Glasgow and Stornoway. Granite and freestone are quarried in the island. Population (1891), 4691; (1901), 4711.

Müller, Ferdinand von, Baron (1825–1896), botanist and explorer, was born at Rostock on the 30th of June 1825, and was educated, after the early death of his parents, in Schleswig. He studied the flora of Schleswig and Holstein from 1840 to 1847, when he emigrated to South Australia and travelled through the colony from 1848 to 1852, discovering and describing a large number of plants previously unknown. In 1852 he was appointed Government botanist for Victoria, and examined its flora, and especially the Alpine vegetation of Australia, which was previously unknown. Then, as phytographic naturalist, he joined the expedition sent out under Augustus Gregory by the duke of Newcastle, Secretary of State for the Colonies. He explored the river Victoria and other portions of North Australia, was one of the four who reached Termination Lake in 1856, and accompanied Gregory's expedition overland to Moreton Bay. From 1857 to 1873 he held the office of director of the Botanical Gardens, Melbourne, and not only introduced many plants into Victoria, but made the excellent qualities of the blue gum (*Eucalyptus globulus*) known all over the world, and succeeded in introducing it into the south of Europe, North and South Africa, California, and the extra-tropical portions of South America. For these services he was decorated by many foreign countries, including France, Spain, Denmark, and Portugal; was created K.C.M.G. in 1879, baron of the kingdom of Würtemberg in 1871, and F.R.S. in 1861. He published eleven volumes of his *Fragmenta Phytographica Australiæ*, two volumes of the *Plants of Victoria*, and other books on the Eucalyptus, Myoporaceæ, Acacias, and Salsolaceæ, all profusely illustrated. He also co-operated in the production of Bentham's *Flora Australiensis*. In 1880 he was the recipient of one of the medals of the Royal Society of London. Baron von Müller took a leading part in promoting Australian exploration, especially the Burke and Wills expedition, which was the first to cross the continent, and in the various attempts to unravel the mystery which attended the fate of his fellow-countryman Leichhardt. He was a commissioner for all the industrial exhibitions held in Melbourne, and a member of the organizations for the representation of Victoria at the international exhibitions of London, Paris, Vienna, and Philadelphia. Baron von Müller was one of the greatest descriptive botanists of the 19th century, but his greatest feat was in the dissemination of the *Eucalyptus globulus*, which has supplied many treeless districts with excellent and fast-growing timber, and has enabled the resources of many districts to be developed which were previously rendered uninhabitable by malaria. He died at Melbourne on the 9th of October 1896.

Müller, Friedrich Max. See Max Müller.

Mullingar, the county town of Westmeath, Ireland, on the Royal Canal, 44 miles north-west of Dublin, in direct communication by rail with every part of Ireland.

It is the centre of the trade of the district, with regular markets and fairs. A post office has been erected. Population (1881) 4787; (1901), 4504.

Multán, or MOOLTAN, a city and district of British India, in the Lahore division of the Punjab. The city is 4 miles from the left bank of the Chenab, near the ancient confluence of the Ravi with that river; it has a railway station. Population (1881), 68,674; (1891), 74,562; municipal income (1897–98), Rs.1,62,275; death-rate (1897), 30 per thousand. The cantonments can accommodate a battery of artillery and four regiments of infantry. It has manufactures of carpets, silk and cotton goods, shoes, glazed pottery and enamel work, and an annual horse fair. It is a station of the Church Mission. There are three high schools (municipal, mission, and Anglo-Sanskrit), a normal school, six printing-presses, and Hindu and Mahommedan associations.

The district of MOOLTAN occupies the lower angle of the Bari Doab, or tract between the Sutlej and the Chenab, with an extension across the Ravi. Area, 6079 square miles; population (1881), 551,964; (1891), 631,434; and (1901), 710,548, showing an increase of 14 per cent., due to the extension of irrigation, between 1881 and 1891, and of 12·5 per cent. between 1891 and 1901; average density, 117 persons per square mile. The land revenue and rates in 1897–98 were Rs.10,57,337, the incidence of assessment being Rs.0 : 4 : 5 per acre; cultivated area, 679,412 acres, of which 582,500 were irrigated, including 427,059 from Government canals; number of police, 762; number of schools (1896–97), 263, attended by 7338 boys, being 11·9 per cent. of the boys of school-going age; death-rate (1897), 33·5 per thousand. The principal crops are wheat, millet, pulse, oil-seeds, cotton, and indigo. There are twenty factories for ginning and pressing cotton. Indigo is made only by native processes. Irrigation is largely conducted by inundation channels from the boundary rivers, but the centre of the district is absolutely barren. The district is traversed by the main line of the North-Western Railway from Lahore, which crosses the Sutlej by the Empress bridge opposite Bahawalpur, 130 miles. It is also entered by the branch from Lyallpur to Khanewal junction, crossing the Ravi. The boundary rivers are navigable for a total length of 344 miles.

Mun, Adrien Albert Marie de, COUNT (1841–——), French politician, was born at Lumigny, in the department of Seine-et-Marne, on 28th February 1841. He entered the army as an officer in the Chasseurs, saw much service in Algeria, and took part in the fighting around Metz in 1870. On the surrender of Metz, he was sent as a prisoner of war to Aix-la-Chapelle, whence he returned in time to assist at the capture of Paris from the Commune. Deeply attached to the Roman Catholic Church, and moved with pity by the condition of the working classes, he resolved to devote his life to forwarding these two interests in common. His impassioned and stately eloquence made him the most prominent member of the Cercles Catholiques d'Ouvriers, and his attacks on the Republican social policy evoked a prohibition from the Minister of War. He thereupon resigned his commission (November 1875), and in the following February stood as Royalist and Catholic candidate for Pontivy. The whole influence of the Church was exerted to secure his election, and the Pope himself, during its progress, sent him the Order of St Gregory. He was returned, but the election was declared invalid. He was re-elected, however, in the following August, and continued to sit, with a short interval, for the same constituency till 1893. The system that he advocated in and out of Parliament was a reversion to the guilds of the Middle Ages. His Christian Socialism differed from the Socialism that relies mainly on State intervention in desiring the regulation of labour by a patriarchal organization, in which employer and employed should live and work "side by side, like the members of a single family." But, pending the realization of these principles, he urged on the State the adoption of remedial measures, such as the prohibition of female labour in factories, compulsory insurance against accidents, and the fixing of a minimum wage. The proposals of successive Republican governments on secondary education and on the increase of the army found in him a warm opponent. He was, indeed, for many years the most conspicuous leader of the anti-Republican party. As far back as 1878 he had declared himself opposed to universal suffrage, a declaration that lost him his seat from 1879 to 1881. He spoke strongly against the expulsion of the princes, and it was chiefly through his influence that the support of the Royalist party was given to General Boulanger. But as a faithful son of the Church, he obeyed the encyclical of 1892, and declared his readiness to support a Republican government, provided that it respected religion. In the following January he received from the Pope a letter commending his action, and encouraging him in his social reforms. He was defeated at the general election of that year, but in 1894 was returned for Morlaix, for which he has since continued to sit. In 1897 he succeeded Jules Simon as a member of the French Academy. This honour he owed to the purity of style and remarkable eloquence of his speeches, which, except a few pamphlets, form his only published work. He took a conspicuous part in the debates on the Dreyfus question, and fought with rare pertinacity and skill against the Associations Bill of 1901, in which, however, he failed to effect any considerable modification.

Muncie, a city of Indiana, U.S.A., capital of Delaware county, on the West Fork of White river, and the Lake Erie and Western, the Cleveland, Cincinnati, Chicago and St Louis, and the Fort Wayne, Cincinnati and Louisville railways, in the eastern part of the state, at an altitude of 950 feet. It is within the natural gas belt, and has extensive manufactures of iron and steel, glass and paper. In 1900 there were altogether 347 manufacturing establishments, with a total capital of $7,793,832, an average number of 6294 wage-earners, and products valued at $12,106,648. Population (1890), 11,345; (1900), 20,942, of whom 1235 were foreign-born and 739 negroes.

Mundella, Right Hon. Anthony John (1825–1897), educational and industrial reformer, was of Italian extraction, and was born at Leicester in 1825. After a few years spent at an elementary school, he was apprenticed to a hosier at the age of eleven. He afterwards became successful in business in Nottingham, filled several civic offices, and was known for his philanthropy. He was sheriff of Nottingham in 1853, and in 1859 organized the first courts of arbitration for the settlement of disputes between masters and men. In November 1868 he was returned to Parliament for Sheffield as an advanced Liberal. He represented that constituency until November 1885, when he was returned for the Brightside division of Sheffield, which he continued to represent until his death. In the Gladstone Ministry of 1880 Mundella was Vice-President of the Council, and shortly afterwards was nominated fourth Charity Commissioner for England and Wales. In February 1886 he was appointed President of the Board of Trade, with a seat in the Cabinet, and was sworn a member of the Privy Council. In August 1892, when the Liberals again came into power, Mundella was again appointed President of the Board of Trade, and he continued in this position until 1894, when he resigned office. His resignation was brought about by his connexion with a financial company which went into liquidation in circumstances calling for the official intervention of the Board of Trade. However innocent his own connexion with the company was, it involved him in a good deal of unpleasant public discussion, and his position became untenable. Having made a close study of the educational systems of Germany and Switzerland, Mundella was an early advocate of compulsory education in England. He rendered valuable service in connexion with the Elementary Education Act of 1870, and when he became head of the Education Department, he made compulsion universal by the passing of the Universal Bye-Laws Act. The Educational Code of 1882, which was specially distinguished in educational circles as the "Mundella Code," marked an entirely new departure in the regulation of public elementary schools and the conditions of the Government grants. It inaugurated a system by which greater recognition was given to intelligent teaching and good management, and, by encouraging the cleverest and most industrious teachers, tended to secure for the children and for the State the best possible results. The seventh standard was a creation of the Mundella Code, and increased help was given to evening schools. Mundella also took an active interest in higher and technical education, as well as in the multiplication of art schools. He was likewise a firm supporter of trade unions, and did much towards securing from Parliament the emancipation of these bodies. To his initiative was chiefly due the Factory Act of 1875, which established a ten-hours day for women and children in textile factories; and the Conspiracy Act, which removed certain restrictions on trade unions. It was he also who established the Labour Department of the Board of Trade, and founded the *Labour Gazette*. He introduced and passed Bills for the better protection of women and children in brick-yards, and for the limitation of their labours in factories; and he effected substantial improvements in the Mines Regulation Bill, and was the author of much other useful legislation. In recognition of his efforts, a marble bust of himself, by Boehm, subscribed for by 80,000 factory workers, chiefly women and children, was presented to Mrs Mundella. He died in London, 21st July 1897.

Münden, a town of Prussia, province of Hanover, picturesquely situated at the confluence of the Fulda and the Werra, 21 miles north-east of Cassel by rail. It is an ancient place, municipal rights having been granted in 1247. A few ruins of its former walls still survive. The large Lutheran church of St Blasius (14th–15th centuries) contains the sarcophagus of Duke Erik I. of Brunswick-Kalenberg (died 1540) and his wife. The 13th-century church of St Ægidius was injured in the siege (by Tilly) of 1625, but subsequently restored. There is a new Roman Catholic church (1895). The town hall (1619), and the ducal castle, built by Duke Erik II. in 1571, and rebuilt in 1898, are the principal secular buildings. In the latter are the municipal museum and the collection of the forestry academy (1869). There are various small industries, and a trade in timber. Population (1885), 7053; (1900), 10,546.

Muni River Settlement (Spanish). See Fernando Po.

Munich, the capital of Bavaria, and the third (1900) largest town in the German empire, near the middle of southern Bavaria, about half-way between Strasburg and Vienna, in 48° 8′ 45″ N. and 11° 36′ 24″ E. (observatory), on the river Isar, in the district of Upper Bavaria, and 25 miles north of the foot-hills of the Alps. The process of converting Munich from a provincial capital into a great continental capital, which was begun shortly before the middle of the 19th century, is still being pursued. As opportunity offers, the narrow streets of the older city are being converted into broad, straight boulevards, lined with palatial mansions and public buildings of architectural pretensions, whilst at the same time building is going on apace in the suburbs—*e.g.*, Giesing, Schwabing, Nymphenburg, and in the quarter south of the English Garden. The hygienic improvement effected by these changes is shown by the mortality averages—40·4 per thousand in 1871–75, 30·4 per thousand in 1881–85, and 24·1 per thousand in 1896–98. The architectural style which has been principally followed in the later public buildings (*e.g.*, the law courts, finished in 1897, the artists' club, the German Bank, St Martin's hospital), as well as in numerous private dwellings, is the Italian and French Rococo or Renaissance, adapted to the traditions of Munich architecture in the 17th and 18th centuries. The new Bavarian National Museum (1899), at the south-east corner of the English Garden, is, however, a free adaptation of the native Renaissance style of the end of the 15th century. Amongst half a dozen new churches, the most noteworthy are St Luke's (Evangelical), a Transitional building, with an imposing dome, finished in 1896; the church of the Giesing suburb, Gothic, with a tower 312 feet high and rich interior decorations (1866–84); and the synagogue (1884–87), in the Romanesque style. Amongst other structures and institutions are the new building of the art association, the museum of plaster casts, and the ethnographical museum, all three in the arcades of the royal garden behind the palace; the academy of the plastic arts (1874–85), in the Renaissance style, situated just outside the gate of victory; the antiquarium, a collection of Egyptian, Greek, and Roman antiquities, under the roof of the new Pinakothek; the Bavarian army museum, in the arsenal; the Schack gallery, bequeathed to the German emperor by Count Schack in 1894, and rich in works by modern German artists; the historical museum and the Maillinger collections of art and civilization, both belonging to the town; the Lotzbeck private collection of sculptures and paintings; and the Ludwig Bridge across the Isar (1890–1891). Further, handsome additions have been made to the public monuments which adorn the streets and squares, including the Wittelsbach Fountain (1895), the monument to the Bavarian army (1892), the monument commemorative of the peace of 1871 (1900), and the marble statue of Liebig (1805–73), the chemist, set up in 1883. Munich in recent years has become one of the principal, if not the principal, art centre of Germany; and in music it is supreme. Among the educational and charitable institutions may be mentioned the technical high school (1865–1868), which in 1899 acquired the privilege of conferring the degree of doctor of technical science; the new military school, military academy, and cadet corps' establishment; the university agricultural college, the Max Joseph educational institute, the Roman Catholic theological seminary, the new deaf and dumb asylum, the St Martin's hospital, the medical and other scientific institutes of the university, the school of the building arts, the hydrographic school, art school, music school, teachers' seminary, industrial and commercial schools, and technical schools. The royal library now contains some 1,300,000 volumes and about 30,000 MSS., several of the latter of unique value; and the university library contains about 300,000 volumes. In 1900 the university, which had 194 professors and teachers, was attended by 4391 students. On the east side of the Isar is the new Maximilian park. During the last six months of 1897 and the first six months of 1898, 71,095,400 gallons of beer were made, of which about 25 millions were exported to foreign countries and other parts of Germany, the rest being consumed in Munich. (See further under Bavaria.) The restaurants and gardens attached to the breweries play a most important part in the social life of the people, and some of the former, *e.g.*, the Hofbräuhaus, are edifices of truly palatial pretensions. Indeed, the remarkable

"THE LAST DAY OF A CONDEMNED PRISONER." BY MUNKACSY.

(By permission of C. Sedelmeyer, Paris.)

number of nearly 12,000 persons depend for a livelihood upon inn and restaurant keeping, and of this number no fewer than 8500 are women. The building and equipment of powerful electric supply works at Höllriegelsgereut on the Isar, a few miles above Munich, has led many industrial establishments to remove out of the city to Sendling and over a score of villages in the neighbourhood. At Planegg near by and at Harlaching, to the south of the city, sanatoria were opened in 1898 and 1900 respectively. Population (1885), 280,373; (1890), 349,024; (1900), 499,959. In 1890 the suburbs of Schwabing and Neuhausen were incorporated in the city.

See *Münchener bürgerliche Baukunst der Gegenwart*, a series of sixty plates, Munich, 1898–99.

Munkács, a corporate town of north-eastern Hungary, in the county of Bereg, with 11,142 inhabitants in 1891, and 14,416 in 1901, situated near the Latorcza, where the hills touch the plains. Its most noteworthy buildings are the upper gymnasium, barracks for "honvéds," the Greek Catholic cathedral, the theatre, and the beautiful castle of Count Schönborn. In the vicinity of the town stands, on a steep hill 580 feet high, the old fort of Munkács, which played an important part in Hungarian history, and was famous especially for its heroic defence by Helene Zrinyi, wife of Emeric Tököli and mother of Francis Rákóczy II., for three years against the Austrians. It was afterwards used as a prison. Ypsilanti, the hero of Greek liberty, and Kazinczy, the regenerator of Hungarian letters, were confined in it. According to tradition, it was near Munkács that the Hungarians, towards the end of the 9th century, entered the country. To commemorate this, it was proposed to erect a statue of Árpád; in 1896 in the fort was built one of the "millennial monuments" established at seven different points of the kingdom.

Munkacsy, Michael von (1844–1900), a painter, whose real name was MICHAEL [MISKA] LEO LIEB, was the third son of Michael Lieb, a collector of salt-tax in Munkács, Hungary, and of Cäcilia Röck. He was born in that town on the 20th of February 1844. In 1848 his father was arrested at Miskolcz for complicity in the Hungarian revolution, and died shortly after his release; a little earlier he had also lost his mother, and became dependent upon the charity of relations, of whom an uncle, Röck, became mainly responsible for his maintenance and education. He was apprenticed to a carpenter, Langi, in 1855, but shortly afterwards made the acquaintance of the painters Fischer and Szamossy, whom he accompanied to Arad in 1858. From them he received his first real instruction in art. He worked mainly at Budapest during 1863–65, and at this time first adopted, from patriotic motives, the name by which he is always known. In 1865 he visited Vienna, returning to Budapest in the following year, and went thence to Munich, where he contributed a few drawings to the *Fliegende Blätter*. About the end of 1867 he was working at Düsseldorf, where he was much influenced by Ludwig Knaus, and painted (1868–69) his first picture of importance, "The Last Day of a Condemned Prisoner," which was exhibited in the Paris Salon in 1870, and obtained for him a *médaille unique* and a very considerable reputation (see Plate). He had already paid a short visit to Paris in 1867, but on the 25th of January 1872 he took up his permanent abode in that city, and remained there during the rest of his working life. Munkacsy's other chief pictures are "Milton dictating *Paradise Lost* to his Daughters" (Paris Exhibition, 1878), "Christ before Pilate" (1881), "Golgotha" (1883), "The Death of Mozart" (1884), "Arpad, Chief of the Magyars, taking possession of Hungary," painted for the new House of Parliament in Budapest, and exhibited at the Salon in 1893, and "Ecce Homo." He had hardly completed the latter work when a malady of the brain overtook him, and ultimately proved fatal. He died on the 30th April 1900, at Endenich near Bonn. Just before his last illness he had been offered the directorship of the Hungarian State Gallery at Budapest. Munkacsy's masterly characterization, force, and power of dramatic composition secured a great vogue for his works, but it is very doubtful if his reputation will be maintained at the level it reached during his lifetime. "Christ before Pilate" and "Golgotha" are said to have been sold for £32,000 and £35,000 respectively to an American buyer. Munkacsy received the following awards for his work exhibited at Paris: Medal, 1870; Medal, 2nd class; Legion of Honour, 1877; Medal of Honour, 1878; Officer of the Legion, 1878; Grand Prix, Exhibition of 1889; Commander of the Legion, 1889.

See F. WALTHER ILGES. "M. von Munkacsy," *Künstler Monographien*, 1899.—CH. SEDELMEYER. *Christ before Pilate.* Paris, 1886.—J. BEAVINGTON ATKINSON. "Michael Munkacsy," *Magazine of Art*, 1881. (E. F. S.)

Munro, Hugh Andrew Johnstone (1819–1885), British scholar, was born at Elgin on 19th October 1819. He was educated at Shrewsbury School, where he was one of Kennedy's first pupils, and proceeded to Trinity College, Cambridge, in 1838. He became scholar of his college in 1840, second classic and first chancellor's medallist in 1842, and fellow of his college in 1843. He became classical lecturer at Trinity College, and in 1869 was elected to the newly-founded chair of Latin at Cambridge, but resigned it in 1872. The great work on which his reputation is mainly based is his edition of Lucretius, the fruit of the labour of many years (1860, 1864). A scholar of wide sympathies, he had yet made Latin poetry his special subject. His extensive knowledge of and enthusiasm for modern poetry found scope in the interpretation of the magnificent outbursts that relieve the exposition of Lucretius's theories, and enabled him to correct the frigid pedantries of his predecessor, Lachmann. His travels in Italy often guided him to a correct interpretation of the landscapes of Lucretius. As a textual critic his knowledge was profound and his judgment unrivalled. But beyond the bounds of pure scholarship, the editing of Lucretius demands an intimate knowledge of ancient philosophy. Munro's commentary bears ample testimony to the extent of his philosophical reading. He had indeed, as early as 1855, marked an epoch in the study of Aristotle's Ethics by his theory that books v. to vii. are the work of Eudemus. In yet another branch of classical antiquity, the study of archæology, he had made himself a master by frequent travels in Italy and Greece. Unfortunately, he gave to the world but few specimens of his powers. In 1867 he published a greatly improved text of *Aetna* with commentary, and in the following year a text of Horace with critical introduction, illustrated by specimens of ancient gems selected by C. W. King. His ripe knowledge and fine taste are nowhere better shown than in his *Criticisms and Elucidations of Catullus* (1878). He was a master of the art of Greek and Latin verse composition. His contributions to the famous volume of Shrewsbury verse, *Sabrinæ Corolla*, are among the most remarkable of a remarkable collection. His *Translations into Latin and Greek Verse* were privately printed in 1884. Like his translations into English, they are characterized by minute fidelity to the original, but never cease to be idiomatic. The combination of all these gifts secured him, by general consent, the first place among the Latin scholars of his age. He died at Rome on 30th March 1885. (H. SY.)

Münster, a town and episcopal see of Prussia, capital of the province of Westphalia, on the Dortmund–Ems canal, and at the junction of several railways, 107 miles south-west of Bremen. The tower of the Lambert church was rebuilt, to the height of 312 feet, in 1887–98, and the three iron cages were restored to their original places. A new Evangelical church was built in 1898. In 1889 a new building was erected for the municipal archives. Other edifices of modern date are the Government offices (1886–89), the post office (1878–80), the academy building (1878–80), and a synagogue (1880). The castle (begun in 1767) is the headquarters of the 7th German Army Corps. Amongst the public institutions may be mentioned the provincial assembly house, a gaol, the museum of Christian art (1866), the provincial museum of natural science, a theological seminary, teachers' seminaries, and colleges for theological candidates. A bronze equestrian statue of the Emperor William I. (1897) by Reusch, a war monument (1872), and the bronze figure of a Westphalian peasant (the *Kiepenkärl*, 1896) lend embellishment to the town. The academy was attended by 691 students (Roman Catholic) in 1900, the number of professors being 48. In the Royal Pauline Library there are about 120,000 volumes. There is an agricultural experimental station. Population (1885), 44,060; (1900), 63,776.

Münster, a town of Germany, in Alsace-Lorraine, district of Upper Alsace, at the east foot of the Vosges Mountains, 16 miles west by south of Colmar by rail. It is a flourishing place, with good houses and a new Evangelical church, and considerable manufacture of calico, cotton, and cloth. Population (1900), 6083.

Münster am Stein, a watering-place of Prussia, in the Rhine province, on the Nahe, 2½ miles south of Kreuznach, with brine springs (87° Fahr.). Above the village are the ruins of the castle of Rheingrafenstein (12th century), the seat of the counts of the Rhine, destroyed by the French in 1689, and those of the castle of Ebernburg, the ancestral seat of the lords of Sickingen, and birthplace of Franz von Sickingen (1481–1523), the famous lansknecht captain and protector of Ulrich von Hutten, to whom a monument was erected on the slope leading up to the ruins in 1889. Population (1900), 826.

Münsterberg, a town of Prussia, province of Silesia, on the Ohlau, 36 miles by rail south of Breslau. It was the former capital of the principality of Münsterberg, which existed from the 14th century down to 1791, when it was purchased by the Prussian crown. It has manufactures of drain-pipes and fireproof bricks; there are also sulphur springs. Population (1900), 8159.

Mural Decoration.—Mural decoration, it might be said, is the first and the last word of art, at least with the races of mankind who have acquired the habit of living in erected dwellings, with the craft of building walls. Primitive and prehistoric drawings and scratched outlines have been found upon the walls of caves, but it has only been with those races and in those countries where the craft of building has been practised that mural decoration has developed. The tendency to scribble and draw rude designs upon any blank wall-surface is observable anywhere and everywhere in our towns and villages, and our children only repeat in so doing the efforts of our primitive ancestors. At first, no doubt, with them, as with our children, the desire is to represent, or to record, some observed fact, or to symbolize something which has impressed their imagination, and this with gradually acquired skill becomes picture-writing, and finally a conscious aim at decorative mural effect. The ancient Egyptians realized to the full the value as mural surfaces of the white plastered walls of their temples and tombs as fields for simple mural painting in tempera in bright primary colours, in which the figures, as in all ancient mural art, are represented as on one plane and in profile, outlined and filled in flat local colours without shadow. This system of treatment, unconsciously perhaps, illustrates, in their simplest form, what may be termed the chief decorative principles of mural decoration, which, however varied, added to, or enriched by succeeding ages and stages of more complex and more conscious art, continually reassert themselves to correct excesses and that tendency to escape from real limitations which so frequently characterizes the evolution of the arts. Upon the external walls of their stone temples, at a later date, to give greater emphasis, the outlines of the figures and shapes of the hieroglyphics were chiselled. This probably led in course of time to the complete bas-relief so largely used by the Assyrians and the Persians in the decoration of the large mural surfaces of their palaces. With the Persians, indeed, as we may see in the coloured and glazed brick frieze of archers from the palace of Darius, or fortress of Susa, construction and decoration are one, since the figures—a repetition of two patterns used alternately, with repeating borders—are built up of separate bricks. Presumably, however, the figures were first modelled upon a slab of clay and afterwards cut up into separate bricks

We see low-relief sculpture, as a mural decoration intended for colour, carried to its perfection in the panathenaic frieze of the Parthenon at Athens, where, however, the Asiatic tradition in the simplicity of the processional and profile arrangement survives, and the single figures are shown on the same plane, and though the horsemen are represented one behind the other, or overlapping, there is but slight acknowledgment of distance. All the subtlety and exquisite refinement of an accomplished sculpture of the Phidian period seem concentrated in the work, which even without colour, as we see the frieze now, is yet full of the decorative effect of rhythmic recurring line and carefully planned balance of masses. The frieze as a whole, although full of life, variety, and movement, illustrates at once the acme of slab-sculpture and the gravity and restraint of true mural decoration.

The principles of mural decoration which dominated Roman civilization may be learnt from the painted walls of the Palatine, and the plaster and stucco reliefs of the tombs of the Latin Way, and the paintings of Pompeii. In these a different feeling comes in. We seem to see some aim at the expression of space and distances, though the main fields of colour upon the wall are still flat. We have fanciful arcades and pilasters, and hanging wreaths and garlands, subjects in separate panels, both figures and landscapes as well as still life, and the use of shadow and modelling in the representation of form; red, black, yellow, and turquoise being the prevailing colours of the grounds and panelled spaces of the wall. On the whole it is a type of mural decoration which seems to have been influenced by the modeller and relief sculptor and architect, and though graceful and often fanciful and even grotesque, has not the dignity and gravity of the Greek or the Asiatic. Raphael and his pupils in his Loggia revived it, and it has survived, more or less, in the mural decoration of Renascence buildings from that time onwards.

A more solemn and splendid type of mural decoration comes to us from the Christianized Greeks in the mosaics of St Sophia, of the churches of Ravenna of the 5th and 6th centuries, and of St Mark's at Venice. Strictly mural alike in structure, method, and effect, no decoration, perhaps, at its best is so impressive or so magnificent, and none seems so perfectly united with the architectural style and construction with which it is associated as mosaic.

As a consequence, perhaps it is the most difficult method to use with success in a building not originally intended for such decoration, or where carved architectural ornament competes with it, especially where the difficulty exists (which is always present) when it is sought by moderns to decorate a building of another age.

Upon the Byzantine traditions brought by Greek artists to Italy were founded her great schools of mural painting. Giotto showed much of the simplicity, directness, and decorative quality of the Byzantine, united with a new infusion of life and nature in the greater ease and freedom natural to the fresco painter. Fresco painting became the mural decoration and the distinctive language of artistic expression in Italy from the 13th to the 16th century, and the Latin race has set the type for mural decoration by painting ever since. Between the Arena chapel at Padua and the Sistine chapel at Rome we may find the whole story of its development, and very splendid the record is.

Such is a very brief and rough sketch of the historic background of mural painting before, in changing conditions, oil-painting and the portable easel picture displaced it —not, however, until mural painting in fresco and tempera had itself declined. Modern efforts at revival of mural painting have looked back to Italy for instruction in method and use of material, but all countries sooner or later, despite the effect of the interchange of ideas and knowledge of other countries and their arts, must be driven to adopt or to invent their own proper forms of mural decoration. Many efforts have been made in England to revive fresco painting. The Houses of Parliament bear witness to this, the principal works there being those of William Dyce and Daniel Maclise. That of G. F. Watts, whose easel work also is generally distinguished by its mural feeling, is full of serious purpose and dignity of conception too rarely employed. "Buono fresco" (the painting in tempera upon a freshly laid ground of plaster while wet), "spirit fresco" or Gambier-Parry method (the painting with a spirit medium upon a specially prepared plaster or canvas ground [1]), and "water-glass" painting (wherein the method is similar to water-colour painting on a prepared plastered wall, the painting when finished being covered with a chemical solution which hardens and protects the surface), have all been tried. Other processes are also in the experimental stage, such as that known as Keim's, which has been successfully tried by Mrs Merritt in a series of mural paintings in a church at Chilworth. Unless, however, some means can be found of enabling the actual painted wall to resist the natural dampness of the English climate, it does not seem likely that true fresco painting can ever be really naturalized in Great Britain. Of two of the few modern artists entrusted with important mural work in England, Ford Madox Brown and Frederick J. Shields, the former, distinguished especially for his fine series of mural paintings in the Manchester Town Hall, in the later paintings there adopted the modern method of painting the design upon canvas in flat oil colour, using a wax medium, and afterwards affixing the canvas to the wall by means of white lead. This is a usual method with modern decorators. Mr Shields has painted the panels of his scheme of mural decoration in the chapel of the Ascension at Bayswater, London, also upon canvas in oils, and has adopted the method of fixing them to slabs of slate facing the wall so as to avoid the risk of damp from the wall itself. Friezes and frieze panels or ceilings in private houses are usually painted upon canvas in oil and affixed to the wall or inserted upon their strainers, like pictures in a frame. (The present writer has used fibrous plaster panels, painting in ordinary oil colours with turpentine as a medium, as in Redcross Hall.) Recently there has been a revival of tempera painting, and a group of painters are producing works on panel and canvas painted in tempera or fresco secco, with yolk of egg as a medium, according to the practice of the early Italian painters and the directions of Cennino Cennini. A remarkably pure and luminous quality of colour is produced by this method, very valuable in mural decoration and also very durable, especially under varnish. There seems no reason why tempera painting should not be used for mural work on fibrous plaster panels, which, being hollow at the back, preserve their dryness. Tempera work can be readily cleaned with bread.

For the decoration and covering of the lower walls of churches, public buildings, and private dwellings, wood-panelling, with or without intarsia, silk hangings, or arras tapestry, have been the principal means from the later Middle Ages to our times, and they still obtain, at least in the houses of the rich. For interior walls, churches, and also in exterior mural decoration on secular buildings, sgraffito might be named as another method recently revived. It consists in cutting or scratching a design through a thinnish surface coat of plaster on to black or various colours previously laid beneath upon the wall. A series of experiments in this method (by the late Mr Moody and his pupils) may be seen on the east wall of the Royal College of Science, Exhibition Road, London. Mr Heywood Sumner has also decorated churches in this method, which is very durable, and being composed of coats of plaster, becomes essentially a part of the wall.

Wall-papers.—For the mural decoration of the house of the ordinary citizen, however, the above-mentioned methods are usually out of reach. The kind of mural decoration in most general use is wall-paper. This was no doubt at first a substitute for textile hangings, and we may still notice how, in type of pattern, wall-paper design is largely influenced by textile hangings. The earliest known example of wall-paper probably dates from the 16th century, but it does not appear to have come into general use until the 18th century. In the 19th century, in design wall-paper closely reflects prevailing taste and modes in decoration and furniture, changing as these have changed. Many eminent designers have given their attention to this sort of design, which demands much ingenuity and taste; among these may be named B. J. Talbot, J. D. Sedding, Lewis F. Day, C. F. A. Voysey, Heywood Sumner, Henry Wilson, &c. William Morris was very successful in changing the public taste and lifting it to higher standards in this direction, causing a strong revulsion of feeling for patterns of much more strictly mural type and mediæval in treatment. He adopted patterns from Venetian, Indian, and old English sources, while his own designs were emphatically mediæval in inspiration. Consisting at first of the repetition of a few simple floral units (like "the Daisy"), they became in his later time very rich and complex; but all, whether gay or quiet in colour, possessed the distinctive mural quality, forming good backgrounds, never in any way imitative; and though showing, as might be expected, a certain textile influence in their forms and spacing, they were always essentially patterns entirely adapted to their method—block-printing. The best wall-papers are printed from wood blocks upon which the pattern is cut, requiring a different block for each colour used, the outlines being formed of brass or copper strips set edgeways in the wood block, forming a kind of cloisonné. The flat colours form the surfaces of the block left by the cutter of the pattern. The colours are printed in succession as each printing dries, and by hand. Thus the size of the block which governs the width and depth of the repeat is necessarily limited—a square of 21 inches being usual; though greater depth is sometimes allowed, the 21-inch width is never exceeded, except in the case of friezes, which have occasionally run to 42 or more inches wide, though they are never deeper than 21 inches. Wall-papers are also stamped with raised patterns, in emulation of stamped leather, and gilded and lacquered. The cheapest kind of wall-paper is that produced by machine, and is printed from rollers, the outlines of the design being formed of brass or copper wire let into the wood of the rollers, the repeat, of course, corresponding to the circumference of the roller, each colour being printed in succession from a corresponding roller. Papers printed by this method never attain the precision, quality of tint, or finish of the block-printed

[1] It was in this method that the lunettes by Lord Leighton at the Victoria and Albert Museum were painted on the plaster wall. The same painter produced a fresco at Lyndhurst Church, Hants.

papers. Another kind, by which a certain quality of surface and depth of colour are given, is called flock. This might have originated in the attempt to imitate or to vie with cut velvet hangings and brocade. The ground colours are printed as before from blocks, the parts of the pattern intended to be raised in flock are printed in size, and the paper is then passed through a kind of well or trough of dry finely-powdered fibre, like dust, stained to the desired tint. The bottom of this well or trough of coloured fibre is flexible and is beaten up with sticks to keep the powdered fibrous colour flying, and enable it to settle evenly to the thickly-sized parts of the pattern, which when finished stand up in relief like the pile of velvet or carpet, though closer and harder. Bold patterns suitable for stencils or for stamped or cut velvets are the most effective in this process, but it is questionable whether paper-staining is not attempting to pass beyond its natural limitations in thus emulating effects which can only be satisfactorily obtained in textiles.

Stencilling.—Another and, in its simpler forms, cheaper and readier method of decorating walls is stencilling. There has been a considerable revival of this method, and the designs shown by various schools of the United Kingdom in the national competition at South Kensington often display remarkable ability in design and dexterity in the cutting and use of stencils. In some cases, indeed, there has been a tendency to over-elaborate, and by the use of blended tints to obtain effects from the method which its mechanical conditions hardly justify. The pattern is cut out of Bristol board or thin sheets of zinc, and so contrived that its parts are held together by what are called ties. In a stencil pattern the forms are blocked out in masses isolated from each other by lines. In the stencil the parts to appear in colour on the wall are holes, the separating lines and ties are solid and stop out the colour, and so when the stencil plate is applied to the wall and the colour painted through, by dabbing a stiff brush on the open parts, the dividing lines and ties appear white, or in the ground tint of the wall or hanging upon which the plate is laid. It may be made a tasteful and effective method of covering large wall surfaces, and is sometimes applied to hangings of various kinds. House painters and decorators do not use stencils much except for small borderings and corners, where they usually have a mean and cheap effect; but used as a means of covering a wall with a bold field of floral repeating pattern of an abstract kind, they may be quite sufficient and agreeable.

As to mural painting and decoration generally, it is to be regretted that more opportunities are not afforded to artists to exercise themselves in this highest field of design. Indeed, it would appear that the real modern equivalent for mural decoration as a popular art is only to be found in the coloured poster which covers the dead walls and temporary hoardings of our towns and cities, among which many clever designs have appeared; but while this class of work certainly frequently demands figure design upon a large scale and bold and simple colouring, the commercial exigencies and necessities of its very existence have a hopelessly vulgarizing effect, so that a serious school of design cannot be expected to arise out of such conditions. (W. Cr.)

Muravieff, Michael Nikolaievitch, Count (1845–1900), Russian statesman, born 19th April 1845, was the son of General Count Nicholas Muravieff (governor of Grodno), and grandson of the Count Michael Muravieff who became notorious for the drastic measures he employed in stamping out the Polish insurrection of 1863 in the Lithuanian provinces. He was educated at a secondary school at Poltava, and was for a short time at Heidelberg University. In 1864 he entered the chancellery of the Minister for Foreign Affairs at St Petersburg, and was soon afterwards attached to the Russian legation at Stuttgart, where he attracted the notice of Queen Olga of Würtemberg. He was transferred to Berlin, then to Stockholm, and back again to Berlin. In 1877 he was second secretary at The Hague. During the Russo-Turkish war of 1878 he was a delegate of the Red Cross Society in charge of an ambulance train provided by Queen Olga of Würtemberg. After the war he was successively first secretary at Paris, chancellor of the embassy at Berlin, and then minister at Copenhagen. In Denmark he was brought much into contact with the Imperial family, and on the death of Prince Lobánof in 1897 he was appointed by the Tsar Nicholas II. to be his Minister of Foreign Affairs. The next three and a half years were a critical time for European diplomacy. The Chinese and Cretan questions were disturbing factors. As regards Crete, Count Muravieff's policy was vacillating; in China his hands were forced by Germany's action at Kiaochow. But he acted with singular *légèreté* with regard at all events to his assurances to Great Britain respecting the leases of Port Arthur and Talienwan from China; he told the British ambassador that these would be "open ports," and afterwards essentially modified this pledge. When the Tsar Nicholas inaugurated the Peace Conference at The Hague, Count Muravieff dexterously extricated his country from a situation of some embarrassment; but when, subsequently, Russian agents in Manchuria and at Peking connived at the agitation which culminated in the Boxer rising of 1900, the relations of the responsible Foreign Minister with the Tsar became strained. Muravieff died suddenly on 21st June 1900, of apoplexy, brought on, it was said, by a stormy interview with the Tsar. He was a man of imperturbable self-confidence, but a political opportunist.

Murcia, a maritime province in the south-east of Spain; area, 4478 square miles. It is divided into ten administrative districts and parishes. Population (1887), 491,436; (1897), 518,263. The birth-rate is 3·72 per cent., the death-rate 3·14 per cent., the illegitimate births 5·03 per cent. New railway lines have been established.

In 1898 wheat was grown on 367,742 acres; rye, oats, barley, and maize on 547,150 acres; pod fruit on 14,600 acres; vines on 58,309 acres; olives on 66,112 acres. The live stock in that year included 11,054 horses, 34,718 mules, 46,620 asses, 8828 cattle, 225,730 sheep, 89,757 goats, and 44,275 pigs. The mines are very important, and many beds remain unworked for lack of means of communication. The mines actually worked in 1898 were 3 sulphur, 1 zinc, 14 iron, and 295 argentiferous lead mines. They employed 2844 hands, and smelting works 960 more. The mineral output included 10,000 tons of sulphurous ore, 46,716 of zinc, 371,391 of iron ore, 149,652 of argentiferous lead ore, and 12,700 of common salt. The smelting gave 1500 tons of sulphur, 80,018 of argentiferous lead, 8431 of poor grade lead, and 500,000 grains troy of silver. These figures show a considerable increase as regards lead and zinc, but a considerable decrease as regards iron. Manufacturing industries, though of minor importance, are numerous, and commerce is active through the ports.

Murcia, the capital of the province, well served by railways, lies 280 miles south-east of Madrid. Population (1887), 98,538; (1897), 108,408. In outward aspect it has greatly improved: promenades have been extended and laid out anew, churches and monuments have been restored, and the schools for primary and higher education, the hospitals, the provincial museums, the theatres and bull-ring, and the various economic societies have all developed. In addition to the silk industry, manufactures of woollen, linen, and cotton goods, saltpetre, flour, leather, and hats are all deserving of notice.

Murfreesboro, a city of Tennessee, U.S.A., capital of Rutherford county, near Stone river, and on the Nashville, Chattanooga and St Louis Railway, near the centre of the state, at an altitude of 583 feet. It was founded about 1800, and from 1817 to 1827 was the capital of the state. It was the scene of one of the battles of the Civil War known as Stone river or Murfreesboro. This occurred on the 31st of December 1862 to the 2nd of January 1863, between the Union forces under General Rosecrans and the Confederate under General Bragg. Although the action was indecisive, it resulted in the retreat of the Confederates. The Union army lost, out of 43,400 men engaged, 1730 killed, 7802 wounded, and 3717 captured. The Confederates, out of 37,800 men engaged, lost 1294 killed, 7945 wounded, 1027 captured. Population (1890), 3739; (1900), 3999, of whom 31 were foreign-born and 2248 negroes.

Murphysboro, a city of Illinois, U.S.A., capital of Jackson county, on the Big Muddy river, on the Illinois Central and the Mobile and Ohio railways, in the southern part of the state. Population (1890), 3880; (1900), 6463, of whom 557 were foreign-born and 456 were negroes.

Murray, Alexander Stuart (1841——), British archæologist, the eldest son of George Murray of Arbroath, was born 8th January 1841, and educated at Arbroath and Edinburgh High Schools, and at Edinburgh and Berlin Universities. In 1867 he entered the British Museum as an assistant in the Department of Greek and Roman Antiquities under Sir Charles Newton, whom he succeeded in 1886. His younger brother, George Robert Milne Murray, F.R.S., was made keeper of the Botanical Department in 1895, the only instance of two brothers becoming heads of departments at the Museum. In 1873 Dr Murray published a *Manual of Mythology*, and in the following year contributed to the *Contemporary Review* two articles, one on the Homeric question, which led to a friendship with Mr Gladstone, the other on Greek painters. He has also written for the *Nineteenth Century*, the *Quarterly Review*, the *Hellenic Journal*, the *Mémoires et Monuments Piot*, the *Revue Archéologique*, and similar periodicals. In 1880–83 he brought out the *History of Greek Sculpture*, which at once became a standard authority, and a second edition was called for in 1890. As keeper of his department, Dr Murray is acknowledged to have shown remarkably good taste in the arrangement of the collection in the exhibition galleries. In the Mausoleum and Ephesus Rooms he took especial interest, and in the latter are to be seen drawings by him representing a restoration of the Temple of Artemis. In 1886 he was selected by the Society of Antiquaries of Scotland to deliver the Rhind Lectures on archæology, out of which grew his *Handbook of Greek Archæology*, published in 1892, which also has become a standard work. In 1894–96 Dr Murray directed some excavations in Cyprus undertaken by means of a bequest of £2000 from Miss Emma Tournour Turner. These were commenced in 1894 by Mr Arthur H. Smith, and continued in the following year by Mr H. B. Walters, assistants in Dr Murray's department, and in 1896 by Dr Murray in person on a new site near Salamis. The numerous objects obtained, which greatly enriched the national collection, are described and illustrated in a handsome folio volume, *Excavations in Cyprus*, published by the Trustees of the Museum in 1900. Among Dr Murray's other official publications are three folio volumes on *Terra-cotta Sarcophagi*, *White Athenian Vases*, and *Designs from Greek Vases*. In 1898 he wrote for the *Portfolio* a monograph on Greek bronzes, founded on lectures delivered at the Royal Academy in that year, and he has contributed many articles on archæology to the standard publications [illegible] day. In recognition of his services to archæology, [illegible] made LL.D. of Glasgow University in 1887, and elected a corresponding member of the Berlin Academy of Sciences in 1900.

Murray, James Augustus Henry (1837——), lexicographer, was born at Denholm, near Hawick, Roxburghshire, in 1837, and after a local elementary education proceeded to Edinburgh, and thence to the University of London, where he graduated B.A. in 1873. Dr Murray, who holds that honorary degree from several universities, British and foreign, was engaged in scholastic work for thirty years, from 1855 to 1885, chiefly at Hawick and Mill Hill. During this time his reputation as a philologist was steadily increasing, and he was assistant examiner in English at the University of London from 1875 to 1879 and president of the Philological Society of London from 1878 to 1880, and again from 1882 to 1884. It was in connexion with this society that Dr Murray undertook the chief work of his life, the editing of the *New English Dictionary* based on materials collected by the society. These materials, which had accumulated since 1857, when the society first projected the publication of a dictionary on philological principles, amounted to an enormous quantity, of which an idea may be formed from the fact that Dr Furnivall sent in "some ton and three-quarters of materials which had accumulated under his roof." After negotiations extending over a considerable period, the contracts between the society, the Delegates of the Clarendon Press, and the editor were signed on 1st March 1879, and Dr Murray commenced the examination and arrangement of the raw material, and the still more troublesome work of re-animating and maintaining the enthusiasm of "readers." In 1885 Dr Murray removed from Mill Hill to Oxford, where his *Scriptorium* has since ranked among the institutions of the University city. A full account of the commencement of the dictionary and the manner of working up the materials will be found in Dr Murray's presidential address to the Philological Society in 1879, while reports of its progress are given in the addresses by himself and other presidents in subsequent years. In addition to his work as a philologist, Dr Murray has been a frequent contributor to the transactions of the various antiquarian and archæological societies of which he is a member. In 1885 Dr Murray received the honorary degree of M.A. from Balliol College.

Murray, Sir John (1841——), British geographer and naturalist, was born at Coburg, Ontario, Canada, 3rd March 1841, and after some years' local schooling studied in Scotland and on the Continent of Europe. He was then engaged for some years in natural history work at Bridge of Allan. In 1868 he began his career as an explorer by a visit to Spitsbergen on a whaler, and in 1872, when the voyage of the *Challenger* was projected, he was appointed one of the naturalists to the expedition. At the conclusion of the voyage he was made principal assistant in drawing up the scientific results, and in 1882 he became editor of the *Reports*, which were completed in 1896. He himself compiled a summary of the results, and was part-author of the *Narrative of the Cruise* and of the *Report on Deep-sea Deposits*. He also published numerous important papers on oceanography and marine biology. In 1898 he was made K.C.B., and from time to time he was the recipient of many distinctions from the chief scientific societies of the world. Apart from his principal work in connexion with the *Challenger Reports*, he went in 1880 and 1882 on expeditions to explore the Faroe Channel, and between 1882 and 1894 was the prime mover in various biological investigations in Scottish waters. References to the important work done by Sir John Murray will be found under the articles treating of geography, oceanography, &c.

Murray, John, publisher. See PUBLISHING.

Murree, a town and sanatorium of British India, in the Rawalpindi district of the Punjab, 7453 feet above the sea, about five hours by cart-road from Rawalpindi town, and the starting-point for Kashmir. Population (1881), 2489; (1891), 1459; but these figures omit the summer visitors and also the British troops; municipal income (1897–98), Rs.44,620. During 1897 the maximum temperature was 89·7° F. in July, and the minimum was 30° F. in December; the total rainfall was 61 inches. Since 1877 the summer offices of the provincial government have been transferred to Simla. It has hotels, banks, and churches, and the largest brewery in India, established in 1880, with an annual out-turn of more than 1,000,000 gallons. The Lawrence Memorial Asylum for the children of European soldiers had 103 boys and 82 girls in 1896–97, and there are four other schools for Europeans. A water-supply has been provided by the municipality out of a loan of Rs.1,00,000; and a water-rate is charged, yielding Rs.9000.

Murshidabad, or MOORSHEEDABAD (formerly Muxadabad), a town and district of British India, in the Presidency division of Bengal, the administrative headquarters of which are at Berhampur. The town is on the left bank of the Bhagirathi or old sacred channel of the Ganges. Population (1872), 46,182; (1881), 39,231; (1891), 35,576, showing a continuous decrease. It is still the residence of the Nawab, who now ranks only as the first nobleman of the province, with the style of Nawab Bahadur of Murshidabad, instead of Nawab Nazim of Bengal. The city is crowded with palaces, mosques, tombs, and gardens, and retains some of the manufactures of luxury, such as carving in ivory, gold and silver embroidery, and silk-weaving. A college is maintained for the education of the Nawab's family, with 60 pupils in 1896–97, and there is a high school, with 347 pupils. There are eleven printing-presses, issuing three vernacular newspapers.

The district of MURSHIDABAD has an area of 2144 square miles. Population (1881), 1,226,790; (1891), 1,250,946; and (1901), 1,335,374, showing an increase of 2 per cent. between 1881 and 1891, and 6·7 per cent. between 1891 and 1901; average density, 623 persons per square mile. Classified according to religion, Hindus in 1891 numbered 620,163; Mahommedans, 618,653; Christians, 540, of whom 68 were Europeans; aborigines, 9333; Jains, 2257. The land revenue and rates in 1896–97 were Rs.11,51,179; number of police, 768; boys at school (1896–97), 25,631, being 28·2 per cent. of the male population of school-going age; registered death-rate (1897), 28·46 per thousand. The principal industries are silk and indigo, though neither is flourishing. There are nearly 50 silk filatures, employing 12,000 persons, with an out-turn of 538,000 ℔, valued at Rs.30,00,000; and 21 indigo factories, employing 4000 hands, with an out-turn of 2000 maunds, valued at Rs.3,35,000. A narrow-gauge railway crosses the district for 14 miles, from the East Indian line at Nalhati to Azimganj on the Bhagirathi, the home of many rich Jain merchants. The district suffered from drought in 1896–98.

Murtoza, a town of Portugal, district of Aveiro, 6 miles north of Aveiro and on the east side of the lagoon. It is an important fishing centre. In 1900 the population numbered 9881.

Murzuk. See TRIPOLI.

Muscat, MUSKAT, or MASKAT, a town on the south-east coast of Arabia, capital of the province of Oman. Its value as a naval base is derived solely from its position, which gives it the command of the entrance to the Persian Gulf and of the Arabian Sea coast. The little district of Gwadur, wherein lies the chief port of Makrán, belongs to Muscat, and it is by political arrangement with the sultan that the British occupy that port with a telegraph station of the Indo-Persian telegraph service. Muscat is under British political influence, and an Indian political residency is established there. The most remarkable feature in its geographical position is its isolation from the interior of the continent. The mountains rise behind it in a rugged wall, across which no road exists. It is only from Matrah, which may be regarded as a northern suburb shut off by an intervening spur which reaches outwards to the sea, that land communication with the rest of Arabia can be maintained. Both Muscat and Matrah are defended from incursions on the landward side by a wall with towers at intervals. Muscat rose to importance with the Portuguese occupation of the Persian Gulf, and it is still noted for the extent of Portuguese ruins about it. Two lofty forts, of which the most easterly is called Jaláli and the western Meráni, occupy the summits of hills on either side the cove overlooking the town; and beyond them on the seaward side are two smaller defensive works called Sirat. All these old Portuguese constructions are in a ruinous condition. A low sandy isthmus connects the rock and fortress of Jaláli with the mainland, and upon this isthmus stands the British residency. The sultan's palace is a large, three-storeyed building near the centre of the town, a relic of Portuguese occupation, called by the Arabs El Jereza, a corruption of Igrezia (church). This term is probably derived from the chapel which was once attached to the block of buildings which formed the Portuguese governor's residence and factory. The bazaar is insignificant, and its most considerable trade appears to be in a sweetmeat prepared from the gluten of maize. Large quantities of dates are also exported. The early history of Muscat is the history of Portuguese ascendancy in the Persian Gulf. When Albuquerque first burnt the place after destroying Karyát in 1508, Kalhat was the chief port of the coast and Muscat was comparatively unimportant. Kalhat was subsequently sacked and burnt, the great Arab mosque being absolutely destroyed, before Albuquerque returned to his ships, "giving many thanks to our Lord." From that date, through 114 years of Portuguese ascendancy, Muscat was held as a naval station and factory during a stormy period of local revolts, Arab incursions, and Turkish invasion by sea; but it was not till 1622, when the Portuguese lost Hormuz, that Muscat became the headquarters of their fleet and the most important place held by them on the Arabian coast. In 1650 the Portuguese were finally expelled from Oman. Muscat had been much reduced in strength previously by the humiliating terms imposed upon the garrison by the Imam of Oman after a successful siege in 1648. For the short period of five years the Persians occupied Oman, but they disappeared in 1741. Under the great ruler of Omán, Saiad Said din Sultan (1804–56), the fortunes of Muscat attained their zenith; but on his death, when his kingdom was divided and the African possessions were parted from western Arabia, Muscat declined to that second-rate position which it still retains. Its recent history is unimportant. In 1883–84, when Turki was sultan, the town was unsuccessfully besieged by the Indabayin and Rehbayin tribes, led by Abdul Aziz, the brother of Turki. In 1885 Colonel Miles, then resident at Muscat, made a tour through Oman, following the footsteps of Wellsted in 1835, and confirmed that previous traveller's report of the fertility and wealth of the province. In 1898 the French acquired the right to make use of Muscat as a coaling station.

STIFFE ("Trading Ports of Persian Gulf," vol. ix. *Geog. Journal*) gives the most comprehensive account of the port of Muscat which has been published during recent years, if we except the political reports of the Indian Government from the Persian Gulf. Colonel Miles's explorations in Oman will be found in vol. vii. *Journal R.G.S.* 1896. (T. H. H*.)

Muscatine, a city of Iowa, U.S.A., capital of Muscatine county, on the west bank of the Mississippi river, and on the Burlington, Cedar Rapids and Northern and the Chicago, Rock Island and Pacific railways, in the eastern part of the state, at an altitude of 554 feet. The city has extensive manufactures of lumber, iron, brick, tiles, and pottery. In 1900 there were altogether in the city 247 manufacturing establishments, with a total capital of $3,725,971 and products valued at $5,791,110. Population (1890), 11,454; (1900), 14 073, of whom 2352 were foreign-born and 125 negroes.

Muscogee, a town in the Creek Nation, Indian Territory, U.S.A., north of the centre of the territory, on a level plain near the Arkansas river, on the Missouri, Kansas, and Texas Railway, at an altitude of 600 feet. It is the United States headquarters of the territory, the official home of the agent for the Indians, and the headquarters of the United States courts. Its inhabitants consist almost entirely of whites and negroes, as the Indians remain away from the railways. Population (1890), 1200; (1900), 4254, of whom 100 were foreign-born and 1120 negroes.

Muscle. See PHYSIOLOGY.

Museums.—Not the least striking aspect of artistic and educational progress during the last quarter of the 19th century has been the growth and development of museums, both in Great Britain and abroad. This growth, as Prof. Stanley Jevons predicted would be the case, synchronizes with the advancement of education. Public museums are now universally required; old institutions have been greatly improved, and many new ones have been founded. The British Parliament has passed statutes conferring upon local authorities the power to levy rates for library and museum purposes, while on the Continent the collection and exhibition of objects of antiquity and art has become a recognized duty of the state and municipality alike. The modern museum differs essentially from the museum formed a century ago. The aimless collection of curiosities and bric-à-brac, brought together without method or system, was the feature of certain famous collections in bygone days, of which the Tradescant Museum, formed in the 17th century, was a good example. This museum was a miscellany, without didactic value; it contributed nothing to the advancement of art; its arrangement was unscientific, and the public gained little or no advantage from its existence. The modern museum, on the other hand, should be organized for the public good, and should be a fruitful source of amusement and instruction to the whole community—to whom most museums now belong. History records few museums as having belonged to the public, the famous museum of Ptolemy at Alexandria (300 B.C.) being for the learned rather than the community at large. In Athens also the collections of sculpture were doubtless accessible to the public, though not directly founded for their benefit. In mediæval times the Church and cloister afforded the only museum and picture gallery to which the public were invited. Great collections were formed by princes and nobles, collections which in many instances have now become public property. And even when Dr Waagen described the collections of England about 1840, private individuals figured chiefly among the owners of art treasures. Nowadays in making a record of this nature the collections belonging to the public would attract most attention. This fact is becoming more obvious every year. Not only are acquisitions of great value constantly made, but the principles of museum administration and development are being more closely defined. What Sir William Flower, an eminent authority, called the "new museum idea" (*Essays on Museums*, p. 37) is pervading the treatment of all the chief museums of the world. Briefly stated, the new principle of museum development, first enunciated in 1870, but now beginning to receive general support, is that the first aim of public collections shall be education, and their second recreation. To be of teaching value, museum arrangement and classification must be carefully studied. Acquisitions must be added to their proper sections; random purchase of "curios" must be avoided. Attention must be given to the proper display and cataloguing of the exhibits, to their housing and preservation, to the lighting, comfort, and ventilation of the galleries. Furthermore, facilities must be allowed to those who wish to make special study of the objects on view. "A museum is like a living organism; it requires continual and tender care; it must grow, or it will perish" (Flower, p. 13). Perhaps the best illustration of the new museum idea is a negative example—the Soane Museum in London, where the collection of Sir John Soane (d. 1837) is exhibited. Like the Tradescant Museum, it has all the faults condemned by the modern rules of organization, being without method or science either in the objects exhibited or in the manner of their display. At the same time it possesses objects of great merit, though their charm and value are minimized by their juxtaposition to other things; but the little museum, being a source of much enjoyment to the public, can at least claim to have attained one objective of the new idea.

Classification.

Great progress is being made in the classification of objects, a highly important branch of museum work. There are three possible systems, namely by date, by material, and by nationality. It has been found possible to combine the systems to some extent; for instance, in the ivory department of the Victoria and Albert Museum, South Kensington, London, where the broad classification is by material, the objects being further subdivided according to their age, and in a minor degree according to their nationality. But as yet there is no general preference of one system to another. Moreover, the principles of classification are not easily laid down; *e.g.*, musical instruments: should they be included in art exhibits, or in the ethnographical section to which they also pertain? Broadly speaking, objects must be classified according to the quality (apart from their nature) for which they are most remarkable. Thus a musket or bass viol of the 16th century, inlaid with ivory and highly decorated, would be properly included in the art section, whereas a common flute or weapon, noteworthy for nothing but its interest as an instrument of music or destruction, would be suitably classified as ethnographic. In England at any rate there is no uniformity of practice in this respect, and though it is to be hoped that the ruling desire to classify according to strict scientific rules may not become too prevalent, it would nevertheless be a distinct advantage if, in one or more of the British museums, some attempt were made to illustrate the growth of domestic arts and crafts according to classification by date. Examples of this classification in Munich, Amsterdam, Basel, Zürich, and elsewhere afford excellent lessons of history and art—a series of rooms being fitted up to show, in chronological order, the home life of our ancestors. In the National Museum of Bavaria (Munich) there is a superb suite of rooms illustrating the progress of art from Merovingian times down to the 19th century. Thus classification, though studied, must not check the elasticity of art museums; it should not be allowed to interfere with the mobility of the exhibits—that is to say, it should always be possible to withdraw specimens for the closer inspection of students, and also to send examples on loan to other museums and schools of art—an invaluable system long in vogue at the South Kensington Museum, and one which should be still more widely adopted. An axiom of museum law is that the exhibits shall be properly shown. "The value of a museum is to be tested by the treatment of its contents" (Flower, p. 24). But in many museums the chief hindrance to study and enjoyment is overcrowding of exhibits. Although a truism, it is necessary to state that each object should be properly seen, cleaned, and safeguarded; but all over the world this rule is forgotten. The rapid acquisition of objects is one cause of overcrowding, but a faulty appreciation of the didactic purpose of the collection is more frequently responsible.

Growth and progress.

In Great Britain, museum progress is satisfactory. Visitors are numbered by millions, access is now permitted on Sundays and week-days alike, and entrance fees are being consistently reduced; in this the contrast between Great Britain and some foreign countries is singular. A generation ago the national collections of Italy used to be always open to the public. Pay days, however, were gradually established, with the result that the chief collections are now only visible on Sundays without payment. In Dresden payment is obligatory five days a week. The British Museum never charges for admission. On the other hand, the increase in Continental collections is more rapid than in Great Britain, where acquisitions are only made by gift, purchase, or bequest. In other European countries enormous collections have been obtained by revolutions and conquest, by dynastic changes, and by secularizing religious foundations. Some of the chief treasures of provincial museums in France were spoils of the Napoleonic armies, though the great bulk of this loot was returned in 1815 to the original owners. In Italy the conversion of a monastery into a museum is a simple process, the Dominican house of San Marco in Florence offering a typical example. A further stimulus to the foundation of museums on the Continent is the comparative ease with which old buildings are obtained and adapted for the collections. Thus the Germanisches Museum of Nuremberg is a secularized church and convent; the enormous collections belonging to the town of Ravenna are housed in an old Camaldulensian monastery. At Louvain and Florence municipal palaces of great beauty are used; at Nîmes a famous Roman temple; at Urbino the grand ducal palace, and so on. There are, however, certain disadvantages in securing both building and collection ready-made, and the special care devoted to museums in Great Britain can be traced to the fact that their cost to the community is considerable. Immense sums have been spent on the buildings alone. The new buildings of the Victoria and Albert Museum are to cost £800,000. Had it been possible to secure them without such an outlay, the collections themselves would have been much increased, though in this increase itself there would have been a danger, prevalent but not yet fully realized in other countries, of crowding the vacant space with specimens of inferior quality. The result is that fine things are badly seen owing to the masses of second-rate examples; moreover, the ample space available induces the authorities to remove works of art from their original places, in order to add them to the museums. Thus the statue of St George by Donatello has been taken from the church of Or San Michele at Florence (on the plea of danger from exposure), and is now placed in a museum where, being dwarfed and under cover, its chief artistic value is lost. The desire to make financial profit from works of art is a direct cause of the modern museum movement in Italy. One result is to displace and thus depreciate many works of art, beautiful in their original places, but quite insignificant when put into a museum. Another result is that, owing to high entrance fees, the humbler class of Italians can rarely see the art treasures of their own country. There are other collections, akin to art museums, which would best be called biographical museums. They illustrate the life and work of great artists or authors. Of these the most notable are the museums commemorating Dürer at Nuremberg, Beethoven at Bonn, Thorwaldsen at Copenhagen, Shakespeare at Stratford, and Michael Angelo at Florence. The sacristies of cathedrals often contain ecclesiastical objects of great value, and are shown to the public as museums. Cologne, Aachen, Milan, Monza, and Reims have famous treasuries. Many Italian cathedrals have small museums attached to them, usually known as "Opera del Duomo."

United Kingdom.—The influence and reputation of the British Museum are so great that its original purpose, as stated in the preamble of the Act by which it was founded (1753, c. 22), may be quoted: "Whereas all arts and sciences have a connexion with each other, and discoveries in natural philosophy and other branches of speculative knowledge, for the advancement and improvement whereof the said museum or collection was intended, do, or may in many instances give help and success to the most useful experiments and undertakings . . ." The "said museum" above mentioned referred to the collection of Sir Hans Sloane, to be purchased under the Act just quoted. Sir Hans Sloane is therein stated "through the course of many years, with great labour and expense, to have gathered together whatever could be procured, either in our own or foreign countries, that was rare and curious." In order to buy his collections and found the museum, a lottery of £300,000 was authorized, divided into 50,000 tickets, the prizes varying from £10 to £10,000. Provision was made for the adequate housing of Sir Robert Cotton's books, already bought in 1700 (12 and 13 Will. III. c. 7). This Act secured for the nation the famous Cottonian manuscripts, "of great use and service for the knowledge and preservation of our constitution, both in church and state." Sir Robert's grandson had preserved the collection with great care, and was willing that it should not be "disposed of or embeziled," and that it should be preserved for public use and advantage. This Act also sets forth the oath to be sworn by the keeper, and deals with the appointment of trustees. This is still the method of internal government at the British Museum, and additions to the Board of Trustees are made by statute, as in 1824, in acknowledgment of a bequest. The trustees are of three classes: (*a*) three principal trustees, namely the Primate, the Lord Chancellor, and the Speaker; (*b*) general trustees, entitled *ex officio* to the position in virtue of ministerial office; (*c*) family, bequest, and nominated trustees. A standing committee of the trustees meets regularly at the museum for the transaction of business. The great departments of the museum (apart from the scientific and zoological collections, now placed in the museum in Cromwell Road, South Kensington) are of printed books, MSS., Oriental books, prints and drawings, Egyptian and Assyrian antiquities, British and mediæval antiquities, coins and medals. Each of these eight departments is under a keeper, with an expert staff of subordinates, the head executive officer of the whole museum being styled director and chief librarian. Among the higher officials there are also assistant keepers of departments, and fifty-eight first and second class assistants. The annual expenditure on the British Museum (excluding science) amounts to £145,000, of which £60,000 is for salaries and wages, £10,000 for furniture and fittings, and £22,000 for purchases. During 1899 the number of visitors amounted to 663,000, the number of students being 237,000. A special feature of the museum work, namely the catalogues and reproductions of acquisitions, realizes an income of £1800 a year. The museum has been enriched by bequests of great importance, especially in the library. Recent legacies have included the porcelain bequeathed by Sir Wollaston Franks, and the valuable collection of works of art (chiefly enamels and goldsmithery) known as the Waddesdon bequest—a legacy of Baron F. de Rothschild. The most important group of acquisition by purchase in the history of the museum is the series of Greek sculptures known as the Elgin Marbles, bought by Act of Parliament (56 Geo. III. c. 99).

British Museum.

There are four national museums controlled by the Board of Education, until recently styled the Department of Science and Art. The chief of these is the Victoria and Albert Museum at South Kensington. This museum has a dependency at Bethnal Green, the Dublin and Edinburgh museums having been now removed from its direct charge. There is also a museum of practical geology in Jermyn Street, containing valuable specimens of pottery

Museums of the Board of Education.

and majolica. The Victoria and Albert Museum owed its inception to the Exhibition of 1851, from the surplus funds of which 12 acres of land were bought in South Kensington. First known as the Department of Practical Art, the museum rapidly established itself on a broad basis. Acquisitions of whole collections and unique specimens were accumulated. In 1857 the Sheepshanks gallery of pictures was presented; in 1879 the India Office transferred to the department the collection of Oriental art formerly belonging to the East India Company; in 1882 the Jones bequest of French furniture and decorative art (1740–1810) was received; in 1884 the Patent Museum was handed over to the department. Books, prints, MSS., and drawings were bequeathed by the Rev. A. Dyce and Mr John Forster. Meanwhile, gifts and purchases had combined to make the collection one of the most important in Europe. The museum is not yet regularly divided into departments under expert keepers, as at the British Museum, but the chief features may be summarized as consisting of pictures, including the Raphael cartoons lent by His Majesty; textiles, silks, and tapestry; ceramics and enamels; ivory and plastic art, metal, furniture, and Oriental collections. (There are also large scientific collections.) The guiding principle of the museum is the illustration of art applied to industry. Beauty and decorative attraction is perhaps the chief characteristic of the exhibits here, whereas the British Museum is largely archæological. With this object in view, the museum possesses numerous reproductions of famous art treasures: casts, facsimiles, and electrotypes, some of them so well contrived as to be almost indistinguishable from the originals. An art library with 75,000 volumes and 250,000 prints and photographs is at the disposal of students, and an art school is also attached to the museum. It is estimated that since its foundation nearly forty million people have visited the museum. As regards the cost, it is impossible to state the exact amount, since the annual estimate deals with the department in general as well as the museum proper. The museum has a staff of 57 members, whose salaries amount to £28,000 annually, apart from a large staff in the secretarial department. The purchase grant for 1900–01 amounted to £11,260. The museum does considerable work among provincial schools of art and museums, "circulation" being its function in this connexion. Works of art are sent on temporary loan to local museums, where they are exhibited for certain periods, and on being withdrawn are replaced by fresh examples. During recent years there has been a satisfactory progress in this branch of work, and in the future it will have to be still further developed, being the only means of repaying the provinces for their share in creating the central museum. The subordinate museum of the Board of Education at Bethnal Green and that at Edinburgh call for no comment, their contents being of slender value. The Dublin Museum, though now controlled by the Irish Department, may be mentioned here as having been founded and worked by the Board of Education. Apart from the fact that it is one of the most suitably housed and organized museums in the British Isles, it is remarkable for its priceless collection of Celtic antiquities, belonging to the Royal Irish Academy, and transferred to the Kildare Street Museum in 1890. Among its most famous specimens of early Irish art may be mentioned the shrine and bell of St Patrick, the Tara brooch, the cross of Cong, and the Ardagh chalice. The series of bronze and stone implements is most perfect, while the jewels, gold ornaments, torques, fibulæ, diadems, and so forth are such that, were it possible again to extend the galleries (thus allowing further classification and exhibition space), the collection would surpass the Danish National Museum at Copenhagen, its chief rival in Europe. The Dublin Museum is visited by 420,000 people yearly. The Edinburgh Museum (costing about £13,000 a year) has about 330,000 visitors yearly.

Other national and quasi-national museums.

The famous collections of Sir Richard Wallace (d. 1890) having been bequeathed to the British nation by his widow, the public has acquired a magnificent gallery of pictures, together with a quantity of works of art, so important as to make it necessary to include Hertford House among national museums. French art predominates, and the examples of bronze, furniture, and porcelain are as fine as those to be seen in the Louvre. Hertford House, however, also contains a most remarkable collection of armour, and the examples of Italian faience, enamels, bijouterie, &c., are of first-rate interest. The maintenance of this collection (which is governed by trustees), when initial outlay upon furnishing and structural work is completed, will cost about £5000 a year. The museum of Sir John Soane, preserved in his house in Lincoln's Inn Fields, to which reference has already been made, was acquired under statute (3 Will. IV. c. 4), and is governed by trustees. The universities of Cambridge and Oxford have museums, the latter including the Ashmolean collections, a valuable bequest of majolica from D. Fortnum, and some important classical statuary, now in the Taylorian Gallery. Christ Church has a small museum and picture gallery. Trinity College, Dublin, has a miniature archæological collection, containing some fine examples of early Irish art. The National Museum of Antiquities of Scotland, now controlled by the Board of Manufactures, was formed by the Scottish Society of Antiquaries, and has a comprehensive collection of Scottish objects, lay and religious. The Tower of London contains armour of historic and artistic interest, and the Royal College of Music has an invaluable collection of musical instruments, presented by Mr George Donaldson. Art museums are also to be found in several public schools in the United Kingdom.

Municipal museums.

The Museums Act of 1845 enabled town councils to found and maintain museums. This Act was superseded by another passed in 1850, by Mr William Ewart, which in its turn has been replaced by amending statutes passed in 1855, 1866, 1868, and 1885. The Museums and Gymnasiums Act of 1891 sanctioned the provision and maintenance of museums for the reception of local antiquities and other objects of interest, and allows a ½d. rate, irrespective of other Acts. Boroughs have also the right to levy special rates under private municipal Acts, Oldham affording a case in point. Civic museums must still be considered to be in their infancy. Although the movement is now firmly established in municipal enterprise, the collections, taken as a whole, are still somewhat nondescript. In many cases collections have been handed over by local societies, particularly in geology, zoology, and other scientific departments. There are now about 250 museums, and it was estimated in 1887, after a most diligent inquiry (*British Association Report*, 1887, p. 97), that of these there were about 16 in which fine art, and 23 in which archæology, predominated. At that time there were some 35,000 specimens of fine art and 350,000 of archæology. There are about 12 museums in which Roman antiquities are noticeable, among them being Leicester, and the Civic Museum of London, at the Guildhall. British and Anglo-Saxon relics are important features at Sheffield and Liverpool; in the former case owing to the Bateman collection acquired in 1876; while the Mayer collection presented to the latter city contains a highly important series of carved ivories. At Salford, Glasgow, and Manchester industrial art is the chief feature of the collections. Birmingham, with perhaps the finest provincial collection of industrial art, is supported by the rates to the extent of £4200 a year. Its collections (including here, as in the majority of great towns, an important gallery of paintings) are entirely derived from gifts and bequests. They are valued at £60,000, and have been visited by as many as 1,100,000 persons in a single year. Birmingham has made a reputation for special exhibitions of works of art lent for a time to the corporation. These loan exhibitions, about which occasional lectures are given, and of which cheap illustrated catalogues are issued, have largely contributed to the great popularity and efficiency of the museum. Liverpool, Preston, Derby, and Sheffield owe their fine museum buildings to private generosity. Other towns have museums which are chiefly supported by subscriptions, *e.g.*, Chester and Newcastle, where there is a fine collection of work by Bewick the engraver. At Exeter the library, museum, and art gallery, together with schools of science and art, are combined in one building. Other towns may be noted as having art museums: Stockport, Nottingham (Wedgwood collection), Leeds, Bootle, Swansea, Bradford, Northampton (British archæology), and Windsor. There are museums at Belfast, Larne, Kilkenny, and Armagh. The cost of the civic museum, being generally computed with the maintenance of the free library, is not easily obtained. In many cases the librarian is also curator of the museum; elsewhere no curator at all is appointed, his work being done by a caretaker. In some museums there is no classification or cataloguing, and the value of existing collections is impaired both by careless treatment and by the too ready acceptance of worthless gifts; often enough the museums are governed by committees of the corporation whose interest and experience are not great. However, municipal museums in the United Kingdom have a great future. With sympathetic encouragement from the public they will develop in a rapid and satisfactory manner. Where municipalities have been assured of public support in their efforts, they have invariably done their utmost to promote the interest of their civic collections.

Foreign Museums.—Art museums are far more numerous on the Continent than in England. In Germany progress has been very striking, their educational aspect being closely studied. In Italy public collections, which are ten times more numerous than in England, are chiefly regarded as financial assets. The best examples of classification are to be found abroad, at Vienna, Amsterdam, Zürich, Munich, and Gizeh in Egypt. The Musée Carnavalet, the historical collection of the city of Paris, is the most perfect civic museum in the world. The buildings in which the objects can be most easily studied are those of Naples, Berlin, and Vienna. The value of the aggregate collections in any single country of the Great Powers, Russia excepted, probably exceeds the value of British collections. At the same time, it must be remembered that masses of foreign collections represent expropriations by the city and the state, together with the inheritance of royal and semi-royal collectors. In Germany and Italy, for instance, there are at least a dozen towns which at one time were capitals of principalities. In some countries the public holds over works of art the pre-emptive right of purchase. In Italy, under the law known as the Editto Pacca, it is illegal to export the more famous works of art. Speaking generally, the cost of maintaining municipal museums abroad is very small, many being without expert or highly-paid officials, while admission fees are often considerable. Nowhere in the United Kingdom are the collections neglected in a manner through which certain towns in Italy and Spain have gained an unenviable name.

Germany and Austria.

Berlin and Vienna have collections of untold richness, and the public are freely admitted. Berlin, besides its picture gallery and architectural museum, has a collection of Christian antiquities in the university. The old museum, a royal foundation, is renowned for its classical sculpture and a remarkable collection of mediæval statuary, in which Italian art is well represented. The new museum is also noteworthy for Greek marbles, and contains bronzes and engravings, together with one of the most typical collections of Egyptian art. Schliemann's discoveries are housed in the Ethnographic Museum. The Museum of Art and Industry, closely similar in object and arrangement to the Victoria and Albert Museum in London, contains collections of the same character—enamels, furniture, ceramics, &c. Vienna also has one of these museums (Kunstgewerbe), in which the great value of the examples is enhanced by their judicious arrangement. The Historical Museum of this city is interesting, and the Imperial Museum (of which the structure corresponds almost exactly with a plan of an ideal museum designed by Sir William Flower) is one of the most comprehensive extant, containing armour of world-wide fame and the choicest specimens of industrial art. Prague, Innsbruck, and Budapest are respectively the homes of the national museums of Bohemia, Tirol, and Hungary. The National Museum of Bavaria (Munich) has been completed, and its exhibition rooms, 100 in number, show the most recent methods of classification, Nuremberg, with upwards of 80 rooms, being its only rival in southern Germany. Mainz and Trier have Roman antiquities. Hamburg, Leipzig, and Breslau have good "Kunstgewerbe" collections. In Dresden there are four great museums — the Johanneum, the Albertinum, the Zwinger, and the Grüne Gewölbe—in which opulent art can best be appreciated; the porcelain of the Dresden galleries is superb, and few branches of art are unrepresented. Gotha is remarkable for its ceramics, Brunswick for enamels (in the grand ducal cabinet). Museums of minor importance exist at Hanover, Ulm, Würzburg, Danzig, and Lübeck.

France.

The central museum of France, the Louvre, was founded as a public institution during the Revolutionary period. It contains the collections of François I., Louis XIV., and the Napoleons. Many works of art have been added to it from royal palaces, and collections formed by distinguished connoisseurs (Campana, Sauvageot, La Caze) have been incorporated in it. The Greek sculpture, including the Venus of Melos and the Niké of Samothrace, is of pre-eminent fame. Other departments are well furnished, and from a technical point of view the manner in which the officials have overcome structural difficulties in adapting the palace to the needs of an art museum is most instructive. The Cluny Museum, bought by the city in 1842, and subsequently transferred to the State, supplements the mediæval collections of the Louvre, being a storehouse of select works of art. It suffers, however, from being overcrowded, while for purposes of study it is badly lighted. At the same time the Maison Cluny is a well-furnished house, decorated with admirable things, and as such has a special didactic value of its own, corresponding in this respect with Hertford House and the Poldi-Pezzoli Gallery at Milan—collections which are more than museums, since they show in the best manner the adaptation of artistic taste to domestic life. The French provincial museums are numerous and important. Twenty-two were established early in the 19th century, and received 1000 pictures as gifts from the State, numbers of which were not returned in 1815 to the countries whence they were taken. The best of these museums are at Lyons; at Dijon, where the tombs of Jean sans Peur and Philip the Bold are preserved; at Amiens, where the capital Musée de Picardie was built in 1850; at Marseilles and at Bayeux, where the "Tapestry" is well exhibited. The collections of Lille, Bordeaux, Toulouse, and Avignon are also important. The objects shown in these museums are chiefly local gleanings, consisting largely of church plate, furniture, together with sculpture, carved wood, and pottery, nearly everything being French in origin. In many towns Roman antiquities and early Christian relics are preserved (*e.g.*, Autun, Nîmes, Arles, and Luxeuil). Other collections controlled by municipalities are kept at Rouen, Douai, Montpellier, Chartres (14th-century sculptures), Grenoble, Toulon, Ajaccio, Épinal (Carolingian objects), Besançon, Bourges, Le Mans (with the remarkable enamel of Geoffrey of Anjou), Nancy, Aix, and in many other towns. As a rule, the public is admitted free of charge, special courtesy being shown to foreigners. In many cases the collections are ill cared for and uncatalogued, and little money is provided for acquisitions in the civic museums; indeed, in this respect the great national institutions contrast unfavourably with British establishments, to which purchase grants are regularly made.

The national, civic, and papal museums of Italy are so numerous that a few only can be mentioned. The best arranged and best classified collection is the Museo Nazionale at Naples, containing many thousand examples of Roman art, chiefly obtained from the immediate neighbourhood. For historical importance it ranks as *primus inter pares* with the collections of Rome and the Vatican. It is, however, the only great Italian museum where scientific treatment is consistently adopted. Other museums of purely classical art are found at Syracuse, Cagliari, and Palermo. Etruscan art is best displayed at Arezzo, Perugia (in the university), Cortona, Florence (Museo Archeologico), Volterra, and the Vatican. The Florentine museums are of great importance, consisting of the archæological museum of antique bronzes, Egyptian art, and a great number of tapestries. The Museo Nazionale, housed in the Bargello (A.D. 1260), is the central depository of Tuscan art. Numerous examples of Della Robbia ware have been gathered together, and are fixed to the walls in a manner and position which reduce their value to a minimum. The plastic arts of Tuscany are represented by Donatello, Verrocchio, Ghiberti, and Cellini, while the Carrand collection of ivories, pictures, and varied mediæval specimens are of much interest. This museum, like so many others, is becoming seriously overcrowded, to the lasting detriment of churches, market-places, and streets, whence these works of art are being ruthlessly removed. The public is admitted free one day a week, and the receipts are devoted to art and antiquarian purposes ("tasse . . . destinate . . . alla conservazione dei monumenti, all' ampliamento degli scavi, ed' all' incremento dei instituti . . . nella città."—Law of 1875, § 5). The museums of Rome are numerous, the Vatican alone containing at least six—Museo Clementino, of classical art, with the Laocoon, the Apollo Belvedere, and other masterpieces; the Chiaramonti, also of classical sculpture; the Gallery of Inscriptions; the Egyptian, the Etruscan, and the Christian museums. The last is an extensive collection corresponding with another papal museum in the Lateran Palace, also known as the Christian Museum (founded 1843), and remarkable for its sarcophagi and relics from the catacombs. The Lateran has also a second museum known as the Museo Profano. Museums belonging to the State are equally remarkable. The Kircher Museum deals with prehistoric art, and contains the "Preneste Hoard." The Museo Nazionale (by the Baths of Diocletian), the Museo Capitolino, and the Palazzo dei Conservatori contain innumerable specimens of the finest classical art, vases, bronzes, mosaics, and statuary, Greek as well as Roman. Among provincial museums there are few which do not possess at least one or two objects of signal merit. Thus Brescia, besides a mediæval collection, has a famous bronze Victory. Pesaro, Urbino, and the Museo Correr at Venice have admirable examples of majolica; Milan, Pisa, and Genoa have general archæology combined with a good proportion of mediocrity. The civic museum of Bologna is comprehensive and well arranged, having Egyptian, classical, and Etruscan collections, besides many things dating from the "Bella Epoca" of Italian art. At Ravenna alone can the Byzantine art of Italy be properly understood, and it is most deplorable that the superb collections in its fine galleries should remain uncatalogued and neglected. Turin, Siena, Padua, and other towns have civic museums.

Italy.

Belgium and Holland.

The Ryks Museum at Amsterdam, containing the national collections of Holland, is a modern building in which a series of historical rooms are furnished to show at a glance the artistic progress of the Dutch at any given period. Nine rooms are also devoted to the chronological display of ecclesiastical art. Besides the famous paintings, this museum (the sole drawback of which is the number of rooms which have no top-light) contains a library, many engravings, a comprehensive exhibit of armour, costume, metal work, and a department of maritime craftsmanship. Arnhem and Haarlem have municipal collections. At Leyden the University maintains a scholarly collection of antiquities. The Hague and Rotterdam have also museums, but everything in Holland is subordinated to the development of the great central depository at Amsterdam, to which examples are sent from all parts of the country. In Belgium the chief museum, that of ancient industrial art, is at Brussels. It contains many pieces of mediæval church furniture and decoration, but in this respect differs only in size from the civic museums of Ghent and Luxemburg and the Archbishop's museum at Utrecht. In Brussels, however, there is a good show of Frankish and Carolingian objects. The city of Antwerp maintains the Musée Plantin, a printing establishment which has survived almost intact, and presents one of the most charming and most instructive museums in the world. As a whole, the museums of Belgium are disappointing, though, *per contra*, the churches are of enhanced interest, not having been pillaged for the benefit of museums.

Russia.

New museums are being founded in Russia every year. Kharkoff and Odessa (the university) have already large collections, and in the most remote parts of Siberia it is curious to find carefully chosen collections. Krasnoyarsk has 12,000 specimens, a storehouse of Buriat art. Irkutsk, the capital, Tobolsk, Tomsk (university), Khabarovsk, and Yakutsk have now museums. In these Russian art naturally predominates. It is only at Moscow and St Petersburg that Western art is found. The Hermitage Palace in the latter city contains a selection of mediæval objects of fabulous value, there being no less than 40 early ivories. But from a national point of view these collections are insignificant when compared with the gold and silver objects illustrating the primitive arts and ornament of Scythia, Crimea, and Caucasia, the high standard attained proving an advanced stage of manual skill. At Moscow (historical museum) the stone and metal relics are scarcely less interesting. There is also a museum of industrial art, the specimens of which are not of unusual value, but being analogous to the Kunstgewerbe movement in Germany, it exercises a wholesome influence upon the designers who study in its schools.

America. Much may be expected of American museums, which are not committed to traditional systems, and where scientific treatment is allowed its fullest scope. They exist in great numbers, and though in most cases their exhibits are chiefly ethnographic, a far wider range of art objects will undoubtedly be secured during the next generation. The National Museum at Washington is chiefly notable for its historical relics of America. The Smithsonian Institute in the same city has similar collections. On the other hand, the Metropolitan Museum of Art (held by trustees for the benefit of the city of New York) has in the Cesnola collection the most complete series of Cypriot art objects. It has also departments of coins, Greek sculpture, and general examples of European and American art. The Museum of Fine Arts at Boston is very comprehensive, and has a remarkable collection of ceramics, together with good reproductions of antique art. The public is admitted free on certain days of the week. There are other museums at St Louis, Chicago, and Washington, as well as Montreal in Canada; and the universities of Harvard, Chicago, and Yale have collections.

Various countries. The Swiss National Museum is situated at Zürich, and though of medium size (50 rooms), it is a model of arrangement and organization. Besides the special feature of rooms illustrating the historical progress of art, its collection of stained glass is important. Basel also (historical museum) is but little inferior in contents or system to the Zürich establishment. Geneva has three collections. Lausanne holds the museum of the canton, and Bern has a municipal collection. All these institutions are well supported financially, and are much appreciated by the Swiss public. The art museums of Stockholm, Christiania, and Copenhagen rank high for their intrinsic excellence, but still more for their scientific and didactic value. Stockholm has three museums: that of the Royal Palace, a collection of costume and armour; the Northern Museum, a large collection of domestic art; the National Museum, containing the prehistoric collections, gold ornaments, &c., classified in a brilliant manner. The National Museum of Denmark at Copenhagen is in this respect even more famous, being probably the second national collection in the world. The arrangement of this collection leaves little to be desired, and it is to be regretted that some British collections, in themselves of immense value, cannot be shown, as at Copenhagen, in a manner which would display their great merits to the fullest degree. There is also at Copenhagen a remarkable collection of antique busts (Gamle Glyptotek), and the Thorwaldsen Museum connected with the sculptor of that name. Norse antiquities are at Christiania (the university) and Bergen. Athens has three museums, all devoted to Greek art: that of the Acropolis, that of the Archæological Society (vases and terra-cotta), and the National Museum of Antiquities. The State owns all discoveries, and these are accumulated at the capital, so that local museums scarcely exist. The collections, which rapidly increase, are of great importance, though as yet they cannot vie with the aggregate in other European countries. The Gizeh Museum of Egyptian antiquities (Cairo), founded by Mariette Bey, and developed by Maspero, is the best national museum in the world, well housed in a large building erected in 1890, well classified, and liberally supported with money and fresh acquisitions. Minor museums exist at Carthage and Tunis. At Constantinople the Turkish Museum contains some good classical sculpture and a great deal of rubbish. The Museo del Prado and the Archæological Museum at Madrid are the chief Spanish collections, containing numerous classical objects and many specimens of Moorish and early Spanish art. In Spain museums are badly kept, and their contents are of indifferent value. The museums of the chief provinces are situated at Barcelona, Valencia, Granada, and Seville. Cadiz and Cordova have also sadly neglected civic collections. The National Museum of Portugal at Lisbon requires no special comment. The progress of Japan is noticeable in its museums as in its industrial enterprise. The National Museum (Weno Park, Tôkyô) is large and well arranged in a new building of Western architecture. Kiôtô and Nara have excellent museums, exclusively of Oriental art, and two or three other towns have smaller establishments, including commercial museums. There are several museums in India, the chief one being at Calcutta, devoted to Indian antiquities. In Australia the museum movement is just beginning to thrive, the desire for national collections having been hitherto limited to pictures.

The best history of museums can be found in the prefaces and introductions to their official catalogues, but the following works will be useful for reference:—Annual Reports presented to Parliament (official) of British Museum and Board of Education; Civil Service Estimates, Class IV., annually presented to Parliament; Second Report of Select Committee of House of Commons on Museums of Science and Art Department (official), 1 vol., 1898; Annual Reports of the Museum Association, London.—EDWARD EDWARDS. *The Fine Arts in England.* London, 1840.—Prof. STANLEY JEVONS. "Use and Abuse of Museums," printed in *Methods of Social Reform.* London, 1882.—Report of Committee on Provincial Museums. Report of British Association. London, 1887.—THOS. GREENWOOD. *Museums and Art Galleries,* London, 1888.—Prof. BROWN GOODE. *Museums of the Future.* Report on National Museums, Washington, 1888–89; *Principles of Museum Administration.* Report of Museum Association, London, 1895.—MARIOTTI. *La Legislazione delle Belle Arti.* Rome, 1892.—L. BÉNÉDITE. *Rapport sur l'organisation . . . dans les musées de la Grande Bretagne* (official). Paris, 1895.—Sir WILLIAM FLOWER. *Essays on Museums.* London, 1898.—*Le Gallerie Nazionali Italiane,* 3 vols. Rome, 1894. (B.)

Músh, the chief town of a sanjak of the same name in the Bitlis vilayet of Asiatic Turkey, altitude 4800 feet, situated on the south side of a fertile plain dotted with villages, through which the Kara Su runs. The climate is healthy, but very cold in winter. The population numbers 15,000, of whom one-half is Armenian. The massacre of Armenians at Sasún, in the mountains to the south, in 1894 aroused general indignation in Europe. (See ARMENIA.)

MUSIC.

SINCE the publication of the article on MUSIC in the earlier volumes (ninth edition) of the *Encyclopædia Britannica*, the conditions of the art have undergone so striking a change, alike in the United Kingdom and in other countries, that it is necessary to give an account, more or less summary, of modern tendencies, and to pass in rapid review the later state of music in the countries where it has been most generally encouraged.

Germany. To begin with the country which for over two centuries was universally recognized as the chief centre of the musical art. Ever since the time of Bach and Handel, Germany has been supreme in music, whether we regard the excellence and thoroughness of her institutions, the superlative eminence of her great masters, or the wide diffusion of a love of music throughout the nation at large. As the 19th century came near to its close, it became increasingly apparent that the legitimate successors to such men as Wagner and Brahms had not yet appeared; the death of the former in 1883 made it clear that there was no great or even very meritorious operatic composer ready to take his place, while on the death of Brahms in 1897 much the same discovery was made in the domain of what is known as "absolute" music. Such merely epigonal figures as Bungert (b. 1846) and Cyrill Kistler could not, even by the most eager set of admirers, be credited with powers in any way comparable to the genius whom they imitated; and Humperdinck's (b. 1854) striking success with *Hänsel und Gretel* (1893) is the result of his application of the Wagnerian principles of "music-drama" to a childish subject and to themes closely analogous to the folk-song, rather than of any great originality of his own. On the other hand, neither the eccentricities of Richard Strauss (*q.v.*), who has tried to out-Liszt Liszt himself, nor the academic productions of a host of younger men, showed anything that could be interpreted as giving promise of the advent of a successor to Brahms, in whom the long line of great German masters appears to have come to an end.

France.

From the earliest days of their music, the French have had the enviable power of assimilating the great innovations which were originated in other countries, without losing their habit of warmly appreciating that which their own countrymen produce. That which happened with the Netherlandish composers of the 16th century, and with Lully in the 17th, has been repeated, more or less exactly, with Rossini in the early part of the 19th century and with Wagner at its close. In one generation after another, the young French composers have succeeded in applying the principles of the great foreigners without forfeiting their own hold on the nation's respect. During the last quarter of the 19th century all that is represented by the once-adored name of Gounod has been discarded in favour of a style as different as possible from his. The change was mainly due to a Belgian musician of masterly cleverness, César Auguste Franck (1822–1890), who established a kind of informal school of symphonic and orchestral composition, as opposed to the conventional methods pursued at the Paris Conservatoire, where attention was chiefly given to the operatic and sentimental styles. Beyond the immediate circle of Franck's actual pupils, what may be called the revolt against sentimentality was widely supported, and its influence can hardly be exaggerated. Massenet was left as almost the only representative of the older school, and from Edouard Lalo (1823–1892) to Charpentier (b. 1860), all the younger composers of France adopted the newer style. With many of them their newly-found freedom in such matters as harmonic relations, modulations, &c., has been somewhat abused, and with Alfred Bruneau (b. 1857), in spite of the intense power of dramatic realization that is revealed in *Le Rêve* and *L'Attaque du Moulin*, there are many passages in his *Requiem* and in *Messidor* that are undeniably lacking in beauty; with him the dramatic propriety of the truth of his music excuses much that would otherwise be repellent, but in the case of Gabriel Fauré (b. 1845) his application of these strange methods to "absolute" music is seldom successful except with the few amateurs who profess to prefer ugly music to beautiful. Camille Saint-Saëns (b. 1835) is beyond question the soundest representative of modern French music, if only by reason of his greater command of resources of every kind and his success in all forms of music. A few other names must be mentioned as making up the modern French school, a body of undoubted distinction and influence: Ernest Reyer (b. 1823) is the author of some ambitious and sterling operas; F. L. V. de Joncières (b. 1839), an enthusiastic follower of Wagner, and a composer of merit; Emanuel Chabrier (1842–1894), a man of extraordinary gift, wrote one of the finest *opéras comiques* of modern times, *Le Roi malgré Lui* (1887), and a grand opera, *Gwendoline*, of no small value; Charles Marie Widor (b. 1845) is an earnest musician of great accomplishment; and Vincent d'Indy (b. 1851), a strongly original writer, alike in dramatic, orchestral, and chamber compositions. In the class of lighter music, which yet lies above the level of *opéra bouffe*, mention must be made of Léo Delibes (1836–1891) and André Messager (b. 1855). In describing the state of music in France, it would be wrong to pass over the work done by the great conductors of various popular orchestral concerts, such as Pasdeloup (b. 1819), Lamoureux (1834–1899), and Colonne (b. 1838).

Italy.

In Italy during the last quarter of the 19th century many important changes took place; three aspects of modern Italian music must claim our notice. First, the later development in the style of Verdi (1813–1901) was only completed in *Otello* (1887) and *Falstaff* (1893), while his last composition, the four beautiful sacred vocal works, show how very far he had advanced in reverence, solidity of style, and impressiveness, from the time when he wrote his earlier operas. By his side during the last years of his life stood Arrigo Boito (*q.v.*), the accomplished writer of his two last libretti, and the composer of *Mefistofele*, a work which had an immense influence on modern Italian music, and not impossibly on Verdi himself. Among the writers of "absolute" music the most illustrious are Sgambati (b. 1843) and Martucci (b. 1856); the latter's great symphony in D minor is a work the like of which has not been heard in Italy for many years, and the composer's high standard and splendid accomplishment can hardly fail to procure him lasting fame. The third and least estimable aspect of modern Italian music is that of the young operatic school, of which the first production was the *Flora Mirabilis* of Spiro Samara (b. 1861), given in 1886. There were a good many operas, many of them in one act, and most of them dealing by preference with tragedies of low life, but the most celebrated of all was *Cavalleria Rusticana* by Pietro Mascagni (b. 1863), upon which a prize was bestowed, and which was brought out in 1890. No work by the same composer has made a similar success, and among the many who have cast in their lot with this squalid school very few have attained more than an ephemeral reputation. The most familiar to English opera-goers is Leoncavallo (b. 1858), whose *Pagliacci* has kept the stage for some years since its production in 1892. In contrast to these composers is the work of Giacomo Puccini (b. 1858), who may be called the legitimate successor of Verdi. His operas are *Le Villi* (1884), *Manon Lescaut* (1893), *La Bohème* (1896), and *Tosca* (1900). So far as concerns the works themselves, the oratorios of Don Lorenzo Perosi (b. 1872) are not of much account, but as an influence on the church music of Italy they must be highly esteemed.

Russia.

The new Russian school of music has been so popular in England for the last few years that its rapid rise into recognition could not be ignored. As a definite school it had its origin with Balakirev (b. 1836), who was instrumental in founding the Free School of Music at Moscow, and who introduced the music of Berlioz and Liszt into Russia; he instilled the principles of "advanced" music into Borodin (1834–1887), Cui (b. 1835), Moussorgsky (b. 1839), and Rimsky-Korsakow

(b. 1844), all of whom, as usual with Russian composers, were, strictly speaking, amateurs in music, having some other profession in the absence of any possible opportunity for making money out of music in Russia. The most remarkable man among their contemporaries was undoubtedly Tschaikowsky (1840–1893), whose works, culminating in the "Pathetic Symphony," have enjoyed a wonderful vogue in Great Britain and elsewhere; Liadow (b. 1855) excels as a writer for the pianoforte, but Glazounow (b. 1865) has already accomplished so much, in so many forms and of such wonderfully high quality, that it seems almost safe to predict that he will be regarded as the chief product of the school.

Scandinavia. Of late years the music of Norway and Sweden has been so closely allied with the name of Grieg, and so very few other composers have made any mark, except sundry imitators of his style, that a reference to the article GRIEG is all that is necessary.

United States. A distinctively American school of composers can hardly be said to have come into existence as yet, but some of the musicians of the United States have reached so high a level of attainment that it would be impossible to ignore them in a general survey of music. It is the fault of European musicians, not their own, that their works have not become as widely recognized outside the United States as many of them deserve to be; and those compositions which have been heard in the United Kingdom have for the most part made a great impression. Of the older American composers, only John Knowles Paine and Dudley Buck, both born in 1839, need be mentioned. The former has written oratorios, choral, orchestral, and other music; is professor of music at Harvard University, and now ranks with the advanced school of romantic composers. The latter was one of the first American composers whose names were known in Europe; and if his numerous cantatas and church music do not reach a very high standard according to modern ideas, he did much to conquer the general apathy with regard to the existence of original music in the States. George Whitfield Chadwick has produced many orchestral and vocal works of original merit. Born in 1854, he may be taken as the typical musician of Boston. Though the works of Clayton Johns (b. 1857) are less ambitious, they have won more popularity in Europe, and his songs, like those of Arthur Foote (b. 1853) and Ethelbert Nevin (b. 1862) are widely known. Edward Alexander MacDowell (b. 1861) has written not only a very large number of artistic songs, piano pieces, and choruses, but symphonic poems, overtures, and suites for orchestra, many of which are better known to German than to English musical audiences. Walter Johannis Damrosch (b. 1862), the eminent conductor of the New York Symphony Orchestra, and of various operatic undertakings, has established his position as an original and poetic composer, not only by his opera, *The Scarlet Letter*, but by such songs as the intensely dramatic "Danny Deever." Within the last few years the name of Horatio William Parker has come into prominence in England, and his oratorio settings of the hymn "Hora novissima" and of "The Wanderer's Psalm" are deservedly popular. Their masterly workmanship and his power of expression in sacred music mark him as a distinct personality, and one from whom much may be expected. Numerous orchestral as well as vocal works have not been heard out of America, but a group of songs, newly set to the words of familiar old English ditties, have obtained great success. Finally, Mrs H. H. A. Beach, the youngest of the prominent composers of the United States, has attained a high reputation as a writer in all the more ambitious forms of music, in which her success is all the more remarkable since she is entirely self-taught in the more advanced kinds of composition as well as in orchestration. Numerous of her songs and anthems have obtained wide popularity in America, and she is a highly accomplished pianist. If the American composers' names are hardly known to the generality of amateurs in Great Britain, it is worthy of note that no country has produced a greater number of the most eminent singers in the present day. Mesdames Eames, Nordica, Susan Strong, Suzanne Adams, Sybil Sanderson, Esther Palliser, Evangeline Florence, and very many more among leading sopranos, with Messrs Oudin and Bispham, to name but two out of the host of excellent male artists, have proved the natural ability of the Americans in vocal music; and it might almost be said that the more notable pupils of the various excellent French schools of voice-production are American with hardly an exception.

United Kingdom. Before attempting to describe the great renaissance of English music which accomplished itself in the last quarter of the 19th century, it will be well to glance at the general conditions of music and the causes of the change. Only the most bigoted admirers of foreign music could deny that there has been a great change in the national feeling with regard to music. The nation had been accustomed for so long to consider music as an exotic, that, notwithstanding the glories of the older schools of English music, the amount of attention paid to everything that came from abroad, and the rich treasures of traditional and distinctively English music scattered through the country, the majority of educated people adhered to the common belief that England was not a musical country. The beauty and the enormous quantity of traditional Irish music, the enthusiasm created in Scotland by trumpery songs written in what was supposed to be an imitation of the Scottish style, the existence of the Welsh Eisteddfodau, were admitted facts, but England was supposed to have had no share in these gifts of nature or art, and the vogue of foreign music, from Italian opera to classical symphonies, was held as evidence of her poverty, instead of being partly the reason of the national sterility. In the successive periods during which the music of Handel and Mendelssohn respectively had been held as all-sufficient for right-thinking musicians, success could only be attained, if at all, by those English musicians who deliberately set themselves to copy the style of these great masters; the few men who had the determination to resist the popular movement were either confined, like the Wesleys, to one branch of music in which some originality of thought was still allowed, that of the Church, or, like Henry Hugo Pierson in the days of the Mendelssohn worship, were driven to seek abroad the recognition they could not obtain at home. For a time it seemed as if the great vogue of Gounod would exalt him into a third artistic despot; but his influence was at first only felt harmfully on the Church music of his time, the introduction of his masses into England being synchronous with the popularity of the Tractarian movement: English opera had fallen on such evil days that no native composer had even the energy to imitate his *Faust*, the only one of his operas that was then popular; and, by the date of the two sentimental oratorios that were written for Birmingham, *The Redemption* (1882) and *Mors et Vita* (1885), the renaissance of English music had already begun, and ultimately English composers had strength enough to resist the effects of their wide though somewhat transient popularity. It should be explained at this point that the phrase "harmful influence" is used quite without reference to the merits or demerits of the music in itself; it refers simply to the kind of influence exerted, which is only to be regretted when the composers are brought face to face with the necessity of consciously and deliberately imitating a popular model, because they know that there is no chance of success in any other way. All the great masters, from Bach, Mozart, and Beethoven, down to Brahms and Wagner, have had influence upon the musicians of their time and upon subsequent generations; but only a very few, and none of those just mentioned, have so dominated a whole nation's music that their influence could fitly be described as harmful. The Sacred Harmonic Society was the chief temple of the *culte* of Handel, as the Ancient Concerts had formerly been; and the Philharmonic Society was almost given over to the adoration of Mendelssohn and his servile imitators.

The opera. Until about the 'eighties, the affairs of foreign opera in England were most depressing; entirely without artistic influence of any kind, the rival houses presided over by the impresarios Frederick Gye (1810–1878) and Colonel J. H. Mapleson (1828–1901) had been going from bad to worse; the traditions of what were called "the palmy days" had been forgotten, and with the retirement of Christine Nilsson in 1881, and the death of Tietjens in 1877, the race of the great queens of song seemed to have come to an end. It is true that Mme. Patti was in the full plenitude of her fame and powers, but the number of her impersonations, perfect as they were, was so small that she alone could not support the weight of an opera season, and her terms made it impossible for any manager to make both ends meet unless the rest of the company were chosen on the principle enunciated by the husband of Mme. Catalani, "Ma femme et quatre ou cinq poupées." Mme. Albani (b. 1851) had made her name famous, but the most important part of her artistic career was yet to come. She had already brought *Tannhäuser* and *Lohengrin* into notice, but in Italian versions, as was then usual; and the great vogue of Wagner's operas did not begin until the series of Wagner concerts given at the Royal Albert Hall in 1877 with the object of collecting funds for the preservation of the Bayreuth scheme, which after the production of the Nibelungen trilogy in 1876 had become involved in serious financial difficulties. The two seasons of German opera at Drury Lane under Dr Hans Richter (b. 1843) in 1882 and 1884, and the production of the trilogy at Her Majesty's in 1882, under Angelo Neumann's managership, first taught stay-at-home Englishmen what Wagner really was, and Italian opera as such (*i.e.*, with Italian as the exclusive language employed and the old "star" system in full swing) ceased to exist as a regular institution a few years after that. The revival of public interest in the opera only took place after Mr (afterwards Sir Augustus) Harris (1852–1896) had started his series of operas at Drury Lane in 1887. In the following season Harris took Covent Garden, and since that time the opera has been restored to greater public favour than it ever enjoyed, at all events since the days of Jenny Lind. The clever manager saw that the public was tired of operas arranged to suit the views of the *prima donna* and no one else, and he cast the works he produced, among which were *Un Ballo in Maschera* and *Les Huguenots*, with due attention to every part. The brothers Jean and Edouard de Reszke, both of whom had appeared in London before, the former as a baritone, and the latter during the seasons 1880–84, were even stronger attractions to the musical public of the time than the various leading sopranos, among whom were Mme. Albani, Miss Macintyre, Mme. Melba, Frau Sucher, and Mme. Nordica, during the earlier seasons, and Mme. Eames, Mlle. Ravogli, MM. Lassalle and Plançon, and many other Parisian favourites later. As time went on, the excellent custom obtained of giving each work in the language in which it was written, and among the distinguished German artists who were added to the company were Frau Ternina, Frau Schumann-Heink, Frau Lilli Lehmann, and many more. Since Harris's death in 1896 the traditions started by him have been on the whole well maintained, and as a sign of the difference between the present and the former position of English composers, it may be mentioned that two operas by Cowen, *Signa* and *Harold*, and two by Stanford, *The Veiled Prophet* and *Much Ado about Nothing*, have been produced. To Signor Lago, a manager of more enterprise than good fortune, belongs the credit of reviving Gluck's *Orfeo* (with the masterly impersonation of the principal character by Mlle. Giulia Ravogli), and of bringing out *Cavalleria Rusticana*, Tschaikowsky's *Eugen Onegin*, and other works. The fortunes of English opera must be pursued in connexion with the renaissance of music.

The renaissance. Without a congenial atmosphere no germ can be developed, and if it be just to name one institution and one man as the creator of such an atmosphere as allowed the genius of English composers to flourish, then that honour must be paid to the Crystal Palace and Mr August Manns (b. 1825), the conductor of its Saturday Concerts. At first engaged as sub-conductor, under a certain Schallehn, at the building which was the lasting result of the great Exhibition of 1851, he became director of the music in 1855, so for the better part of half a century his influence was exerted on behalf of the best music of all schools, and especially in favour of anything of English growth. Through evil report and good report he supported his convictions, and for many years he introduced one English composer after another to a fame which they would have found it hard to gain without his help and that of Sir George Grove, his loyal supporter. In 1862, when Arthur Sullivan had just returned from his studies in Leipzig, his *Tempest* music was produced at the Crystal Palace, and, whatever views may be taken as to the composer's music as a whole, it is beyond question that it was this success and that of the succeeding works from the same hand which first showed Englishmen that music worth listening to might be produced by an English hand. The hold of Sullivan's music upon the English public was at its strongest in the series of "Savoy Operas," from *The Sorcerer* to *Utopia, Limited*; and though these works owe their success at least as much to Gilbert's admirable librettos as to Sullivan's music, they convinced the average English theatre-goer that English comic opera could be as bright as French. Sullivan reached the highest point of his achievement in *The Golden Legend* (1886), his most important contribution to the music of the renaissance. An important part of the Crystal Palace music was that the concerts did not follow, but led, popular taste; the works of Schubert, Schumann, and many other great masters were given constantly, and the whole repertory of classical music was gone through, so that a constant attendant at these concerts would have become acquainted with the whole range of the best class of music. From 1859 onwards the classical chamber-music could be heard at the Popular Concerts started by Mr Arthur Chappell, and for many years their repertory was not less catholic than that of the Crystal Palace undertaking; that in later times the habit increased to a lamentable extent of choosing only the "favourite" (*i.e.*, hackneyed) works of the great masters does not lessen the educational value of the older concerts. The lovers of the newer developments of music were always more fully satisfied at the concerts of the Musical Union, a body founded by Mr John Ella in 1844, which lasted until 1880. From 1879 onwards the visits of Hans Richter, the conductor, were a feature of the musical season, and the importance of his work, not only in spreading a love of Wagner's music, but in regard to every other branch of the best orchestral music, cannot be exaggerated. Like the Popular Concerts, the Richter Concerts somewhat fell away in later years from their original purpose, and their managers were led by the popularity of certain pieces to give too little variety. The importance of Richter's work was in bringing forward the finest English music in the years when the masters of the renaissance were young and untried. Here were to be heard the orchestral works of Parry, Stanford, Mackenzie, and Cowen; and the fact that the audience from the first contained a large proportion of the cultivated aristocracy of London brought the names of these composers into notice much more effectually than could have been the case in other surroundings. Meanwhile outside London the work of the renaissance was being carried on, notably at Cambridge, where by the amalgamation of various smaller societies with the University Musical Society, Stanford created in 1875 a splendid institution which did much to foster a love of the best music for many years; and at Oxford, where private meetings in the rooms of Hubert Parry brought about the institution of the Musical Club, which has borne fruit in many ways, though only in the direction of chamber-music. The Bach Choir, founded by Mr Arthur Duke Coleridge in 1875, and conducted for the first ten years of its existence by Mr Otto Goldschmidt and subsequently by Professor Stanford, worked on purely uncommercial lines ever since its foundation, and besides many important works of Bach, it brought forward most important compositions by Englishmen, and had a prominent share in the work of the renaissance. The careers of the five composers who must be called the masters of the renaissance — Parry, Stanford, Mackenzie, Goring Thomas, and Cowen—are dealt with separately under their own headings; but taking them as a group or school of composers, it will be realized by every thoughtful student of music that their works show a spontaneity, a warmth of imagination, a degree of power and technical skill, which are scarcely to be found in the perfunctory, conventional music of the older generation of English writers, the purveyors of what Wagner called "Kapellmeistermusik." Parry's earlier compositions had a certain austerity in them which, while it commanded the homage of the cultivated few, prevented their obtaining wide popularity; and it was not until the date of his choral setting of Milton's *Ode at a Solemn Musick* that he found his true vein. In this and its many successors, produced at the autumn festivals, though very rarely given in London, there are a nobility of utterance, a sublimity of conception, a mastery of resource, that far surpass anything accomplished in England since the days of Purcell; while his "Symphonic Variations" for orchestra, and at least two of his symphonies, exhibit his command of the modern modifications of classical forms in great perfection. Like Parry, Stanford first caught the ear of the public at large with a choral work, the stirring ballad-setting of Tennyson's *Revenge;* and in all his earlier and later works alike, which include compositions in every form, he shows himself a supreme master of effect; in dramatic or lyrical handling of voices, in orchestral and chamber-music, his sense of beauty is unfailing, and while his ideas have real distinction, his treatment of them is nearly always the chief interest of his works. The work of the musical renaissance has been more beneficially fostered by these two masters than by any other individuals, through the medium of the Royal College of Music. In 1876 the National Training School of Music was opened with Sullivan as principal; he was succeeded by Sir John Stainer in 1881, and the circumstance that such artists as Mr Eugen d'Albert and Mr Frederic Cliffe received there the foundation of their musical education is the only important fact connected with the institution, which in 1882 was succeeded by the Royal College of Music, under the directorship of Sir George Grove, and with Parry and Stanford as professors of composition. In 1894 Parry succeeded to the directorship, and before and after this date work of the best educational kind was done in all branches of the art, but most of all in the important branch of composition. Mackenzie's place among the masters of the renaissance is assured by his romantic compositions for orchestra, such as *La Belle Dame sans Merci* and the two "Scottish Rhapsodies"; some of his choral works, such as the oratorios, show some tendency to fall back into the conventionalities from which the renaissance movement was an effort to escape; but in *The Cottar's Saturday Night; The Story of Sayid; Veni, Creator Spiritus,* and many other things, not excepting the opera *Colomba*, or the witty "Britannia" overture, he shows no lack of spontaneity or power. As principal of the Royal Academy of Music (he succeeded Macfarren in 1888) he revived the former glories of the school, and the excellent plan by which it and the Royal College unite their forces in the examinations of the Associated Board is largely due to his initiative. The opera just mentioned was the first of the modern series of English operas brought out from 1883 onwards by the Carl Rosa company during its tenure of Drury Lane Theatre: at the time it seemed as though English opera had a chance of getting permanently established, but the enterprise, being a purely private and individual one, failed to have a lasting effect upon the art of the country, and after the production of two operas by Mackenzie, two by Arthur Goring Thomas, one by F. Corder, two by Cowen, and one by Stanford, the artistic work of the company grew gradually less and less important. In spite of the strong influence of French ideals and methods, the music of Arthur Goring Thomas was remarkable for individuality and charm; in any other country his beautiful opera *Esmeralda* would have formed part of the regular repertory, even if the same favour had not been accorded to its successor, *Nadeshda;* and his orchestral suites, cantatas, and a multitude of graceful and original songs remain as evidence that if his career had been prolonged, the art of England might have been enriched by some masterpiece it would not willingly have let die. After a youth of extraordinary precocity, and a number of variously successful attempts in the more ambitious and more serious branches of the art, Cowen found his chief success in the treatment of fanciful or fairy subjects, whether in cantatas or orchestral works; here he is without a rival, and his ideas are uniformly graceful, excellently treated, and wonderfully effective. His second tenure of the post of conductor of the Philharmonic Society showed him to be a highly accomplished conductor.

In regard to English opera two more undertakings deserve to be recorded, although the hope that London will be placed on an equality with the other European capitals in the possession of a permanent operatic institution seems as far off as ever. In 1891 the "Royal English Opera-House" was opened with Sullivan's *Ivanhoe*, a work written specially for the occasion: the absence of anything like a repertory, and the retention of this one work in the bills for a period far longer than its attractions could warrant, brought the inevitable result, and shortly after the production of a charming French comic opera the theatre was turned into the Palace music hall. The charming and thoroughly characteristic *Shamus O'Brien* of Stanford was produced in 1896 at the Opera Comique Theatre, and ran with great success. This work brought into public prominence the young conductor Mr

Henry J. Wood (b. 1870), who exercised a powerful influence on the art of the country by means of his orchestra, which was constantly to be heard at the Queen's Hall, and which attained, by continual performance together, a degree of perfection before unknown in England. If the organization did a good deal more for Russian than for English music, it at least achieved an important work in bringing music within the reach of all classes at the Promenade Concerts given through each summer, as well as by means of the Symphony Concerts at other seasons.

The new school of English writers contains many names of skilled composers whose attainment of a high place upon the roll of fame is only doubtful because the British public at large is still slow to realize that any good can come out of England in the way of musical creations. Some of these have already attained conspicuous success, and a few of them have been heard of in Continental centres of music. Dr Edward Elgar has made his reputation within the last few years by his vigorous *Caractacus* and the grandiose imaginings of his *Dream of Gerontius*, as well as by orchestral and chamber compositions of decided merit and individuality. Mr Edward German (b. 1862) has won great success as a writer of incidental music for plays, and in various lighter forms of music, for which his great skill in orchestration and his knowledge of effect stand him in good stead. Mr Frederic Cliffe's orchestral works are too few in number, but their quality is extremely high. Mr Arthur Somervell (b. 1863) has won the public ear by his charming songs, and notably by a fine song-cycle from Tennyson's *Maud*, though his *Mass* and various orchestral works and cantatas and pianoforte pieces show his conspicuous ability in other forms. Various compositions written by Mr Hamish MacCunn (b. 1868), while still a student at the Royal College of Music, were received with acclamation; but his later work up to 1902 was not of equal value, though his operas *Jeanie Deans* and *Diarmid* were successful. Mr Granville Bantock, an ardent supporter of the most advanced music, has written many fine things for orchestra, and Mr William Wallace, in various orchestral pieces played at the Crystal Palace and elsewhere, and in such things as his "Freebooter songs," has shown strong individuality and imagination; considerable power was exhibited by the late Erskine Allon, and Mr Arthur Hinton has produced things of fanciful beauty and quaint originality. Miss Ethel M. Smyth, whose *Mass* was given at the Royal Albert Hall some years ago in most favourable conditions, has had her opera *Fantasio* produced at Weimar and Carlsruhe and *Der Wald* at Covent Garden; her strength lies in orchestral writing, and her ideas are remarkable for power. Miss Maude Valerie White's graceful and expressive songs must not pass without a word of recognition, nor the cleverly devised cycles of songs or quartets by which Mme. Liza Lehmann made a new reputation after her retirement from the profession of a singer. The first part of Mr S. Coleridge Taylor's *Hiawatha* scenes was performed while he was still a student at the Royal College, and so great was its popularity that the third part of the trilogy was commissioned for performance by the Royal Choral Society: his name is known by this work throughout England, and musicians have long realized that he possesses a style quite his own, in which the subtle art of emphasis by reiteration is thoroughly understood. His feeling for orchestral colouring is very strong, and his permanent success a matter of certainty. Dr H. Walford Davies and Mr W. Y. Hurlstone excel in the serious kind of chamber-music, and use the classic forms with notable skill; and if Mr S. P. Waddington's *John Gilpin* and Mr R. H. Walthew's *Jackdaw of Rheims* seem to convey the idea that their leanings are towards what is trivial, the power and humour with which both composers have done their work and their other compositions show them to be worthy to be numbered among the best of the younger writers.

English executive musicians have never suffered from foreign competition in the same degree as English composers, and the success of such singers as Miss Anna Williams, Miss Macintyre, Miss Marie Brema, Miss Clara Butt, Messrs Ben Davies, Edward Lloyd, Santley, Ffrangcon Davies, Plunket Greene, Andrew Black, and Watkin Mills, or of such pianists as Miss Fanny Davies and Mr Borwick, is but a continuance of the tradition of British excellence. If no English violinists have been able to command the success of Sarasate, Ysaye, or Kubelik, Messrs Kreuz and Hobday as viola players and Messrs Squire and Ludwig as violoncellists established a firm hold upon the public; and the fame of the best English artists cannot be shaken by such phenomena as the extraordinary rage for M. Paderewski, or the fashion, commoner a few years ago than at the present day, of attaching great importance to the performances of infant prodigies.

The election of Sir Frederick Bridge (b. 1844) to the Gresham professorship on the death of Dr Wylde in 1890 put a new value on the lectures, for as organist of Westminster Abbey he had the faculty of attracting the attention of the public at large, and his lectures were not only instructive, but very amusing also. His appointment as conductor of the Royal Choral Society, in succession to Sir Joseph Barnby, was a popular success. Of the societies formed for the purpose of bringing the best music into the lives of the poor, the People's Concert Society, founded in 1878, is the oldest and the most widely useful; the musical organizations in connexion with such philanthropic undertakings as the Passmore Edwards settlement and the Oxford House at Bethnal Green are doing a valuable work in a thoroughly artistic if unobtrusive way.

The scientific study of the music of the past has more and more decidedly taken its place as a branch of musical education; the learned writings of W. S. Rockstro (1823–1895), many of them made public first in Grove's *Dictionary of Music*, made the subject clear to many who had been groping in the dark before; and the actual performance of old music has been undertaken not only by the Bach Choir, but by the Magpie Madrigal Society under Mr Lionel Benson's able direction. In vocal and instrumental music alike the musical side of the International Exhibition of 1885 did excellent work in its historical concerts; and in that branch of archæology which is concerned in the structure and restoration of old musical instruments important work has been done by Mr A. J. Hipkins, the Rev. F. W. Galpin, and others. The formation of the Folk-Song Society in 1899 drew attention to the importance and extent of English traditional music, and did much to popularize it with singers of the present day. (J. A. F. M.)

Music Halls.—If the Thespian cart or chariot, with all the dramatic sock and buskin actions represented on that movable platform, and the miracle plays performed by the monks in religious sanctuaries, in which the principal characters often represented the ruling powers of heaven, hell, and earth, were the origin of the theatre, the British theatre, protected by monopolist laws and patent rights, was undoubtedly the creator of that sturdy, comparatively modern, and very flourishing institution known generally as the music hall. The "saloon theatres" of the 'thirties were the music halls of to-day, and they owed their form and existence to the restrictive action of the patent theatres. These theatres had the exclusive right of representing what was broadly called the "legitimate drama," which ranged from Shakespeare to Monk Lewis, and from Sheridan and Goldsmith to Kotzebue and Alderman Birch of Cornhill, citizen and poet, and the founder of the turtle-soup trade. The patent houses defended their rights when they were attacked by the "minor" and "saloon" theatres, but they often acted in the spirit of the dog in the manger. While they pursued up to fine and even imprisonment the poachers on their dramatic preserves, they too often neglected the "legitimate drama" for the supposed meretricious attractions offered by their illegitimate competitors. The British theatre gravitated naturally to the inn or tavern. The tavern was the source of life and heat, and warmed all social gatherings. The inn galleries offered rather rough stages, before the Shakespeare and Alleyn playhouses were built. The inn yards were often made as comfortable as possible for the "groundlings" by layers of straw, but the tavern character of the auditorium was never concealed. Excisable liquor was always obtainable, and the superior members of the audience who chose to pay for seats at the side of the stage or platform (like the "avant-scène" boxes at a Parisian theatre), were allowed to smoke Raleigh's Virginian weed, then a novel luxury. This was, of course, the first germ of a "smoking theatre."

While the drama progressed as a recognized public entertainment in England, and was provided with its own buildings in the town, or certain booths at the fairs, the Crown exercised its patronage in favour of certain individuals, giving them power to set up playhouses at any time in any parts of London and Westminster. The first and most important grant was made by Charles II. to his "trusty and well-beloved" Thomas Killigrew "and Sir William Davenant." This was a personal grant, not connected with any particular sites or buildings, and is known in theatrical history as the "Killigrew and Davenant patent." Killigrew was the author of several unsuccessful plays, and Sir William Davenant, said to be an illegitimate child of William Shakespeare, was a stage manager of great daring and genius. Charles II. had strong theatrical leanings, and had helped to arrange the court ballets at Versailles for Louis XIV. The Killigrew and Davenant patent in course of time descended, after a fashion, to the Theatres Royal, Covent Garden and Drury Lane, and was and still is the chief legal authority governing these theatres. The "minor" and outlying playhouses were carried on under the Music and Dancing Act of George II., and the annual licences were granted by the local magistrates.

The theatre proper having emancipated itself from the inn or tavern, it was now the turn of the inn or tavern to develop into an independent place of amusement, and to lay the foundation of that enormous middle-class and lower middle-class institution or interest which we agree to term the music hall. It rose from the most modest, humble, and obscure beginning—from the public-house bar-parlour, and its weekly "sing-songs," chiefly supported by voluntary talent from the "harmonic meetings" of the "long-room" upstairs, generally used as a Foresters' or Masonic club-room, where one or two professional singers were engaged and a regular chairman was appointed, to the "assembly-room" entertainments at certain hotels, where private balls and school festivals formed part of an irregular series. The district "tea-garden," which was then an agreeable feature of suburban life—the suburbs being next door to the city and the country next door to the suburbs—was the first to show dramatic ambition, and to erect in some portion of its limited but leafy grounds a lath-and-plaster stage large enough for about eight people to move upon without incurring the danger of falling off into the adjoining fish-pond and fountain. A few classical statues in plaster, always slightly mutilated, gave an educational tone to the place, and with a few coloured oil-lamps hung amongst the bushes the proprietor felt he had gone as near the "Royal Vauxhall Gardens" as possible for the small charge of a sixpenny refreshment ticket. There were degrees of quality, of course, amongst these places, which answered to the German beer-gardens, though with inferior music. The Beulah Spa at Norwood, the White Conduit House at Pentonville, the Yorkshire Stingo in the Marylebone Road, the Monster at Pimlico, the St Helena at Rotherhithe, the Globe at Mile End, the Red Cow at Dalston, the Highbury Barn at Highbury, the Manor-House at Mare Street, Hackney, the Rosemary Branch at Hoxton, and other *rus-in-urbe* retreats, were up to the level of their time, if rarely beyond it.

The suspended animation of the law—the one Georgian Act, which was mainly passed to check the singing of Jacobite songs in the tap-rooms and tea-gardens of the little London of 1730, when the whole population of the United Kingdom was only about six millions—encouraged the growth eventually of a number of "saloon theatres" in various London districts, which were allowed under the head of "Music and Dancing" to go as far on the light dramatic road as the patent theatres thought proper to permit. The 25th of George II., cap. 36, which in 1902 was still the only Act under which the music halls of forty millions and more of people were licensed, was always liberally interpreted, as long as it kept clear of politics.

The "saloon theatres," always being taverns or attached to taverns, created a public who liked to mix its dramatic amusements with smoking and light refreshments. The principal "saloons" were the "Effingham" in the Whitechapel Road, the "Bower" in the Lower Marsh, Lambeth, the "Albert" at Islington, the "Britannia" at Hoxton, the "Grecian" in the City Road, the "Union" in Shoreditch, the "Stingo" at Paddington, and several others of less importance. All these places had good companies, especially in the winter, and many of them nourished leading actors of exceptional merit. The dramas were chiefly rough adaptations from the contemporary French stage, occasionally flying as high as Alexandre Dumas the elder and Victor Hugo. Actors of real tragic power lived, worked, and died in this confined area. Some went to America, and acquired fame and fortune; and among others, Frederick Robson, who was trained at the "Grecian," first when it was the leading saloon theatre and afterwards when it became the leading music hall (a distinction with little difference), fought his way to the front after the abolition of the "patent rights" and was accepted as the greatest tragi-comic actor of his time. The "Grecian" saloon theatre, better known perhaps, with its pleasure garden or yard, as the "Eagle Tavern," City Road, which formed the material of one of Charles Dickens's *Sketches by Boz*, was a place managed with much taste, enterprise, and discretion by its proprietor, Mr Rouse. It was the "saloon" where the one and only attempt, with limited means, was ever made to import almost all the original repertory of the Opéra Comique in Paris, with the result that many musical works were presented to a sixpenny audience that had never been heard before nor since in England. Auber, Hérold, Adolphe Adam, Boieldieu, Grétry, Donizetti, Bellini, Rossini, and a host of others gave some sort of advanced musical education, through the "Grecian," to a rather depressing part of London, long before board schools were established. The saloon theatres rarely offended the patent houses, and when they did the law was soon put in motion to show that Shakespeare could not be represented with impunity. The "Union Saloon" in Shoreditch, then under the direction of Mr Samuel Lane, who afterwards, with his wife, Mrs Sara Lane, at the "Britannia Saloon," became the leading local theatrical manager of his day, was tempted in 1834 to give a performance of *Othello*. It was "raided" by the then rather "new police," and all the actors, servants, audience, directors, and musicians were taken into custody and marched off to Worship Street police station, confined for the remainder of the night, and fined and warned in the morning. The same and only law still exists for those who are helping to keep a "disorderly house," but there are no holders of exclusive dramatic patent rights to set it in motion. The abolition of this privileged monopoly was effected about this time by a combination of distinguished literary men and dramatists, who were convinced, from observation and experience, that the patent theatres had failed to nurse the higher drama, while interfering with the beneficial freedom of public amusements.

The effect of Covent Garden and Drury Lane on the art of acting had resulted chiefly in limiting the market for theatrical employment, with a consequent all-round reduction of salaries. They kept the Lyceum Theatre (or "English Opera House") for years in the position of a music hall, giving sometimes two performances a night, like a "gaff" in the New Cut or Whitechapel. They had not destroyed the "star" system, and Edmund Kean and the boy Betty—the "Infant Roscius"—were able to command sensational rewards. In the end Charles Dickens, Sir Edward Bulwer-Lytton, Sir Thomas Noon Talfourd, and others got the patents abolished, and the first step towards free trade in the drama was secured.

The effect of this change was to draw attention to the "saloon theatres," where during the performances smoking, drinking, and even eating were allowed in the auditorium. An Act was soon passed, known as the Stage-Play Act—the 6 and 7 Vict. c. 68—appointing a censor of stage-plays, and placing the London theatres under the control of a Crown officer, changing with ministries. This was the Lord Chamberlain for the time being. The Lord Chamberlain of this period drew a hard-and-fast line between theatres under his control, where no smoking and drinking were allowed "in front," and theatres or halls where the old habits and customs of the audience were not to be interfered with. These latter were to go under the jurisdiction of the local magistrates, or other licensing authorities, under the 25 Geo. II. cap. 36—the Music and Dancing Act—and so far a divorce was decreed between the taverns and the playhouses. The Lord Chamberlain eventually made certain concessions. Refreshment bars were allowed at the Lord Chamberlain's theatres in unobtrusive positions, victualled under a special Act of William IV., and private smoking-rooms were allowed at most theatres on application. All this implied that stage plays were to be kept free from open smoking and drinking, and miscellaneous entertainments were to enjoy their old social freedom. The position was accepted by those "saloon theatres" which were not tempted to become Lord Chamberlain houses, and the others, with many additions, started the first music halls.

Amongst the first of these halls, and certainly the very first as far as intelligent management was concerned, was the "Canterbury" in the Lower Marsh, Lambeth, which was next door to the old Bower Saloon, then transformed into a "minor theatre." The "Canterbury" sprang from the usual tavern germ, its creator being Mr Charles Morton, who honourably earned the name of the "*doyen* of the music halls." It justified its title by cultivating the best class of music, and exposed the prejudice and unfairness of Planché's sarcasm in a Haymarket burlesque—"most music hall—most melancholy." Mr Charles Morton added pictorial art to his other attractions, and obtained the support of *Punch*, which stamped the "Canterbury" as the "Royal Academy over the water." At this time by a mere accident Gounod's great opera of *Faust*, through defective international registration, fell into the public domain in England and became common property. The "Canterbury," not daring to present it with scenery, costumes, and action, for fear of the Stage-Play Act, gave what was called "An Operatic Selection," the singers standing in plain dresses in a row, like pupils at a school examination or a chorus in an oratorio at Exeter Hall. The music was well rendered by a thoroughly competent company, night after night, for a long period, so that by the time the opera attracted the tardy attention of the two principal opera managers at Her Majesty's Theatre in the Haymarket and Covent Garden Theatre, the tunes most popular were being whistled by the "man in the street," the "boy in the gutter," and the tradesman waiting at the door for orders.

With the "Canterbury Hall," and its brother the "Oxford" in Oxford Street—a converted inn and coaching yard—built and managed on the same lines by Mr Charles Morton, the music halls were well started. They had imitators in every direction—some large, some small, and some with architectural pretensions, but all anxious to attract the public by cheap prices and physical comforts not attainable at any of the regular theatres.

With the growth and improvement of these "Halls," the few old cellar "singing-rooms" gradually disappeared. "Evans's" in Covent Garden was the last to go. "Rhodes's," or the "Cyder Cellars" in Maiden Lane, at the back of the Adelphi Theatre; the "Coal Hole," in the Strand, which now forms the site of Terry's Theatre; the "Doctor Johnson," in Fleet Street (oddly enough, within the precincts of the City of London), disappeared one by one, and with them the compound material for Thackeray's picture of "The Cave of Harmony." This "Cave," like Dickens's "Old Curiosity Shop," was drawn from the features of many places. To do the "cellars" a little justice, they represented the manners of a past time—heavy suppers and heavy drinks, and the freedom of their songs and recitations was partly due to the fact that the audience and the actors were always composed of men. Thackeray clung to "Evans's" to the last. It was his nightly "chapel of ease" to the adjoining Garrick Club. In its old age it became decent, and ladies were admitted to a private gallery, behind screens and a convent grille. Before its death, and its revival in another form as a sporting club, it admitted ladies both on and off the stage, and became an ordinary music hall.

In its most prosperous days (or nights) "Evans's" never applied for a music licence, and the other "cellars" followed its example. The music, as in circuses, was held to be ancillary, not what the public paid for. They were kept in countenance by places like "Willis's Rooms" in King Street, St James's, where the fashionable and exclusive assemblies known as "Almack's" were held without any formal legal sanction. The Georgian Act was probably considered too common and vulgar to touch; and until the licensing authority was taken from the local magistrates and handed over to the London County Council, the Act 25 Geo. II. c. 36 was often neglected on both sides. The L.C.C. examine and enforce their powers. They have been advised that they can separate a music from a dancing licence if they like, and that when they grant the united licence the dancing means the dancing of paid performers on a stage, and not the dancing of the audience on a platform or floor, as at the short-lived but elegant Cremorne Gardens, or an old-time "Casino." They are also advised that they can withhold licences, unless the applicants agree not to apply for a drink licence to the local magistrates sitting in brewster sessions, who still retain their control over the liquor trade. Theatre licences are often withheld unless a similar promise is made—the drink authority in this case being the Excise, empowered by the Act of William IV. (5 and 6 Will. IV. c. 39, s. 7).

The rise and progress of the London music halls naturally excited a good deal of attention and jealousy on the part of the regular theatres, and this was increased when the first "Great Variety Theatre" was opened in Leicester Square. The building was the finest example of Moorish architecture on a large scale ever erected in England. It was burnt down in the 'eighties, and the present theatre was built in its place. Originally it was "The Panopticon," a palace of "recreative science," started under the most distinguished direction on the old polytechnic institution lines, and with ample capital. It was a commercial failure, and after being tried as an "American Circus," it was turned into a great variety theatre, the greatest of its kind in Europe, under the name of the Alhambra Palace. Its founder was Mr E. T. Smith, the energetic theatrical manager, and its developer was Mr Frederick Strange, who came full of spirit and money from the Crystal Palace. He produced in 1865 an ambitious ballet—the Dagger Ballet from Auber's *Enfant Prodigue*, which had been seen at Drury Lane Theatre in 1851, translated as "Azaël."

The Alhambra was prosecuted in the superior courts for infringing the Stage-Play Act—the 6 and 7 Vict. c. 68. The case is in the law reports—*Wigan* v. *Strange*—the ostensible plaintiffs being Mr Horace Wigan, the actor and manager, and Mr Benjamin Webster, the celebrated actor and manager. They were supported by Mr J. B. Buckstone and many other managers. A long trial before eminent judges, with eminent counsel on both sides, produced a decision which was not very satisfactory, and far from final. It held that, as far as the entertainment went, according to the evidence tendered, it was not a ballet representing any distinct story or coherent action, but it might have been a "divertissement"—a term suggested in the course of the trial. A short time after this a pantomime scene was produced at the same theatre, called "Where's the Police?" which had a clown, a pantaloon, a columbine, and a harlequin, with other familiar characters, a mob, a street, and even the traditional red-hot poker. This inspired proceedings by the same plaintiffs before a police magistrate at Marlborough Street, who inflicted the full penalties—£20 a performance for 12 performances, and costs. An appeal was made to the Westminster quarter sessions, supported by Serjeant Ballantine and opposed by Mr Hardinge Giffard (afterwards Lord Chancellor Halsbury), and the conviction was confirmed. Being heard at quarter sessions, there is no record in the law reports.

About this time "Pepper's Ghost" was a great public attraction at the theatres and music halls in London and the country. The music halls were prosecuted for infringing stage law in this case, although the actors and actresses never appeared on the stage in a solid form, but were thrown up as reflections by an underground arrangement of mirrors. The chief offenders in the provinces were Messrs Day and Son, music hall proprictors, of Birmingham, and in London Mr Charles Morton at the "Canterbury." Convictions were obtained in all cases. There were other prosecutions for other offences under the Act, one being against the "Royal" Music Hall (formerly known as "Weston's) in Holborn. This performance openly broke two laws at the same time—the Copyright Act and the Stage-Play Act. It was a condensed version of Barnett's charming opera of *The Mountain Sylph*, originally produced at the "Grecian," and the chief magistrate at Bow Street had no option but to fine the defendants, Messrs Sweasey and Holland. The fines were light, the prosecution in this case acting on principle.

These prosecutions, and threats of more, suggested the institution of a parliamentary inquiry, and a House of Commons Select Committee was appointed in 1866, at the instigation of the music halls and variety theatres. The committee devoted much time to the inquiry, and examined many witnesses—amongst the rest Lord Sydney, the Lord Chamberlain, who had no personal objection to undertake the control of these comparatively young places of amusement and recreation. Much of the evidence was directed against the Stage-Play Act, as the difficulty appeared to be to define what was *not* a stage play. Lord Denman, Mr Justice Byles, and other eminent judges seemed to think that any song, action, or recitation that excited the emotions might be pinned as a stage play, and that the old definition—"the representation of any action by a person (or persons) acting, and not in the form of narration"—could be supported in the then state of the law in any of the higher courts. The variety theatres on this occasion were encouraged by what had just occurred at the time in France. Napoleon III., acting under the advice of M. Michel Chevalier, passed a decree known as "La Liberté des Théâtres," which fixed the status of the Parisian and other music halls. Operettas, ballets of action, ballets, vaudevilles, pantomimes, and all light pieces were allowed, and the managers were no longer legally confined to songs and acrobatic performances. The report of the Select Committee of 1866, signed by the chairman, Mr (afterwards Viscount) Goschen, was in favour of granting the variety theatres and music halls the privileges they asked for, which were those enjoyed in France and other countries.

Parliamentary interference and the introduction of several private Bills in the House of Commons, which came to nothing, checked, if they did not altogether stop, the prosecutions. The variety theatres advanced in every direction in number and importance. Ballets grew in splendour and coherency. The lighting and ventilation, the comfort and decoration of the various "palaces" (as many of them were now called) improved, and the public, as usual, were the gainers. Population increased, and the six millions of 1730 had become forty millions (and more) in 1902. The same and only Act (25 Geo. II. c. 36), adequate or inadequate, still remained. London is defined as the "administrative county of London," and its area—the 20-miles radius—is mapped out. The Metropolitan Board of Works retired or was discharged, and the London County Council was created and has taken its place. The London County Council, with extended power over structures and structural alterations, acquired the licensing of variety theatres and music halls from the local magistrates (the Middlesex, Surrey, Tower Hamlets, and other magistrates) within the administrative county of London. The spread of so-called "sketches"—a kind of condensed drama or farce—in the variety theatres, and the action of the London County Council in trying to check the extension of refreshment licences to these establishments, with other grounds of discontent on the part of managers (individuals or "limited companies"), led to the appointment of a second Select Committee of the House of Commons in 1892 and the production of another Bluebook. The same ground was gone over, and the same objections were raised against a licensing authority which is elected by public votes, only exists for three years before another election is due, and can give no guarantee for the continuity of its judgments. The consensus of opinion (as in 1866) was in favour of a State official, responsible to Parliament—like the Home Office or the Board of Trade—the preference being given to the Lord Chamberlain and his staff, who know much about theatres and theatrical business. The chairman of the committee was the Hon. David Plunkett (afterwards Lord Rathmore), and the report in spirit was the same as the one of 1866. Three forms of licence were suggested: one for theatres proper, one for music halls, and one for concert rooms.

Though the rise and progress of the music hall and variety theatre interest is one of the most extraordinary facts of the last half of the 19th century, the business has little or no corporate organization, and there is nothing like a complete registration of the various properties throughout the United Kingdom. In London the "London Entertainments Protection Association," which has the command of a weekly paper called the *Music Hall and Theatre Review*, looks after its interests. The general figures placed in the hands of the chairman at a late meeting were sufficiently startling, but they are more likely to be under- than over-stated. In London alone five millions sterling of capital is said to be invested in these enterprises, employing 80,000 persons of all grades, and entertaining during the year about twenty-five millions of people. The annual applications for music licences in London alone are over 300.

Besides the "Canterbury" and the "Alhambra," London in 1902 had the "Palace" in Charing Cross Road, the "Empire" in Leicester Square, the "Pavilion" in Piccadilly Circus (occupying the finest site in western London), the "Hippodrome" in Cranbourn Street, the "Oxford" in Oxford Street, the "Royal" in Holborn, the "South London" in London Road, the "Paragon" at Mile End, the "Cambridge" at Shoreditch, the "Empire" at Bow, the "Bedford" at Camden Town, the "Metropolitan" in the Edgware Road, the "Granville" at Walham Green, the "London" at Shoreditch, the "Foresters'" at Bethnal Green, the "Tivoli" in the Strand, and other theatres of variety in every quarter, including the suburbs. The "provinces," as they are called, are not inclined to lag behind the metropolis, and in the North of England, at Blackpool, a coast town much frequented by "trippers," there are five amusement enterprises outside the regular theatres, concert halls, and gardens, that represent one million sterling. Some of these places may be over-capitalized, but after every allowance is made, enough remains to show that there the theatres proper have now to face a formidable and growing competition. Professional variety "artistes," with their own companies, go "on tour" from one place to another throughout the year. These "tours" are not always confined to the United Kingdom. They often extend to America and Australia, and to various parts of South Africa. Some few get to India and Ceylon, and many go to France, Hungary, Russia, Sweden, and Norway, and particularly to Germany and Holland. (J. HD.)

Muskegon, a city of Michigan, U.S.A., capital of Muskegon county, on the southern shore of Muskegon Lake, 5 miles from Lake Michigan, in the western part of the state, at an altitude of 589 feet. Muskegon Lake forms an excellent harbour, one of the best on the Great Lakes, with a depth at the entrance of 14 feet. The city has regular steamboat communication with Chicago, Milwaukee, and other lake ports, and a large commerce by water. Three railways enter the city, the Pere Marquette, the Grand Rapids and Indiana, and the Grand Trunk. It derives its water supply by pumping from Lake Michigan. Muskegon is a manufacturing city of much importance. In 1900 its manufacturing establishments numbered 200, with a total capital of $4,602,390, and 3235 hands. The products were valued at $5,097,059; of this sum $1,223,918 represented the value of the lumber and timber products. Population (1890), 22,702; (1900), 20,818, of whom 6236 were foreign-born and 23 negroes. The death-rate in 1900 was 12·2.

Musselburgh, a municipal and parliamentary burgh, at the eastern extremity of the coast-line of Midlothian, 5½ miles from Edinburgh, bisected by the river Esk, which divides Musselburgh proper from the more populous district of Fisherrow. While still retaining most of the venerable features of its High Street, the town has tended more and more to become a seaside suburb of Edinburgh, and has thus lost something of its old individuality. New streets and buildings are springing up, and water, drainage, and other improvements have been carried out. The golf-links, though injured by over-playing, are still a great attraction. Musselburgh joins with Leith in sending a member to Parliament. Population (1891), 8888; (1901), 11,704.

Mussoorie, or MASURI, a town and sanatorium of British India, in the Dehra Dun district of the North-West Provinces, 6600 feet above the sea. Population (1891), 10,086; municipal income (1897–98), Rs.70,890, the incidence of taxation being Rs.5:8 per head. It stands on a peak of one of the lower Himalayan ranges, amidst beautiful mountain scenery. It practically forms one station with Landaur, the convalescent depot for European troops, 7362 feet above the sea. Some distance off, on the road to Simla, is the cantonment of Chakrata, 7300 feet. Hitherto it has been approached by road from Saharanpur in the plains, but in 1900 the railway was opened to Dehra. There are numerous schools for Europeans, including St George's College, the Philander-Smith Institute, the Oak Grove School of the East Indian Railway, and several Church of England and Roman Catholic institutions. It has two English newspapers. The first brewery in India was established here in 1850. There are now two breweries, with an annual out-turn of 400,000 gallons; and a third, at Chakrata, with an out-turn of 73,000 gallons. It has botanical gardens, and is the summer headquarters of the Trigonometrical Survey.

Muthuswamy Aiyar, Sir T. (1832–1895), native Indian judge of the High Court of Madras, was born of poor parents in the village of Vuchuwadi, near Tanjore, on the 28th of January 1832. His widowed mother was forced by poverty to remove with Muthuswamy and his brother to Tiruvarar, where the former learnt Tamil, and soon set to work under the village accountant at a monthly salary of one rupee. About this time he lost his mother, whose memory he cherished with reverence and affection to the last. His duty took him to the court-house of the Tahasildar, Mr Naiken, who soon remarked his extraordinary intelligence and industry. There was an English school at Tiruvarar, where Muthuswamy managed to pick up an elementary knowledge of the English language. Mr Naiken then sent him to Sir Henry Montgomery's school at Madras, as a companion to his nephew, and there he won prizes and scholarships year after year. In 1854 he won a prize of 500 rupees offered to the students of the Madras Presidency by the Council of Education for the best English essay. This success brought him to the notice of Sir Alexander Arbuthnot and Mr Justice Holloway. He was offered help to proceed to England and compete for the civil service, but being a Brahmin and married, he declined to cross the ocean. Instead he entered the subordinate

Government service, and was employed in such various posts as school teacher, record keeper in Tanjore, and in 1856 deputy inspector of schools. At this time the Madras authorities instituted the examination for the office of pleaders, and Muthuswamy came out first in the first examination, even beating Sir T. Madhowrao, his senior by many years. Muthuswamy was then appointed in succession district munsiff at Tranquebar, deputy collector in Tanjore in 1859, sub-judge of south Canara in 1865, and a magistrate of police at Madras in 1868. While serving in the last post he passed the examination for the degree of bachelor of laws of the local university. He was next employed as a judge of the Madras Small Causes Court, until in 1878 he was raised to the bench of the High Court, which office he occupied with ability and distinction for over fifteen years, sometimes acting as the Chief Justice. He attended by invitation of the Viceroy the Imperial Assemblage at Delhi in 1877. In 1878 he received the honour of C.I.E. and in 1893 the K.C.I.E. was conferred on him. But he did not live long to enjoy this dignity, dying suddenly in 1895. Muthuswamy was too devoted to his official work to give much time to other pursuits. Still he took his full share in the affairs of the Madras University, of which he was nominated a fellow in 1872 and a syndic in 1877, and was well acquainted with English law, literature, and philosophy. He was through life a staunch Brahmin, devout and amiable in character, with a taste for the ancient music of India and the study of the Vedas and other departments of Sanskrit literature.

Mutsu Hito, MIKADO OR EMPEROR OF JAPAN (1852——), succeeded his father, Osahito, the former emperor, in 1867, and was crowned at Osaka in 1868. The country was then in a ferment owing to the concessions which had been granted to foreigners by the preceding shogun, Iemochi, who in 1854 concluded a treaty with Commodore Perry by which it was agreed that certain ports should be open to foreign trade. This convention gave great offence to the more conservative daimios, and on their initiative the mikado suddenly decided to abolish the shogunate. This resolution was not carried out without strong opposition. The reigning shogun, Hitotsubashi, yielded to the decree, but many of his followers were not so complaisant, and it was only by force of arms that the new order of things was imposed on the country. The main object of those who had advocated the change was to lead to a reversion to the primitive condition of affairs, when the will of the mikado was absolute and when the presence in Japan of the hated foreigner was unknown. But the reactionary party was not to be allowed to monopolize revolutions. To their surprise and discomfiture, the powerful daimios of Satsuma and Chōshū suddenly declared themselves to be in favour of opening the country to foreign intercourse, and of adopting many far-reaching reforms. With this movement Mutsu Hito was cordially in agreement, and of his own motion he invited the foreign representatives to an audience on 23rd March 1868. As Sir Harry Parkes, the British minister, was on his way to this assembly, he was attacked by a number of two-sworded *samurai*, who, but for his guard, would doubtless have succeeded in assassinating him. The outrage was regarded by the emperor and his ministers as a reflection on their honour, and they readily made all reparation within their power. While these agitations were afoot, the emperor, with his advisers, was maturing a political constitution which was to pave the way to the assumption by the emperor of direct personal rule. As a step in this direction, Mutsu Hito transferred his capital from Kyôtô to Yedo, the former seat of the shoguns' government, and marked the event by renaming the city Tôkyô, or Eastern Capital. In 1869 the emperor paid a visit to his old capital, and there took as his imperial consort a princess of the house of Ichijo. In the same year Mutsu Hito bound himself by oath to institute certain reforms, the first of which was the establishment of a deliberative assembly. In this onward movement he was supported by the majority of the daimios, who in a supreme moment of patriotism surrendered their estates and privileges to their sovereign. This was the death-knell of the feudalism which had existed for so many centuries in Japan, and gave Mutsu Hito the free hand which he desired. A centralized bureaucracy took the place of the old system, and the nation moved rapidly along the road of progress. Everything European was eagerly adopted, even down to frock-coats and patent-leather boots for the officials. Torture was abolished (1873), and a judicial code, adapted from the Code Napoléon, was authorized. The first railway—that from Yokohama to Tôkyô—was opened in 1872; the European calendar was adopted, and English was introduced into the curriculum of the common schools. In all these reforms Mutsu Hito took a leading part. But it was not to be expected that such sweeping changes could be effected without opposition, and thrice during the period between 1876 and 1884 the emperor had to face serious rebellious movements in the provinces. These he succeeded in suppressing; and even amid these preoccupations he managed to inflict a check on his huge neighbour the empire of China. As the Government of this state declared that it was incapable of punishing certain Formosan pirates for outrages committed on Japanese ships (1874), Mutsu Hito landed a force on the island, and, having inflicted chastisement on the bandits, remained in possession of certain districts until the compensation demanded from Peking was paid. The unparalleled advances which had been made by the Government were now held by the emperor and his advisers to justify a demand for the revision of the foreign treaties, and negotiations were opened with this object. They failed, however, and the consequent disappointment gave rise to a strong reaction against everything foreign throughout the country. Foreigners were assaulted on the roads, and even the Russian Cesarevitch, afterwards the Tsar Nicholas II., was attacked by would-be assassins in the streets of Tôkyô. A renewed attempt to revise the treaties in 1894 was more successful, and in that year Great Britain led the way by concluding a revised treaty with Japan. Other nations followed, and by 1901 all those obnoxious clauses suggestive of political inferiority had finally disappeared from the treaties. In the same year (1894) war broke out with China, and Mutsu Hito, in common with his subjects, showed the greatest zeal for the campaign. He reviewed the troops as they left the shores of Japan for Korea and Manchuria, and personally distributed rewards to those who had won distinction. In this, as in all matters, Mutsu Hito always placed himself in the van of his countrymen. He led them out of the trammels of feudalism; by his wise and progressive rule he lived to see his country advanced to the first rank of nations; and he was the first Oriental sovereign to form a defensive alliance with a first-rate European Power. He had several sons and daughters, his heir-apparent being Yoshi Hito (b. 31st August 1879), and he adopted the epithet of *Meiji*, or "Enlightened Peace," as the *Nengo* or title of his reign. The year 1902, according to the Japanese calendar, was the 35th year of Meiji.

Muttra, or MATHURA, a city and district of British India, in the Agra division of the North-West Provinces.

The city is on the right bank of the Jumna, 30 miles above Agra; it has a railway station. Population (1881), 57,724; (1891), 61,195; (1901), 59,574; municipal income (1897–98), Rs.61,225, mostly from octroi; incidence of taxation, 14 annas per head; registered death-rate (1897), 53 per thousand. The special cult of Krishna with which the neighbourhood is associated seems to be of comparatively late date. Much of its prosperity is due to the residence of a great family of Seths or native bankers, who were conspicuously loyal during the Mutiny. Temples and bathing stairs line the river bank. Most of the public buildings are of white stone, handsomely carved. There are an American mission, a Roman Catholic church, a museum of antiquities, a high school, thirteen printing-presses, and it is a cantonment for a native infantry regiment.

The district of MUTTRA has an area of 1441 square miles; population (1881), 671,690; (1891), 713,421; (1901), 763,221, showing an increase of 6 per cent. between 1881 and 1891, and of 7 per cent. between 1891 and 1901; average density, 529 persons per square mile. The land revenue and rates are Rs.17,38,808, the incidence of assessment being R.1 : 8 : 6 per acre; cultivated area (1896–97), 677,224 acres, of which 283,606 were irrigated from wells, &c., including 100,640 from Government canals; number of police, 2465; vernacular schools, 96, with 4880 pupils; registered death-rate (1897), 38·6 per thousand. The principal crops are millet, pulse, cotton, wheat, and indigo. There are 41 indigo factories, with an out-turn valued at Rs.2,52,000. The famine of 1878 was severely felt. The eastern half of the district is watered by the Agra canal, which is navigable, and the western half by branches of the Ganges canal. A branch of the Rajputana Railway, from Achnera to Hathras, crosses the district, and the proposed chord line of the East India, from Agra to Delhi, will traverse it from north to south. Besides Muttra city, the district also contains the holy places of Brindaban, Gobardhan, Gokul, and Mahaban, all associated with the cult of Krishna as a herdsman.

Muzaffar-ed-Dîn, SHAH OF PERSIA (1853–——), the second son of Shah Nasr-ed-Dîn, was born 25th March 1853. He was in due course declared *valî ahd*, or heir-apparent, and invested with the governorship of Azarbaijan, but on the assassination of his father in 1896 it was feared that his elder brother, the governor of Ispahan, might prove a dangerous rival, especially when it was remembered that Muzaffar-ed-Dîn had been recalled to Tehran by his father upon his failure to suppress a Kurd rising in his province. In fact, in early youth he had been a fanatical supporter of orthodox Islam, but his views had undergone a complete change under French influence at Tehran. All opposition, however, was satisfactorily obviated, and Muzaffar-ed-Dîn was duly enthroned 8th June 1896. On this occasion he announced the suppression of all purchase of civil and military posts, and then proceeded to remit in perpetuity all taxes on bread and meat, thus lightening the taxation on food, which had caused the only disturbances in the last reign. That his character had become stronger with maturity was shown by his firmness in repressing the fanatical outbreak against Christian Armenians at Kazoni in September 1899. In accordance with his long-expressed intention of visiting the Paris Exhibition of 1900, the Shah arrived 23rd July, and was conducted by President Loubet to the Palais des Souverains in the Bois de Boulogne. While residing there a dastardly attempt was made to assassinate him by an anarchist named François Salson, but he escaped without injury. (See also PERSIA.)

Muzaffargarh, a town and district of British India, in the Derajat division of the Punjab. The town is near the right bank of the river Chenab, and has a railway station. Population (1881), 2720; (1891), 3058; municipal income (1897–98), Rs.11,728.

The district of MUZAFFARGARH occupies the lower end of the Sind-Sagar Doab. Area, 3422 square miles; population (1881), 338,605; (1891), 381,095; (1901), 405,743, showing an increase of 12 per cent., due to the extension of irrigation, between 1881 and 1891, and of 6·5 per cent. between 1891 and 1901; average density, 119 persons per square mile. The land revenue and rates in 1897–98 were Rs.7,07,892, the incidence of assessment being Rs.0 : 6 : 8 per head; cultivated area, 472,358 acres, of which 359,025 were irrigated, including 294,194 from Government canals; number of police, 389; number of schools (1896–97), 174, attended by 3721 boys, being 9 per cent. of the boys of school-going age; death-rate (1897), 44 per thousand. The principal crops are wheat, pulse, rice, and indigo. The most important domestic animal is the camel. The district is crossed for 64 miles by the North-Western Railway, and the boundary rivers are navigable for 277 miles. These rivers also furnish numerous irrigation channels, originally constructed under native rule.

Muzaffarnagar, a town and district of British India, in the Meerut division of the North-West Provinces. The town is 790 feet above the sea, and has a station on the North-Western Railway. Population (1881), 15,080; (1891), 18,166; municipal income (1896–97), Rs.19,488, mostly derived from octroi; incidence of taxation, nearly 14 annas per head; registered death-rate (1897), 46·95 per thousand. There are a high school and one printing-press.

The district of MUZAFFARNAGAR has an area of 1658 square miles; population (1881), 758,444; (1891), 772,874; (1901), 877,984, showing an increase of only 2 per cent. between 1881 and 1891, and of 13·6 per cent. between 1891 and 1901; average density, 529 persons per square mile. The land revenue and rates are Rs.18,41,322, the incidence of assessment being R.1 : 8 : 7 per acre; cultivated area (1896–97), 627,348 acres, of which 310,522 were irrigated, including 202,026 from Government canals; number of police, 1860; vernacular schools, 133, with 4577 pupils; registered death-rate (1897), 31·8 per thousand. The principal crops are wheat, pulse, cotton, and sugar-cane. The district is watered by the Ganges and Eastern Jumna canals, and crossed by the North-Western Railway for 26 miles.

Muzaffarpur, a town and district of British India, in the Patna division of Bengal. The town is on the right bank of the Little Gandak river, and has a railway station. Population (1881), 42,460; (1891), 49,192; (1901), 45,499. It is a well-laid-out town, and is an important centre of trade, being on the direct route from Patna to Nepal. The high school had 448 pupils in 1896–97. It has a German mission, six printing-presses, and a club for Indians.

The district of MUZAFFARPUR has an area of 3003 square miles; population (1881), 2,582,060; (1891), 2,711,445; (1901), 2,746,009, showing an increase of 5 per cent. between 1881 and 1891, and of 1·2 per cent. between 1891 and 1901; average density, 914 per square mile, being exceeded in all India only by the neighbouring district of Saran. Classified according to religion, Hindus in 1891 numbered 2,378,168; Mahommedans, 332,906; Christians, 371, of whom 123 were Europeans. The land revenue and rates in 1897–98 were Rs.14,99,312; number of police, 509; number of boys at school (1896–97), 30,058, being 15·3 per cent. of the male population of school-going age, compared with 28 per cent. for the province generally; registered death-rate (1897), 32 per thousand. Indigo and opium are largely grown. There are 30 indigo factories, employing 40,000 persons, with an out-turn of 9000 maunds, valued at Rs.14,68,000. The district is traversed in several directions by the Tirhut system of the Bengal and North-Western Railway. It suffered from drought in 1873–74, and again in 1897–98.

Muztagh. See PAMIRS.

Mweru, a large lake of Eastern Central Africa, traversed by the Luapula or Upper Congo. It measures about 76 miles in length by some 25 in breadth, and is roughly rectangular, the axis running from south-south-west to north-north-east. At the south end a shallow bay extends to 9° 31′ S. East of this, and some miles farther north, the Luapula enters from a vast marsh inundated at high water. The southern portion of the lake is bordered by flat country, that to the east being forest-clad and abounding in rubber trees. In the northern half both shores form low cliffs, 100 to 200 feet high, while farther from the lake the country rises on the west to an extensive plateau, and on the east to a range of broken hills some

800 feet above the water-level. The Luapula leaves the lake at its north-west corner, making a sharp bend to the west before assuming a northerly direction. The northern shore was found by Mr Weatherley, by careful rope measurement, to be almost 19 miles in length. Besides the Luapula, the principal influent is the Kalungwizi, from the east. North-west of the Luapula mouth lies the island of Kilwa, about 8 miles in length, rising into plateaux 600 feet above the lake. Here the air is cool and balmy, the soil dry, with short turf and clumps of shady trees, affording every requirement for a sanatorium. The lake was reported by the Belgian Lieutenant Brasseur, in 1897, to be diminishing in size, but this probably referred to periodic fluctuations. Mweru was reached by Livingstone in 1867, but its western shore was first explored in 1890 by Mr Alfred Sharpe, who two years later effected its circumnavigation. The whole eastern shores from the Luapula entrance to its exit, together with Kilwa island, belong to British Central Africa; the western to the Congo Free State.

See Sharpe in *Proc. R.G.S.*, 1892, and *Geographical Journal*, vol. i., 1893. (E. He.)

Myaungmya, a district in the Irrawaddy division of Lower Burma, formed in 1896 out of a portion of the Bassein district. It has an area of 3005 square miles, and a population (1891) of 217,878, and (1901), 303,308, showing an increase of 39·2 per cent. and a density of 101 inhabitants to the square mile. In 1898–99 there were 844 villages, paying Rs.15,41,719 revenue. Of the population, 203,319 were Buddhists and Jains, 1787 Mahommedans, 569 Hindus, and 12,203 Christians, of whom 12,111 were natives, mostly Karens. There were also 271 non-Christian Karens. Of the total area of 1,923,200 acres, 432,682 were cultivated in 1898–99, 472,494 acres were not available for cultivation, and the cultivable area available, apart from fallow, was 898,968 acres. The total rainfall in 1898–99 was 118·82 inches. The chief town is Pantanaw, which had in 1891 a population of 6030. Myaungmya, which is a municipal town, had 2162 inhabitants in 1891.

Mycenaean Civilization.—"Mycenaean" is a convenient epithet for a certain phase of a prehistoric civilization, which as a whole is often called "Aegean." It owes its vogue to the fame of Henry Schliemann's discovery at Mycenae in 1876, but is not intended to beg the open question as to the origin or principal seat of the Bronze Age culture of the Greek lands.

The site of Mycenae itself was notorious for the singular and massive character of its ruins, long before Schliemann's time. The great curtain wall and towers of the citadel, of mixed Cyclopean, polygonal, and ashlar construction, and unbroken except on the south cliff, and the main gate, crowned with a heraldic relief of lionesses, have never been hidden; and though much blocked with their own ruin, the larger dome-tombs outside the citadel have always been visible, and remarked by travellers. But since these remains were always referred vaguely to a "Heroic" or "proto-Hellenic" period, even Schliemann's preliminary clearing of the gateway and two dome-tombs in 1876, which exposed the engaged columns of the façades, and suggested certain inferences as to external revetment and internal decoration, would not by itself have led any one to associate Mycenae with an individual civilization. It was his simultaneous attack on the unsearched area which was enclosed by the citadel walls, and in 1876 showed no remains above ground, that led to the recognition of a "Mycenaean civilization." Schliemann had published in 1868 his belief that the Heroic graves mentioned by Pausanias (ii. 16) lay within the citadel of Mycenae, and now he chose the deeply-silted space just within the gate for his first sounding. About 10 feet below the surface his diggers exposed a double ring of upright slabs, once capped with cross slabs, and nearly 90 feet in diameter. Continuing downwards through earth full of sherds and other débris, whose singularity was not then recognized, the men found several sculptured limestone slabs, showing subjects of war or the chase, and scroll and spiral ornament rudely treated in relief. When, after some delay, the work was resumed, some skeletons were uncovered lying loose, and at last, 30 feet from the original surface, an oblong pit-grave was found, paved with pebbles, and once roofed, which contained three female skeletons, according to Schliemann, "smothered in jewels." A few feet to the west were presently revealed a circular altar, and beneath it another grave with five corpses, two probably female, and an even richer treasure of gold. Three more pits came to light to the northward, each adding its quota to the hoard; and then Schliemann, proclaiming that he had found Atreus and all his house, departed for Athens. But his Greek ephor, clearing out the rest of the precinct, came on yet another grave and some gold objects lying loose. Altogether there were nineteen corpses in six pits, buried, as the grave furniture showed, at different times, but all eventually included in a holy ring.

These sepulchres were richer in gold than any found elsewhere in the world, a fact which led to an absurd attempt to establish their kinship with the later and only less golden burials of Scyths or Kelts. The metal was worked up into heavy death-masks and lighter breastplates, diadems, baldrics, pendants, and armlets, often made of mere foil, and also into goblets, hair-pins, rings engraved with combats of men and beasts, miniature balances, and an immense number of thin circular plaques and buttons with bone, clay, or wooden cores. Special mention is due to the inlays of gold and niello on bronze dagger-blades, showing spiral ornament or scenes of the chase, Egyptian in motive, but non-Egyptian in style; and to little flat models of shrine-façades analogous to those devoted to Semitic pillar-worship. The ornament on these objects displayed a highly developed spiraliform system, and advanced adaptation of organic forms, especially octopods and butterflies, to decorative uses. The shrines, certain silhouette figurines, and one cup bear moulded doves, and plant forms appear inlaid in a silver vessel. The last-named metal was much rarer than gold, and used only in a few conspicuous objects, notably a great hollow ox-head with gilded horns and frontal rosette, a roughly modelled stag, and a cup, of which only small part remains, chased with a scene of nude warriors attacking a fort. Bronze swords and daggers and many great caldrons were found, with arrow-heads of obsidian, and also a few stone vases, beads of amber, intaglio gems, sceptre heads of crystal, certain fittings and other fragments made of porcelain and paste, and remains of carved wood. Along with this went much pottery, mostly broken by the collapse of the roofs. It begins in grave 4 (Fig. 1), with a dull painted ware, which we now know as late "proto-Mycenaean," and it develops into a highly-glazed fabric, decorated with spiraliform and marine schemes in lustrous paint, and showing the typical forms, false-mouthed amphorae and long-footed vases, now known as distinctively Mycenaean. The loose objects found outside the circle include the best intaglio ring from this site, admirably engraved with a cult scene, in which women clad in flounced skirts are chiefly concerned, and the worship seems to be of a sacred tree. In houses south of the circle occurred some goldsmiths' moulds, which supply indubitable evidence of native productivity, many rude painted idols in terra-cotta, and (it is said) the fragments of a most notable vase, decorated with armed warriors in a debased style approaching the later "Dipylon" manner.

This treasure as a whole was admitted at once to be far too highly developed in technique and ornament, and too individual in character, to belong, as the lionesses over the gate used to be said to belong, merely to a first stage in Hellenic art. It preceded in time the classical culture of the same area; but, whether foreign or native, it was allowed to represent a civilization that was at its acme and practically incapable of further development. So the bare fact of a great prehistoric art-production, not strictly Greek, in Greece came to be accepted without much difficulty. But before describing how its true relations were unfolded thereafter, it may be mentioned that the site of Mycenae had yet much to reveal after Schliemann left it. Ten years later the Greek Archæological Society resumed exploration there, and M. Tsountas, probing the summit of the citadel, hit upon and opened out a fragment of a palace with hearth of stucco, painted with geometric design, and walls adorned with frescoes of figure subjects, armed men and horses. An early Doric temple was found to have been built over this palace, a circumstance which disposed for ever of the later dates proposed for Mycenaean objects. Subsequently many lesser structures were cleared in the east and south-west of the citadel area, which yielded commoner vessels of domestic use, in pottery, stone, and bronze, and some more painted objects, including a remarkable fragment of stucco, which shows human ass-headed figures in procession, a tattooed head, and a plaque apparently showing the worship of an aniconic deity.

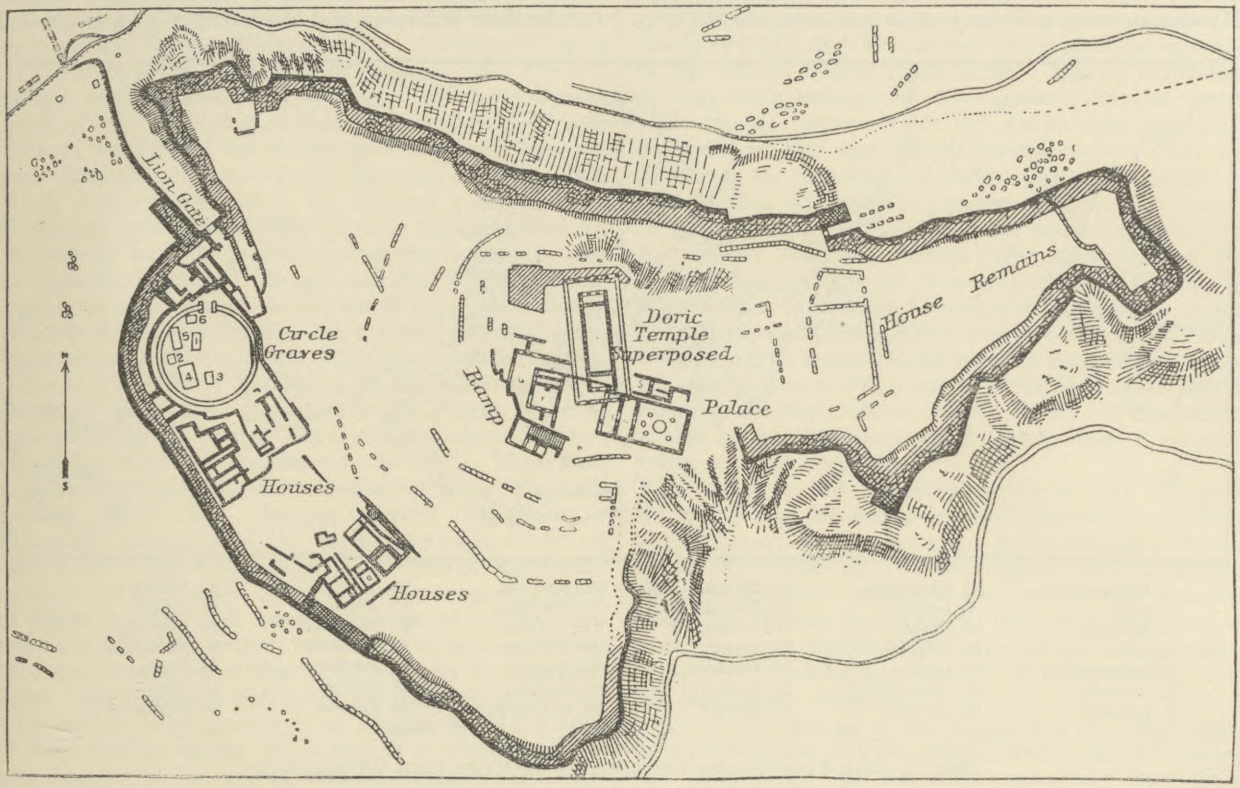


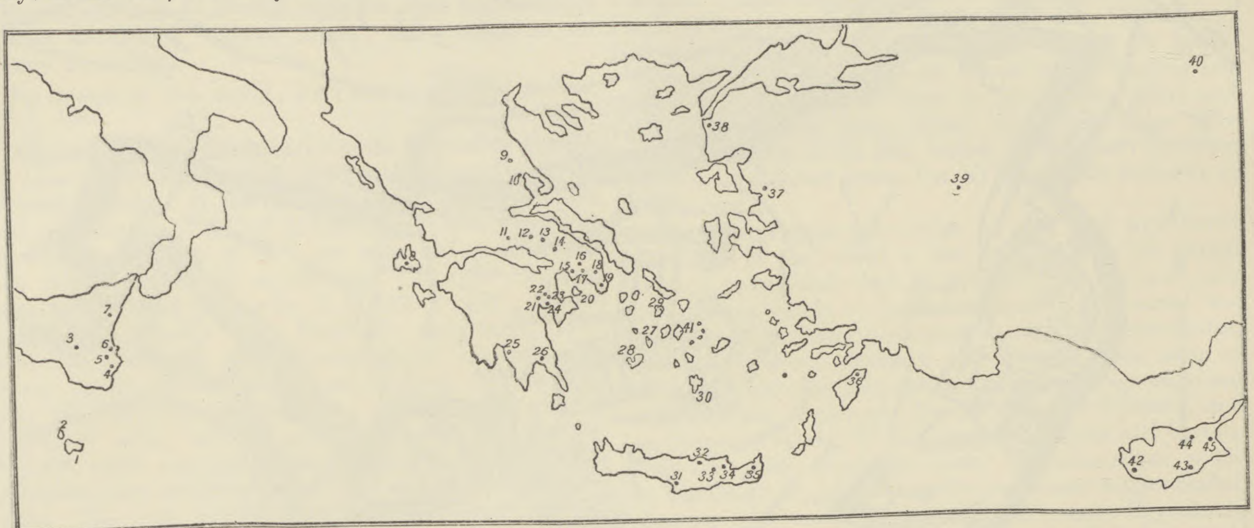
FIG. 1.—PLAN OF THE CITADEL OF MYCENAE.

(Based on a plan in Schuckhardt's "Schliemann's Excavations.")

From the immense variety of these domestic objects more perhaps has been learned as to the affinities of Mycenaean civilization than from the citadel graves. Lastly, a most important discovery was made of a cemetery west of the citadel. Its tombs are mostly rock-cut chambers, approached by sloping *dromoi;* but there are also pits, from one of which came a remarkable ivory mirror handle of Oriental design. The chamber graves were found to be rich in trinkets of gold, engraved stones, usually opaque, vases in pottery and stone, bronze mirrors and weapons, terra-cottas and carved ivory; but neither they nor the houses have yielded iron except in very small quantity, and that not fashioned into articles of utility. The presence of fibulae and razors supplied fresh evidence as to Mycenaean fashions of dress and wearing of the hair, and a silver bowl, with male profiles inlaid in gold, proved that the upper lip was sometimes shaved. All the great dome-tombs known have been cleared, but the process has added only to our architectural knowledge. The tomb furniture had been rifled long ago. Part of the circuit of a lower town has been traced, and narrow embanked roadways conducted over streams on Cyclopean bridges lead to it from various quarters.

The abundance and magnificence of the circle treasure had been needed to rivet the attention and convince the judgment of scholars, slow to reconstruct *ex pede Herculem.* But there had been a good deal of evidence available previous to 1876, which, had it been collated and seriously studied, might have greatly discounted the sensation that the citadel graves eventually made. Although it was recognized that certain tributaries, represented, *e.g.*, in the 18th Dynasty tomb of Rekhmara at Egyptian Thebes, as bearing vases of peculiar form, were of Mediterranean race, neither their precise habitat nor the degree of their civilization could be determined while so few actual prehistoric remains were known in the Mediterranean lands (Fig. 2). Nor did the Mycenaean objects which were lying obscurely in museums in 1870 or thereabouts provide a sufficient test of the real basis underlying the Hellenic myths of the Argolid, the Troad, and Crete, to cause these to be taken seriously. Both at Sèvres and at Neuchâtel Aegean vases have been exhibited since the 'thirties, the provenience in the one case being Phylakopi in Melos, in the other case Cephalonia. Ross, by his explorations in the Greek islands from 1835 onwards, called attention to the early intaglios, now known as *inselsteine;* but it was not till 1878 that Newton demonstrated these to be no strayed Phoenician products. In 1866 primitive structures were discovered in the island of Therasia by quarrymen extracting pozzolana for the Suez Canal breakwaters; and when this discovery was followed up in 1870 on the neighbouring Santorin by representatives of the French School at Athens, much pottery of a class now known immediately to precede the typical Mycenaean ware, and many stone and metal objects, were found and dated by the geologist Fouqué, somewhat arbitrarily, to 2000 B.C., by consideration of the superincumbent eruptive stratum. Meanwhile, in 1868, tombs at Ialysos in Rhodes had yielded to M. Biliotti many fine painted vases of styles which came later to be called the third and fourth Mycenaean; but these, bought by Mr Ruskin, and presented to the British Museum, excited less attention than they deserved, being supposed to be of some local Asiatic fabric of uncertain date. Nor was a connexion immediately detected between them and the objects found four years later in a dome-tomb at Menidi in Attica and a rock-cut "bee-hive" grave near the Argive Heraeum.

Even Schliemann's first excavations at Hissarlik in the Troad did not surprise those familiar equally with Neolithic settlements and Hellenistic remains. But the "Burnt City" of the second stratum, revealed in 1873, with its fortifications and vases, and the hoard of gold, silver, and



1. Malta.
2. Gozo.
3. Ragusa.
4. Noto.
5. Palazzolo.
6. Lentini.
7. Licodia.
8. Maskarata.
9. Larissa.
10. Dimini.
11. Delphi.
12. Daulis.
13. Orchomenos.
14. Thebes.
15. Eleusis.
16. Menidi.
17. Athens.
18. Spata.
19. Thoricos.
20. Aegina.
21. Argos.
22. Mycenae.
23. Heraeum.
24. Tiryns.
25. Kampos.
26. Vaphio.
27. Siphnos.
28. Phylakopi.
29. Syros.
30. Thera.
31. Phaestos.
32. Knossos.
33. Psychro.
34. Goulas.
35. Praesos.
36. Ialysos.
37. Pitane.
38. Hissarlik.
39. Midas City.
40. Pteria.
41. Naxos.
42. Paphos.
43. Mari.
44. Nicosia.
45. Salamis.

FIG. 2.—MAP SHOWING THE DISTRIBUTION OF MYCENAEAN CIVILIZATION.

bronze objects, which the discoverer connected with it (though its relation to the stratification is doubtful still), made a stir, which was destined to spread far outside the narrow circle of scholars when in 1876 Schliemann lighted on the Mycenae graves. Like the "letting in of water," light at once poured in from all sides on the prehistoric period of Greece. It was established that the character of both the fabric and the decoration of the Mycenaean objects was not that of any well known art. A wide range in space was proved by the identification of the *inselsteine* and the Ialysos vases with the new style, and a wide range in time by collation of the earlier Theraean and Hissarlik discoveries. A relation between objects of art described by Homer and the Mycenaean treasure was generally recognized, and a correct opinion prevailed that, while certainly posterior, the civilization of the *Iliad* was reminiscent of the great Mycenaean period. Schliemann got to work again at Hissarlik in 1878, and greatly increased knowledge of the lower strata, but did not recognize the Mycenaean remains in his "Lydian" city of the sixth stratum; but by laying bare in 1884 the upper remains on the rock of Tiryns, he made a contribution to the science of domestic life in the Mycenaean period, which was amplified two years later by Tsountas's discovery of the Mycenae palace. From 1886 dates the finding of Mycenaean sepulchres outside the Argolid, from which, and from the continuation of Tsountas's exploration of the buildings and lesser graves at Mycenae, a large treasure, independent of Schliemann's princely gift, has been gathered into the National Museum at Athens. In that year were excavated dome-tombs, most already rifled, at Arkina and Eleusis in Attica, at Dimini near Volo in Thessaly, at Kampos on the west of Mount Taygetus, and at Maskarata in Cephalonia. The richest grave of all was explored at Vaphio in Laconia in 1889, and yielded, besides many gems and miscellaneous goldsmiths' work, two golden goblets chased with scenes of bull-hunting. In 1890 and 1893 Stacs cleared out more homely dome-tombs at Thoricus in Attica; and other graves, either rock-cut "bee-hives" or chambers, were found at Spata and Aphidna in Attica, in Aegina and Salamis, at the Heraeum and Nauplia in the Argolid, near Thebes and Delphi, and lastly not far from the Thessalian Larissa.

But discovery was far from being confined to the Greek mainland and its immediate dependencies. The limits of the prehistoric area were pushed out to the central Aegean islands, to Antiparos, to Ios, to Amorgos, to Syros and Siphnos, all of which are singularly rich in evidence of the pre-Mycenaean period. The series of Syran built graves, containing crouching corpses, is the best and most representative that is known in the Aegean. Melos, long marked as containing early objects, but not systematically excavated until taken in hand by the British School at Athens in 1896, shows at Phylakopi remains of all the Aegean periods. Crete has been proved by the tombs of Anoja and Erganos, by the excavations on the site of Knossos begun in 1878 by M. Minos Kalokairinos and resumed with startling success in 1900 by Messrs Evans and Hogarth, and by those in the Dictaean Cave and at Phaestos, Gournia, Zakro, and Palaeokastro, to be prolific in remains of the prehistoric periods out of all proportion to remains of classical Hellenic culture. A map of Cyprus in the later Bronze Age now shows more than five-and-twenty settlements in and about the Mesaoréa district alone, of which one, that at Enkomi, near the site of later Salamis, has yielded the richest gold treasure found outside Mycenae. Half round the outermost circle to which Greek influence attained in the classical period remains of the same prehistoric civilization have been happened on. M. Chantre in 1894 picked up lustreless ware, like that of Hissarlik, in central Phrygia, and the English archæological expeditions sent subsequently into north-western Anatolia have never failed to bring back "Aegean" specimens from the valleys of the Rhyndacus and Sangarius, and even of the Halys. In Egypt Mr Petrie found painted sherds of Cretan style at Kahun in the Fayum in 1887, and farther up the Nile, at Tell el-Amarna, chanced on bits of not less than 800 Aegean vases in 1889. There have now been recognized in the collections at Gizeh, Florence, London, Paris, and Bologna several Egyptian or Phoenician imitations of the Mycenaean style to set off against the many debts which the centres of Mycenaean culture owed to Egypt. Two Mycenaean vases were found at Sidon in 1885, and many fragments of Aegean, and especially Cypriote, pottery have been turned up during the recent excavation of sites in Philistia by the Palestine Fund. South-eastern Sicily has proved, ever since Orsi excavated the Sikel cemetery near Lentini in 1877, a mine of early remains, among which appear in regular succession Aegean fabrics and motives of decoration from the period of the second stratum at Hissarlik down to the latest Mycenaean. Sardinia has Mycenaean sites, *e.g.*, at Abini near Teti; and Spain has yielded objects recognized as Mycenaean from tombs near Cadiz, and from Saragossa.

The results of three excavations will especially serve as rallying points and supply a standard of comparison. After Schliemann's death, Dörpfeld returned to Hissarlik, and recognized in the huge remains of the sixth stratum, on the southern skirts of the citadel mound, a city of the same period as Mycenae at its acme. Thus we can study there remains of a later stage in one process of development superposed on earlier remains, after an intervening period. The links there missing are, however, apparent at Phylakopi in Melos, excavated systematically from 1896 to 1899. Here buildings of three main periods appear one on another. The earliest overlie in one spot a deposit of sherds of the most primitive type known in the Aegean and found in the earliest cist-graves. The second and third cities rise one out of the other without evidence of long interval. A third and more important site than either, Knossos in Crete, awaits fuller publication. Here are ruins of a great palace, mainly of two periods. Originally constructed about 2000 B.C., it was almost entirely rebuilt at the acme of the Mycenaean Age, but substructures and other remains of the earlier palace underlie the later. The latter was built round a great central court, and was more than one storey high. Stairways and galleries and fragments of the upper storeys remain, chiefly on the east side. The palace was not fortified. Numerous store galleries, sunken baths, and a room with stone throne and seats are the main architectural features. Much has been recovered of internal decoration in fresco, painted plaster relief-work, and carved stone; and great variety of furniture in all materials, including objects which supply links with Egypt.

Since recent researches, some of whose results are not yet published, have demonstrated that in certain localities, for instance, Cyprus, Crete, and most of the Aegean islands, where Mycenaean remains were not long ago supposed to be merely sporadic, they form in fact a stratum to be expected on the site of almost every ancient Aegean settlement, we may safely assume that Mycenaean civilization was a phase in the history of all the insular and peninsular territories of the east Mediterranean basin. Into the continents on the east and south we have no reason to suppose that its influence penetrated either very widely or very strongly. There has been much excavation in Egypt, but not half-a-dozen sites have yielded the characteristic pottery, not even sites near the Levant sea as thoroughly explored as Naucratis and Daphnae. About Syria and inland Asia Minor we must speak with more reserve; but all research made hitherto suggests that there, as in Sicily, the peculiar products of the Mycenaean culture were sporadic importations. As to Thrace and Macedonia, as well as the Cyrenaic coast of Africa, there is no good evidence as yet available.

The remains that especially concern us here belong to the later period illustrated by these discoveries, and have everywhere a certain uniformity. Some common influence spread at a certain era over the Aegean area and reduced almost to identity a number of local civilizations of similar origin but diverse development. Surviving influences of these, however, combined with the constant geographical conditions to reintroduce some local differentiation into the Mycenaean products.

The Neolithic Age in the Aegean has now been abundantly illustrated from the yellow bottom clay at Knossos, and its products do not differ materially from those implements and vessels with which man has everywhere sought to satisfy his first needs. The mass of the stone tools and weapons, and the coarse hand-made and burnished pottery, might well proceed from the spontaneous invention of each locality that possessed suitable stone and clay; but the common presence of flaked blades, arrowheads, and blunt choppers of an obsidian native, so far as is known, to Melos only, speaks of inter-communication even at this early period between many distant localities and the city whose remains have been unearthed at Phylakopi. The wide range of the peculiar cist-grave strengthens the belief that late Stone Age culture in the Aegean was not of sporadic development, and prepares us for a striking similarity in the succeeding ware with incised non-spiraliform geometric ornament which prevails over an area extending from Hissarlik to Sicily, and for the universality of a certain fiddle-shaped type of stone idol. Local divergence is, however, already apparent in the relative prevalence of certain forms; for example, a shallow bowl is common in Crete, but not in the Cyclades, while the *pyxis*, so common in the graves of Amorgos and Melos, has left little sign of itself in Crete; and from this point the further development of civilization in the Aegean area results in increasing differentiation. The Greek mainland has produced as yet very little of the earlier periods (the excavators of the Heraeum promise additions), but the primitive remains in the rest of the area may be divided into four classes of strong family likeness but distinct development.

The pottery supplies the best criterion, and will suffice for our end. We have no such comprehensive and certain evidence from other classes of remains. Except for the Great Treasure of Hissarlik, and the weapons in Cycladic graves, there have been found as yet hardly any metal products of the period. Of the few stone products, one class, the "island idols" already referred to, was obviously exported widely, and supplies an ill test either of place or date. There have not been discovered sufficiently numerous structures or graves to afford a basis of classification. Fortified towns have been explored in Melos, Siphnos, and the Troad, and a few houses in Aegina and Thera; but neither unaltered houses nor tombs of undoubted primitive character have appeared in Crete as yet, nor elsewhere than in the Cyclad isles.

(1) Crete follows up the geometric incised ware with a painted geometric fabric developed out of it. This is made on the wheel, and covered with dull glaze, mostly fired black to dull red, on which colour is applied. In fabric, form, and decoration it quickly develops so marked an individuality that, but for the predominance of certain peculiar vase-shapes found also in the Cyclades, it would not readily be known for an Aegean product at all. The walls of the vessels are often reduced to a metallic egg-shell consistency, and both the forms and the treatment of the clay surface are imitated with extraordinary fidelity from metallic, probably gold, fabrics, and the decoration, whether in sharply-moulded rings and protuberances, incrustation, white spotting, or hard geometric painted lines and conventional plant forms, owes its origin to the metallurgist. This ware, known as "Kamáres," from a cave near a village on the south-east of Mount Ida, where it was first observed, but apparently to be found always between the primitive and the Mycenaean strata in Crete, is singular in the field of ceramics, and must owe its fully developed character to some peculiar influence, perhaps to the impression made on a people which did not possess the precious metals by some imported gold or silver fabrics.

(2) If the ware of Crete shows the paramount influence of metal, that of the central Cyclades shows the influence of hard stone. There the geometric incised linear ornament is developed into incised curvilinear of an elaborate kind—an advance which potters elsewhere, not accustomed to an intractable material, could achieve only by paint. At present Syra has yielded the best examples, but early sites exist in the marble islands, Naxos and Paros, and also in Siphnos, and the origin of the Syran forms and decoration will probably be found elsewhere.

(3) The volcanic isles of the south-west, Thera and Melos, display the most orderly development of the art of working clay, unaffected by other materials, probably because good clay was readily procurable. Paint appears on the grey body clay of vessels found at very low levels, and curvilinear colour schemes slowly replace rectilinear. Not hampered by the traditions of workers in stone or metal, the Melian and Theraean potters are those that evolve the most suitable fabrics and shapes in earthenware, and earliest begin to adopt natural forms as motives of decoration. All kinds of vegetable schemes, most naturalistically treated, become characteristic of their school, and from those they pass to marine motives, fish, seaweeds, and the like, and finally to birds and even the human form.

(4) There remains the eastern Aegean, where vessels found in the Burnt City at Hissarlik, at one end, show strong affinity to those from early graves in Cyprus at the other. Here is a certain unmistakable Asiatic element. The use of the wheel and of slip and colour come in early, but the shapes develop towards the fantastic and grotesque, and the decoration makes no approach to nature. One would say that a race whose natural artistic capacity was free to develop in the western isles was either not itself present in the easternmost part of the area, or was quickly contaminated there by some strong alien influence. But such conjectures as to history are very hazardous, while not only has very little of the Anatolian coast been explored, but the earlier sites in the great Sporades islands are unknown.

Here are indubitably distinct lines of local development, but there persists, nevertheless, an equally indubitable common character, which both binds all together into one family of civilization and distinguishes all from other contemporary civilizations, for example, from those of the Nile or Mesopotamian valleys. To take one piece of evidence only. A certain form of beaked jug, called by German archæologists *schnabelkanne* (Fig. 3), is characteristic of the whole area from before the first introduction of the potter's wheel to the end of the period. The shape is so peculiar that reason revolts against the suggestion of spontaneous invention in divers places. It is found with the same inevitable certainty on Cretan sites as at Hissarlik.

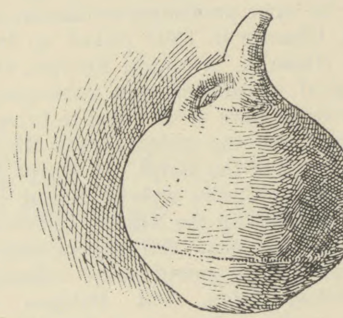


Fig. 3.—Schnabelkanne.

Above the strata, however, which contain these remains of local divergent development, there lies in all districts of the Aegean area a rich layer of deposit, whose contents show a rapid and marked advance in civilization, are essentially uniform, and have only subsidiary characteristics due to local influence or tradition. The civilization there represented is not of an origin foreign to the area. The germs of all its characteristic fabrics, forms, and motives of decoration exist in the underlying strata, though not equally in all districts, and the change which Mycenaean art occasions is not always equally abrupt. It is most reasonable to see in these remains the result of the action of some accidental influence which greatly increased the wealth and capacity of one locality in the area, and caused it to impose its rapidly developing culture on all the rest. The measure of the reaction that took place in divers localities thereafter depended naturally on the point to which local civilizations had respectively advanced in the pre-Mycenaean period.

The pottery, which supplies a voluminous commentary on the new period, is distinguished not only by the regularity of its forms, the purity of its clay, the smoothness of its slip, and the quality of its glaze, but especially by the general use of a peculiar paint, lustrous on properly prepared surfaces. Traces, however, of an earlier knowledge of that pigment have been found in Melos. Along with this ware, however, continued to exist ruder fabrics in common use. In the ware, found up to 1885 mainly at Mycenae, Furtwängler and Löschke distinguished four stages of development. At first greyish ware with dull white and red decoration in a paint only slightly lustrous, because applied on the body clay. To this early class belong, for example, the vases found by Schliemann in the fourth and fifth graves of the Mycenae circle. Next a class with black-brown decoration on a white slip, found in Thera and the Heraeum and Spata graves. Thirdly, the acme of the style, a thin yellow ware of very pure clay with hard slip and decorated with paint highly lustrous. This predominates at Mycenae, and prevails all over the area from Sicily to Cyprus. The decoration varies from brown through yellow to red, detail being often applied in white on a surface polished by hand; and it differs from the fourth and last class only in that its paint is more lustrous, its ground deeper in tint, and its glaze more brilliant. Of this fourth class Ialysos in Rhodes has supplied good examples.

As to the decorative motives in vogue there is less uniformity. The earlier Mycenaean vessels have curvilinear and generally spiraliform geometric schemes. These pass into naturalistic vegetable forms, and finally become in the finest typical vases almost exclusively marine—algae, octopods, molluscs, shells, in many combinations. Of the last kind is the most of the Rhodian ware, and

Fig. 4.—Bugelkanne.

that which lay thickly just below the surface at Phylakopi, and is not of Melian manufacture. On the native Cretan products with Mycenaean paint and slip vegetable schemes of strongly naturalistic character predominate, but marine motives are not absent. Everywhere animal, bird, and human forms are but seldom found. Man certainly appears very late, and in company with the Oriental motives which characterize the Spata objects. Insects, especially butterflies, become common, and when their antennae terminate in exquisite spirals decorative art is at the end of its progress.

The vase-forms become so numerous and various that only a reference to Furtwängler and Löschke's *Formentafel* will give any idea of them. All the later Greek shapes find their prototypes. One type alone must have special mention, since it is as characteristic of this period as the *schnabelkanne* of the earlier. This is the pseudamphora or *bugelkanne* (Fig. 4), with false neck and a small spout projecting from the body of the vase. Originally the neck was open, and the subsidiary spout was introduced for convenience of drinking; and the later evolution is so singular that it amounts to proof, if not of the common origin, at least of the common character of Mycenaean civilization. It is found everywhere in the area, made of various local clays, and it long survived into the "Geometric" or sub-Mycenaean period.

Not only in the continuous and universal commentary of painted earthenware, but in many other media, we have evidence of "Mycenaean" art, but varying in character according to the local abundance or variety of particular materials. We have reached an age when the artist had at his disposal not only terra-cotta, hard and soft stone, and wood, but much metal—gold, silver, lead, copper, bronze containing about 12 per cent. of tin alloy—as well as bone and ivory, and various compositions from soft lime plaster up to opaque glass. If it were not for the magnificent stone utensils, in the guise of lioness heads, triton shells, palm and lotus capitals, with spirals in relief and miniature shields for handles, which have come to light at Knossos, we should have supposed stone to have been a material used (except architecturally) only for such rude metallic-seeming reliefs as stood over the Mycenae gate and circle graves, or for heavy commonplace vases and lamps. We have discovered no large free statuary in the round in any material as yet, though part of a hand at Knossos speaks to its existence; but figurines in metal, painted terra-cotta, and ivory, replacing the earlier stone idols, are fairly abundant. For these bronze is by far the commonest medium, and two types prevail; a female with bell-like or flounced divided skirt, and hair coiled or hanging in tails, and a male, nude but for a loincloth. The position of the hands and legs varies with the skill of the artist, as in all archaic statuary. Knossos has revealed for the first time the Mycenaean artist's skill in painted plaster-relief (*gesso duro*). The life-size bull's head from the northern entrance of the palace and fragments of human busts challenge comparison triumphantly with the finest Egyptian work. And from the same site comes the fullest assurance of a high development of fresco-painting. Tiryns had already shown us a galloping bull on its palace wall, Mycenae smaller figures and patterns, and Phylakopi its panel of flying-fish; but Knossos is in advance of all with its processions of richly-dressed vase-carriers, stiff in general pose and incorrect in outline, but admirably painted in detail and noble in type; and its yet more novel scenes of small figures, in animated act of dance or ritual or war, irresistibly suggestive of early Attic vase-painting. Precious fragments of painted transparencies in rock-crystal have also survived, and both Mycenae and Knossos have yielded stone with traces of painted design. Moulded glass of a cloudy blue-green texture seems to belong to the later period, at which carved ivory, previously rare, though found even in pre-Mycenaean strata, becomes common. The Spata tomb in Attica alone yielded 730 pieces of the latter material, helmeted heads in profile, mirror-handles and sides of coffers of Orientalizing design, plaques with outlines of heraldic animals, and so forth. Articles in paste and porcelain of native manufacture, though often of exotic design, have been found most commonly where Eastern influence is to be expected; for instance, at Enkomi in Cyprus. But the glassy blue composition, known to Homer as κύανος, an imitation of lapis-lazuli, was used in architectural ornament at Tiryns.

But it is in precious metals, and in the kindred technique of gem-cutting, that Mycenaean art effects its most distinctive achievements. This is, as we have said, an age of metal. That stone implements had not entirely passed out of use is attested by the obsidian arrow-heads found in the circle graves, and the flint knives and basalt axes which lay beside vases of the full "Mycenaean" style at Cozzo del Pantano in Sicily. But they are survivals, unimportant beside the objects in copper, bronze, and precious metals. Iron has been found with remains of the period only as a great rarity. Some five rings, a shield boss, and formless lumps alone represent it at Mycenae. In the fourth circle grave occurred thirty-four vessels of nearly pure copper. Silver makes its appearance before gold, and is found moulded into bracelets and bowls, and very rarely into figurines. Gold is more plentiful. Beaten, it makes face-masks, armlets, pendants, diadems, and all kinds of small votive objects; drawn, it makes rings whose bezels are engraved with the burin; riveted, it makes cups; and overlaid as leaf on bone, clay, wood, or bronze cores, it adorns hundreds of discs, buttons, and blades. Next to Mycenae in wealth of this metal ranks Enkomi in Cyprus, and pretty nearly all the tombs of the later period have yielded gold, conspicuously that of Vaphio. From the town sites, *e.g.*, Phylakopi in Melos, and Knossos, it has disappeared almost entirely. Detached from the mass of golden objects which show primitive or tentative technique are a few of such elaborate finish and fineness of handiwork that it is hard to credit them to the same period and the same craftsmen. The Mycenae inlaid dagger-blades are famous examples, and the technical skill which beat out each of the Vaphio goblets in a single unriveted plate has never been excelled. The goldsmiths seem not to have used acids. They imitate the *cloisonnée* work of Egypt in pastes only, but reproduce very beautifully the soldered bead patterns of the same land. In general schemes of decoration metal follows pottery. Linear ornament passes through vegetable to organic forms, mainly marine, which are finally stylized into heraldic conventions.

The intaglios in stone, work of the same class of artist as the ring bezels, are fashioned oftenest out of agates, among semi-transparent materials, and jaspers, among opaque. But finer stones, such as amethyst, are not infrequent, and soft stones, like hæmatite and steatite, are also used. Rock-crystal seems to have been the most esteemed material. In shape the intaglios are lentoid, oval, or round. The subjects engraved are animals in various attitudes, single, combative, heraldically opposed, or held in human hands by the leg or neck. The lion, the bull, and various kinds of goat appear most often. Less commonly are seen human figures, men semi-nude, women in flounced skirts, sometimes seemingly in act of adoration before altars or aniconic divinities, sometimes engaged in combat. Rarer still are birds and fish and fantastic combinations like the griffon. On the commoner sort of stones we see geometric schemes, but very rarely vegetable. Impressions of gems bearing human portrait heads were found at Knossos, and the vast number of other clay impressions unearthed there and at Zakro confirms the theory that the use of these intaglios was primarily for sealing. They appear, from a Knossian fresco, to have been worn, among other places, on the wrist.

We are fortunate in possessing very considerable remains of all kinds of construction and structural ornament of the Mycenaean period. The great walls of Mycenae, of Tiryns (though perhaps due to an earlier epoch), and of the sixth layer at Hissarlik, show us the simple scheme of fortification—massive walls with short returns and corner towers, but no flank defences, approached by ramps or stairs from within and furnished with one great gate and a few small sally-ports. Chambers in the thickness of the wall seem to have served for the protection of stores rather than of men. The style of building is faced Cyclopean, tending towards polygonal, with ashlar coigns. The great central residences on the citadels are usually of what is known as the Megaron type; that is to say, they consist of an outer court, from which a vestibule is entered across a massive threshold placed between *antae*, and a second and smaller threshold admits to a paved and columned hall with central hearth. Besides this, both at Tiryns and Phylakopi, is found a second block of chambers enclosed by a distinct wall and entered from a common passage, which is conjectured to have been the residence of the harem. The Cretan palaces at Knossos and Phaestos, however, are of much more complicated plan. Remains of much architectural decoration have been found in these palaces—at Mycenae, frescoes of men and animals; at Knossos, frescoes of men, fish, and sphinxes, vegetable designs, painted reliefs, and rich conventional ornament, such as an admirably carved frieze in hard limestone; at Tiryns, traces of a frieze inlaid with lapis-lazuli glass, and also frescoes. The rough inner walls that appear now on these sites must once have looked very different. The smaller houses at Mycenae and Phylakopi consist of two or three rooms opening off a common passage, but at Zakro and Knossos more elaborate structures have been found containing ten or more rooms opening one from the other and from a central hall. Certain chambers at Knossos, paved and lined with gypsum, and two in Melos, have square central piers. These seem to have had a religious significance, and are possibly shrines devoted to pillar-worship. The houses of the great dead were hardly less elaborate. The "Treasury of Atreus" had a moulded façade with engaged columns in a sort of proto-Doric order and marble facing; and there is good reason to suppose that its magnificent vault was lined within with metal ornament or hanging draperies. The construction itself of this and the other masonry domes bespeaks skill of a high order. For lesser folk bee-hive excavations were made in the rock, and at the latest period a return was made apparently to the tetragonal chamber; but now it has a pitched or vaulted roof, and generally a short passage of approach whose walls converge overhead towards a pointed arch but do not actually meet. The corpses are laid on the floor, neither mummified nor cremated; but in certain cases they were possibly mutilated and "scarified," and the limbs were then enclosed in chest urns. There is evidence for this both in Crete and Sicily. But the order of burial which first made Mycenaean civilization known to the modern world continues singular. Similar shaft graves, whether contained within a circle of slabs or not, have never been found again.

The latest excavation has at last established beyond all cavil that the civilization which was capable of such splendid artistic achievement was not without a system of written communication. Thousands of clay tablets (many being evidently labels) and a few inscriptions on pottery from the palace at Knossos have confirmed Mr A. J. Evans's previous deduction, based on gems, masons' and potters' marks, and one short inscription on stone found in the Dictaean Cave, that more than one script was in use in the period. Most of the Knossos tablets are written in an upright linear alphabetic or syllabic character, often with the addition of ideographs, and showing an intelligible system of decimal numeration. Since many of the same characters have been found in use as potters' marks on sherds in Melos, which are of earlier date than the Mycenaean period, the later civilization cannot be credited with their invention. Other clay objects found at Knossos, as well as gems from the east of Crete, show a different system more strictly pictographic. This seems native to the island, and to have survived almost to historic times; but the origin of the linear system is more doubtful. No such tablets or sealings have yet been found outside Crete, and their writing remains undeciphered. The affinities of the linear script seem to be with the Asianic systems, Cypriote and Hittite, and perhaps with later Greek. The characters are obviously not derived from the Phoenician.

This Mycenaean civilization, as we know it from its remains, belongs to the Aegean area (*i.e.*, roughly the Greek), and to no other area with which we are at present acquainted. It is apparently not the product of any of the elder races which developed culture in the civilized areas to the east or south-east, much as it owed to those races. It would be easy to add to the singular vase-forms, script, lustrous paint, idols, gems, types of house and tomb, and so forth, already mentioned, a long list of Mycenaean decorative schemes which, even if their remote source lies in Egypt, Babylonia, or inner Anatolia, are absolutely peculiar in their treatment. But style is conclusive. From first to last the persistent influence of a true artistic ideal differentiates Mycenaean objects from the hieratic or stylized products of Egypt or Phoenicia. A constant effort to attain symmetry and decorative effect for its own sake inspires the geometric designs. Those taken from organic life show continual reference to the model and a "naturalistic grasp of the whole situation," which resists convention and often ignores decorative propriety. The human form is fearlessly subjected to experiment, the better to attain lightness, life, and movement in its portrayal. A foreign motive is handled with a breadth and vitality which renders its new expression practically independent. The conventional bull of an Assyrian relief was referred to the image of a living bull by the Knossian artist, and made to express his emotions of fear or wrath by the Vaphio goldsmith, the Cypriote worker in ivory mirror handles, or the "island-gem" cutter.

Since we have a continuous series of links by which the development of the characteristic Mycenaean products can be traced within the area back to very primitive forms, we can fearlessly assert that not only did the full flower of the Mycenaean civilization proper belong to the Aegean area, but also its essential origin. That it came to have intimate relations with other contemporary civilizations, Egyptian, Mesopotamian, perhaps "Hittite," and early began to contract a huge debt, especially to Egypt, is equally certain. Not to mention the certainly imported Nilotic objects found on Mycenaean sites, vases in grey granite and diorite, statuettes and fragments of porcelain and paste bearing hieroglyphic inscriptions and cartouches of Pharaonic personages, the later Aegean culture is deeply indebted to the Nile for forms and decorative motives. For example, the Cretan funerary urns are as Egyptian in shape as in their ornamental schemes of ducks chasing insects among the lotus plants. The same must be said of the Knossian frescoes of scenery. Only the treatment of the subjects on the Mycenaean dagger-blades is native; technique and subject are alike borrowed. The beautiful spiral and lotus pattern, of which the Orchomenos ceiling gives the finest presentation, finds its prototype in Egyptian, not Boeotian Thebes. And so forth, through a long list of Mycenaean products, none the less of home manufacture and, in virtue of treatment, distinct in their kind.

At what epoch did Aegean civilization reach its full development? It is little use to ask when it arose. A *terminus a quo* in the Neolithic Age can be dated only less vaguely than a geological stratum. But it is known within fairly definite limits when it ceased to be a dominant civilization. Nothing but derived products of sub-Mycenaean style falls within the full Iron Age in the Aegean. Bronze, among useful metals, accompanies almost alone the genuine Mycenaean objects, at Enkomi in Cyprus, as at Mycenae. This fact supplies a *terminus ad quem*, to which a date may be assigned at least as precise as scholars assign to the Homeric lays. For these represent a civilization spread over the same area and in process of transition from bronze to iron, and if they fall in the 9th century B.C., then the Mycenaean period proper ends a little earlier, at any rate in the west. It is possible, indeed probable, that in Asia Minor and Cyprus, where the descent of northern tribes about 1000 B.C., remembered by the Greeks as the "Dorian invasion," did not have any direct effect, the Mycenaean culture survived longer in something like purity, and passed by an uninterrupted process of development into the Hellenic; and even in Crete, where there was certainly a cataclysm, and in the Argolid, where art was temporarily eclipsed about the 10th century, earlier influence survived and came once more to the surface when peace was restored. Persistence of artistic influence under a new order, and differences in the artistic history of different districts widely sundered, have to be taken into account. The appearance, *e.g.*, of late Mycenaean objects in Cyprus, does not necessarily falsify the received Mycenaean dates in mainland Greece. For the main fact however, viz., the age of greatest florescence all over the area, a singular coincidence of testimony points to the period of the 18th Pharaonic Dynasty in Egypt, usually dated from the middle of the 18th to the end of the 16th century B.C. To this dynasty refer all the scarabs or other objects inscribed with royal cartouches (except an alabaster lid from Knossos, bearing the name of the earlier "Shepherd King," Khyan), as yet actually found with true Mycenaean objects, even in Cyprus. In a tomb of this period at Thebes was found a bronze patera of fine Mycenaean style. At Tell el-Amarna, the site of a capital city which existed only in the reign of Amenhotep IV., have been unearthed by far the most numerous fragments of true "Aegean" pottery found in Egypt; and of that singular style, which characterizes Tell el-Amarna art, the art of the Knossian frescoes is irresistibly suggestive. To the 18th and two succeeding dynasties belong the tomb-paintings which represent vases of Aegean form; and to these same dynasties Mr Petrie's latest comparisons between the fabrics, forms, and decorative motives of Egypt and Mycenae have led him. The lapse of time between the 18th and the 10th centuries is by no means too long, in the opinion of most competent authorities, to account for the changes which take place in Mycenaean art.

The question of race, which derives a special interest from the possibility of a family relation between the Mycenaean and the subsequent Hellenic stocks, is a controversial matter as yet. The light recently thrown on Mycenaean cult does not go far to settle the racial problem. The aniconic ritual, involving tree and pillar symbols of divinity, which prevailed at one period, also prevailed widely elsewhere than in the Aegean, and we are not sure of the divinity symbolized. Even if sure that it was the Father God, whose symbol alike in Crete and Caria is the *labrys* or double axe, we could not say if Caria or Crete were prior, and whether the Father be Aryan or Semitic or neither. When it is remembered that, firstly, knowing not a word of the Mycenaean language, we are quite ignorant of its affinities; secondly, not enough Mycenaean skulls have yet been recovered to establish more than the bare fact that the race was mixed and not wholly Asiatic; and thirdly, since identity of civilization in no sense necessarily entails identity of race, we may have to do not with one or two, but with many races—it will be conceded that it is more useful at present to attempt to narrow the issue by excluding certain claimants than to pronounce in favour of any one. The facial types represented not only on the Knossian frescoes, but by statuettes and gems, are distinctly non-Asiatic, and recall strongly the high-crowned brachycephalic type of the modern northern Albanians and Cretan hillmen. Of the elder civilized races about the Levantine area, the Egyptians, Assyrians, and Babylonians may be dismissed at once. We know their art from beginning to end, and its character is not at any period the same as that of Aegean art. As for the Phoenicians, for whom on the strength of Homeric tradition a strong claim has been put forward, it cannot be said to be impossible that some objects thought to be Mycenaean are of Sidonian origin, since we know little or nothing of Sidonian art. But the presumption against this Semitic people having had any serious share in Mycenaean development is strong, since, facial types apart, the only scripts known to have been used in the Mycenaean area and period are in no way affiliated to the Phoenician alphabet, and neither the characteristic forms nor the characteristic style of Phoenician art, as we know it, appear in Mycenaean products. The one thing of which recent research has assured us in this matter is this, that the *Keftiu*, represented in 18th Dynasty tombs at Thebes, were a "Mycenaean" folk, an island people of the northern sea. They came into intimate contact, both peaceful and warlike, with Egypt, and to them no doubt are owed the Aegean styles and products found on Nile sites. Exact parallels to their dress and products, as represented by Egyptian artists, appear in the work of Cretan artists; and it is now generally accepted that the *Keftiu* were "Mycenaeans" of Crete at any rate, whatever other habitat they may have possessed.

As to place of origin, central Europe or any western or northern part of the continent is out of the question. Mycenaean art is shown by various remains to have moved westwards and northwards, not *vice versâ*. It arose within the Aegean area, in the Argolid as some, *e.g.*, the Heraeum excavators, propose, or Crete, the Cyclades, or Rhodes; or, if outside, then the issue is narrowed for practical purposes to a region about which we know next to nothing as yet, northern Libya, and to Asia Minor. So far as the Mycenaean objects themselves testify, they point to a progress not from south or west, but from east. In the western localities, notably Crete and Mycenae, we have more remains of highly developed Mycenaean civilization, but less of its early stages than elsewhere. Nothing in the Argolid, but much in the Troad, prepares us for the Mycenaean metallurgy. The appearance of Mycenaean forms and patterns is abrupt in Crete, but graduated in other islands, especially Thera and Melos. The Cretan linear script seems to be of "Asianic" family, and to be inscribed in Melos on sherds of earlier date than its appearance at Knossos. Following Mycenaean development backwards in this manner, we seem to tend towards the Anatolian coasts of the Aegean, and especially the rich and little-known areas of Rhodes and Caria.

It does not advance seriously the solution of the racial problem to turn to Greek literary tradition. Now that we are assured of the wide range and the long continuance of the influence of Mycenaean civilization, overlapping the rise of Hellenic art, we can hardly question that the early peoples whom the Greeks knew as Pelasgi, Minyae, Leleges, Danai, Carians, and so forth, shared in it. But were they its authors? and who, after all, were they themselves? The Greeks believed them their own kin, but what value are we to attach to the belief of an age to which scientific ethnology and archæology were unknown? Nor is it useful to select traditions, *e.g.*, to accept those about the Pelasgi, and to override those which connect the Achaeans equally closely with Mycenaean centres. We are gradually learning that the classical Hellene was of no pure race, but the result of a blend of several racial stocks, into which those pre-existing in his land can hardly fail to have entered; and if we have been able to determine that Mycenaean art was distinguished by just that singular quality of idealism which is of the essence of the art which succeeded it in the same area (whatever be the racial connexion), it can scarcely be doubted in reason that Mycenaean civilization was in some sense the parent of the later civilization of Hellas. In fact, now that the Mycenaean remains are no longer to be regarded as isolated phenomena on Greek soil, but are seen to be intimately connected on the one hand with a large class of objects which carry the evolution of civilization in the Aegean area itself back to the Stone Age, and on the other with the earlier products of Hellenic development, the problem is no longer purely one of antiquarian ethnology. We ask less what race was so greatly gifted, than what geographical or other circumstances will account for the persistence of a certain peculiar quality of civilization in the Aegean area.

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Myelat, a division of the southern Shan States of Burma, including sixteen states, none of any great size, with a total area of 3723 square miles. The name properly means "the unoccupied country," but it has been occupied for many centuries. All central Myelat and great parts of the northern and southern portions consist of rolling grassy downs quite denuded of jungle. It has a great variety of different races, Taungthus and Danus being perhaps the most numerous. They are all more or less hybrid races. The chiefs of the Myelat are known by the Burmese title of *Ngwekunhmu*, *i.e.*, chiefs paying their revenue in silver. The amount paid by the chiefs to the British Government is Rs.99,567. The largest state, Loi Lông, has an area of 1600 square miles, a great part of which is barren hills. The smallest, Nam Hkon, has no more than 4 square miles. The majority of the states have less than 100 square miles. Under British administration the chiefs have powers of a magistrate of the second class. The chief cultivation besides rice is sugar-cane, and considerable quantities of crude sugar are made and exported.

Myers, Frederic William Henry (1843–1901), English poet and essayist, son of Frederic Myers of Keswick—author of *Lectures on Great Men* (1856) and *Catholic Thoughts* (first collected 1873), a book marked by a most admirable prose style—was born at Keswick, Cumberland, on the 6th of February 1843, and educated at Cheltenham and Trinity College, Cambridge, where he won numerous honours, and in 1865 was appointed classical lecturer. He had no love for teaching, which he soon discontinued, but he took up his permanent abode at Cambridge in 1872, when he became a school inspector under the Education Department. Meanwhile he published, in 1867, an unsuccessful essay for the Seatonian prize, a poem entitled *St Paul*, which met at the hands of the general public with a success that would be difficult to explain, for it lacks sincerity, and represents views which the writer rapidly outgrew. It was followed by small volumes of collected verses in 1870 and 1882: both are marked by a flow of rhetorical ardour which culminates in a poem of real beauty, "The Renewal of Youth," in the 1882 collection. His best verse is in heroic couplets. Myers is more likely to be remembered by his two volumes of *Essays, Classical and Modern* (1883). The essay on *Virgil*, by far the best thing he ever wrote, represents the matured enthusiasm of a student and a disciple to whom the exquisite artificiality and refined culture of Virgil's method were profoundly congenial. Next to this in value is the carefully wrought essay on *Ancient Greek Oracles* (this had first appeared in *Hellenica*). Scarcely less delicate in phrasing and perception, if less penetrating in insight, is the monograph on *Wordsworth* (1881) for Mr John Morley's "English Men of Letters." In 1882, after several years of inquiry and discussion, Myers took the lead among a small band of explorers (including the Sidgwicks and Mr Hodgson, Mr Gurney, and Mr F. Podmore), who founded the society for Psychical Research. He continued for many years to be the mouthpiece of the society, a position for which his *perfervidum ingenium*, still more his abnormal fluency and alertness, admirably fitted him. His proficiency in the neo-hermeneutic jargon evolved by the society excited the admiration of all who frequented the psychical meetings in Westminster town hall. He contributed greatly to the coherence of the society by steering a mid-course between extremes (the extreme sceptics on the one hand, and the enthusiastic spiritualists on the other), and by sifting and revising the cumbrous mass of *Proceedings*, the chief concrete results being the two volumes of *Phantasms of the Living* (1886). Like many theorists, he had a faculty for ignoring hard facts, and in his anxiety to generalize plausibly upon the alleged data, and to hammer out striking formulæ, his insight into the real character of the evidence may have left something to be desired. His long series of papers on *Subliminal Consciousness*, the results of which were embodied in a posthumous work called *Human Personality and its Survival of Bodily Death*, constitute his own chief contribution to psychical theory, and this, as he himself would have been the first to admit, was little more than provisional. The last work published in his lifetime was a small collection of essays, *Science and a Future Life* (1893). He died at Rome on 17th January 1901, but was buried in his native soil, at Keswick. (T. SE.)

Myingyan, a district in the Meiktila division of Upper Burma. It lies in the valley of the Irrawaddy, to the south of Mandalay, on the east bank of the river. Area, 3139 square miles. Population (1891), 351,861; (1901), 357,117, showing an increase of 1·49 per cent. and a density of 113 inhabitants to the square mile. There were 868 villages in 1898–99, paying Rs.6,52,057 revenue. The greater part of the district is flat, especially to the north and along the banks of the Irrawaddy. Inland the country rises in gently undulating slopes. The most noticeable feature is Popa hill, an extinct volcano, in the south-eastern corner of the district. The highest peak is 4962 feet above sea-level. The climate is dry and healthy, with high south winds from March till September. The total rainfall in 1898–99 was 35·28 inches, which was slightly above the average. The highest shade reading was 106° F. in May, and the lowest reading in the cold weather a little over 70°. The ordinary crops are millet, sesamum, cotton, maize, paddy, gram, and a great variety of peas and beans. The district as a whole is not well watered, and most of the old irrigation tanks had fallen into disrepair before the annexation. There are no forests, but a great deal of low scrub in the district. The lacquer ware of Nyaung-u and other villages near Pagan is noted throughout Burma.

The population was classified as follows in 1891:—Buddhists and Jains, 348,667; Hindus, 1386; Mahommedans, 1213; Christians, 595. A considerable number of Chinese inhabit Myingyan and others of the larger villages. The net area cropped during 1898–99 was 251,190 acres, and 831,134 acres remained available for cultivation, while there were 276,473 acres of fallow. 650,000 acres are uncultivable out of the total acreage of 2,008,797. The headquarters town, MYINGYAN, stands on the Irrawaddy, and had a population in 1891 of 19,790. It is the terminus of the branch railway through Meiktila to the main line from Mandalay to Rangoon. The steamers of the Irrawaddy Flotilla Company also call here.

Myitkyina, the most northerly of the districts of Upper Burma in the Mandalay division. It was separated from the Bhamo district in 1895. The district is cut up into strips by comparatively low parallel ranges of hills running in a general way north and south. The chief plain is that of Myitkyina, covering some 600 square miles. To the east of the Irrawaddy, which bisects the district, it is low-lying and marshy. To the west it rises to a higher level, and is mostly dry. Except in the hills inhabited by the Kachin tribes, there are practically no villages off the line of the Irrawaddy. The Indawgyi lake, a fine stretch of water measuring 16 miles by 6, lies in the south-west of the district. A very small amount of cultivation is carried on, mostly dry cultivation. The area under forest during 1898–99 was 82,560 acres. Area, 10,640 square miles. Population (1891), 51,021; (1901), 67,149, showing an increase of 31·6 per cent. and a density of 6 inhabitants to the square mile. The people live in 139 villages, and pay Rs.67,767. The numbers of the Kachins in the hills were, however, very imperfectly known. The rainfall in 1898–99 was 74·07 inches. The headquarters town, MYITKYINA, had in 1898 a population of 1623, including the garrison of 400 military police. It is the limit of navigation on the Irrawaddy, and is also the terminus of the railway from Rangoon and Sagaing.

Mymensingh, or MAIMANSINGH, a district of British India, in the Dacca division of Bengal. It occupies a portion of the alluvial valley of the Brahmaputra, east of the main channel (called the Jamuna) and north of Dacca. The administrative headquarters are at Nasirabad, sometimes called Mymensingh town. Area, 6332 square miles. Population (1881), 3,055,237; (1891), 3,472,186; (1901), 3,917,460, showing an increase of 14 per cent. between 1881 and 1891, and of 12·8 per cent. between 1891 and 1901; average density, 619 persons per square mile. Classified according to religion, Mahommedans in 1891 numbered 2,396,800; Hindus, 1,045,566; Christians, 211, of whom 18 were Europeans; aborigines, 29,609. The land revenue and rates in 1897–98 were Rs.10,69,960; number of police, 695; number of boys at school (1896–1897), 62,534, being 22·4 per cent. of the male population of school-going age; registered death-rate (1897), 27·8 per thousand. The two staple crops are rice and jute. There are 20 jute presses, employing 1000 persons, with an outturn of 680,000 bales, valued at Rs.25,00,000. A branch line of the Eastern Bengal Railway, running north from Dacca to Nasirabad, will ultimately connect, through Jamalpur, with Jagannathganj on the main stream of the Brahmaputra. The district was severely affected by the earthquake of 12th June 1897, which destroyed the church and high school at Nasirabad, and damaged even the solid buildings.

Myriapoda.—In Professor Moseley's article on the Myriapoda, in vol. xvii. of this work, the relationship was mentioned which the class bears to the Insecta. Much work has since been done, especially in the department of embryology, and several eminent naturalists have expressed the opinion that the class Myriapoda, which has hitherto been considered a homogeneous group, should be broken up; and that of its two larger sub-classes, the Chilopoda should be joined with the Hexapoda, the Diplopoda being left by themselves under the original class-name. Mr Pocock proposes to give to the Diplopoda, Scolopendrellidæ, and Pauropoda the name of Progoneata, and to the Chilopoda and Hexapoda the name of Opisthogoneata. A few of the principal differences between Chilopoda and Diplopoda which have led to this view may be mentioned:—

(1) The mouth parts cannot satisfactorily be homologized in these two sub-classes; (2) the form of the somites is different, the sternum in Chilopods being wide and in Diplopods compressed, while the sectional form of Diplopoda is cylindrical and that of Chilopoda flattened dorsoventrally; (3) the stigmata and tracheæ are simpler in Diplopods than in Chilopods; (4) there are no foramina repugnatoria in Chilopods (except in very rare cases); (5) the reproductive organs open in Chilopoda in the posterior region of the body, and in Diplopoda in the anterior. In Chilopods the generative organs are dorsal, in Diplopods ventral. In Diplopods the gonad is unpaired and opens by two ducts, in Chilopods it is paired and opens by a single duct; (6) the nerve-cord in Chilopoda is double (Fig. 2), and is only united at the ganglia, and in Diplopoda the two cords are fused together.

Of these differences some tend to show a closer relationship to the Hexapoda;—(1) the mouth parts of the Chilopods can be homologized with those of Hexapods; (2) the stigmata and the tracheæ in their complexity show a likeness to those of Hexapods; (3) the terminal opening of the generative tube and the junction of two ducts to form a single tube furnish a resemblance to Hexapods. On the other hand, it may be urged that the different number of legs to each segment cannot be reckoned as a real difference, as both embryology and palæontology show that the so-called double segments of Diplopoda are not double in reality, but are double segments imperfectly fused. Further, the differences in the width of the sternal region, and in the separation of the nerve cords, are bridged over by the embryonic form of the Diplopoda and by the adult Polyxenus. The form of the young Chilopod is cylindrical in section. The junction of the two generative ducts to form a single tube is not without exception in Hexapoda.

Thus the position of the generative tube and its opening is left as the chief character on which to found the new arrangement, and more evidence appears to be required before the groups should be described as proposed. As regards the claims of Scolopendrella to form a link between the Chilopoda and Insecta, the opinions as to its position are very conflicting. A Chilopod has been described by Pocock, the structural peculiarities of which link together the Scolopendroid and Lithobioid forms. He has named it Craterostigmus. It resembles the Lithobiomorpha and differs from the Scolopendromorpha in the form of the poison claws, in the coxa of the 15th pair, in the presence of 6 pairs of stigmata on the 3rd, 5th, 8th, 12th, and 14th segments, and in the possession of a single eye. *Cermatobius*, another Chilopod discovered since Professor Moseley wrote, has its stigmata in a more dorsal position than Lithobius, and forms a link between Lithobius and Scutigeridæ.

We will now consider the chief points which have been worked out by later investigators in the embryology of the class.

In the Diplopoda the *segmentation of the ovum* is partial. In *Julus moreletti* the surface is marked by furrows corresponding with the segments, but in *Julus terrestris* this is not the case. The mesoblast is formed from a keel-like thickening of the ventral surface of the blastoderm, the epiblast by the layer of cells surrounding the exterior of the yolk; while the hypoblast is represented by the cells still remaining in the yolk at the close of segmentation. In the *first formation of the embryo*, the

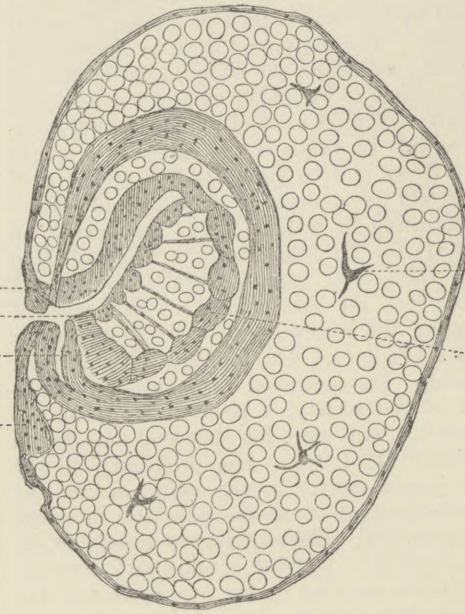

Fig. 1.—Section through twelfth-day Julus.

somites are formed in order from before backwards. The ventral flexure takes place in *Julus* when the antennæ, the mouth parts, and three pairs of legs are formed. In Strongylosoma the ventral flexure is formed much earlier, before the appearance of the antennæ, and the furrow is not so deep as in *Julus*. In Polyxenus it is somewhat deeper. In the *nervous system* (Fig. 1) the cerebral ganglion arises as a thickening of the cephalic lobes, and is split off from the epiblast. In *Julus* two pits are formed in the cephalic lobes, a process which is probably connected with the formation of the optic ganglion. The ventral chain arises as two thickenings in the middle ventral line of the epiblast, partially divided by a furrow. The ganglia are formed as thickenings on the cord. The ganglia in the young Diplopoda are more widely separated than in the adult. The *generative organs* are formed from the somatic part of the primitive segments. The coelom-sacs fuse in the middle line, and each coelom-sac fuses with the one behind, so as to form the long generative tube. In the *digestive system* (Fig. 2) the formation of the proctodæum and stomodæum takes place much earlier than that of the mid-gut. The former structures are epiblastic and are formed by invagination, while the latter arises as an accumulation of the cells remaining in the yolk. The Malpighian tubes are formed as evaginations of the proctodæum. The *heart* is formed by the cells remaining in the yolk. These arrange themselves in the pseudocoele so as to form a tube, which is at first imperfectly closed, but gradually becomes firmer and more perfect, leaving, however, unclosed spaces which afterwards become the ostia. A pericardial sinus beneath the heart is formed by the same cells. The *tracheæ* appear late in the development. In *Julus* they begin as pit-like invaginations of the epidermis as soon as the animal is hatched. The *eye* in *Julus* begins as a thickening of the epidermis in which pigment is deposited. Then a cavity is formed in the thickened part, so that the whole appears as an optic vesicle. As the cavity increases the internal wall becomes thin and the external thick. The internal represents the retina and the external the lens. A further discovery in the development of the Diplopoda, made by Verhoeff, is of the greatest interest. Professor Moseley drew attention to the peculiar shape of the first pair of legs in the male *Julus.* Dr C. Verhoeff discovered

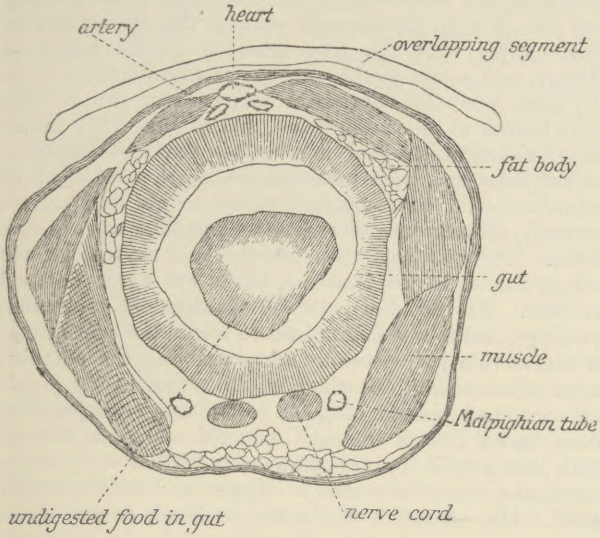

Fig. 2.—Section through just-hatched Lithobius.

that there is a stage of development in which the immature animal has a complete pair of legs in place of the hook-like legs of the mature animal. This immature or larval stage differs from the mature stage in three points: in the shape of the cheeks, in the form of the first pair of legs, and in the shape of the copulatory organ. He calls the immature or larval stage the "status medius," and the animal the larva (*schalt-männchen*). He compares this stage in Myriapoda to the subimaginal stage in Insecta.

In the Chilopoda the structure of the ovum and the segmentation have been worked out in *Geophilus ferrugineus,* and resemble those in the Diplopoda except that the process of segmentation is extended in a greater degree to the yolk, the latter as well as the surface being divided into yolk-pyramids, which, however, are connected at the centre. A ventral keel is formed as in the Diplopoda. The smaller cells of the ventral surface mark out the germinal streak at the end of which the cephalic lobes are formed. The somites are marked off by constrictions from before backwards. The anus is formed very early in the development of Geophilus, the mouth much later. The ventral flexure is formed when a considerable number of somites are present. The development of *Scolopendra cingulata* and *Sc. Dalmatica* has been worked out very carefully by Heymons. The segmentation is a modified form of epibole, the yolk-free micromeres surrounding the yolk-laden macromeres. The coelom arises by splitting of the mesoderm, and the coelom sacs are not enterocoelic. The brain consists of a præ-oral syncerebrum and three pairs of post-oral ganglia. The head in Diplopoda, Chilopoda, and Insecta consists of the acron united to six posterior metameres. The lymphatic bands of the adult are the representatives of the nephridia of Annelids, and the cephalic lymph bodies are equivalent to the green glands of Crustacea. The coelom extends into the dorso-lateral regions, and sends a diverticulum to the upper part of the legs. The generative organs are formed from the upper part of the dorso-lateral coelom on either side, which unite in the middle line. The heart and vascular system are derived from the schizocoele. For a long time there is a zone of undifferentiated tissue between the 30th metamere and the telson, which zone is homologous with the zone of budding in other forms. There are a series of invaginations connected with the formation of the nervous system which resemble the ventral organs of *Peripatus.*

Fossil Myriapods have been divided into four orders: (1) Protosyngnatha, (2) Archipolypoda, (3) Chilopoda, (4) Diplopoda. The first two of these orders differ considerably from those of the present day. The Protosyngnatha have ten somites; the body is cylindrical in section; the head, bearing antennæ and mouth parts, shows no signs of segmentation; bundles of bristles are arranged in longitudinal rows along the back. There is a single dorsal and a single ventral plate to each segment, the dorsal and ventral plates being of equal breadth. There is a wide space between the base of the leg on one side and the base of the leg on the opposite side. The Archipolypoda have legs on every somite, no somite being apodous. The dorsal

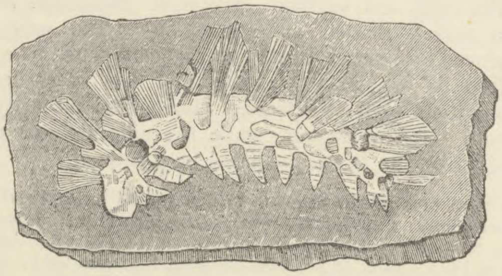

Fig. 3.—*Palæocampa anthrax.* (From the *Cambridge Natural History*, by permission of Messrs Macmillan.)

plates are more or less perfectly divided, the divisions corresponding with the pairs of legs. The Chilopoda and

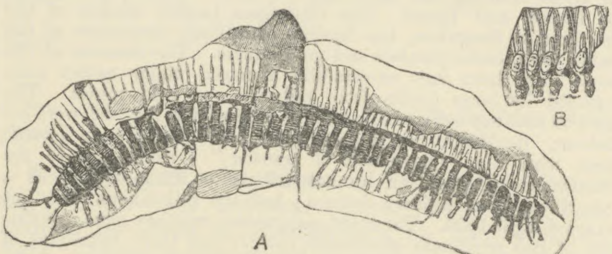

Fig. 4.—*Acantherpestes major.* A, Whole animal; B, Branchiæ on ventral surface. (From the *Cambridge Natural History*, by permission of Messrs Macmillan.)

Diplopoda bear a great resemblance to those of the present day.

1. Protosyngnatha. *Palæocampa anthrax* (Coal) (Fig. 3).
2. Archipolypoda. Fams.:—(1) Archidesmidæ (Old Red Sandstone); (2) Euphoberidæ (Coal), *Acantherpestes major* (Fig. 4), and *A. inæqualis, Euphoberia* (with nine species); (3) Archijulidæ (Coal), *Archijulus, Xylobius, Mazonus.*
3. Chilopoda. Fams.:—(1) Geraseutigeridæ (Coal), resembling Scutigeridæ; (2) Eoscolopendridæ (Coal), *Eileticus, Anthracinus, Aequalis, Ilyodes, Palanarthrus;* (3) Lithobiidæ; (4) Scolopendridæ; (5) Schizotarsia; (6) Geophilidæ. The last four are mostly from amber.
4. Diplopoda. Fams.:—(1) Glomeridæ (Amylispes may belong here); (2) Polydesmidæ; (3) Lysiopetalidæ; (4) Craspedosomidæ; (5) Julidæ; (6) Polyxenidæ. These are mostly from amber; *Julopsis cretacea,* from the chalk of Greenland.

The Carboniferous fossils discovered by Scudder have completely altered our ideas as to the age of the Chilopoda. Before his discovery the earliest Chilopods had been found in amber; now we know that they extended back into the Carboniferous times. The fossil forms show a certain approximation between the Chilopodous and Diplopodous forms of the present day in the following particulars: (1) the number of legs to each somite, the Archipolypoda having the dorsal segment more or less perfectly divided, thus agreeing with the facts of embryology; (2) the cylindrical shape of the body, a feature that is also paralleled in the embryological history of the two stocks; (3) the wide sternal region which, as has been said before, is reproduced in the embryology of *Julus.*

Good bibliographies of the subject may be found in LATZEL. *Die Myriapoden der Oesterreich-Ungarischen Monarchie*, 1884. —ZITTEL. *Handbuch der Palæontologie.* Munich, 1885.—KORSCHELT and HEIDER. *Lehrbuch der Vergleichenden Entwicklungsgeschichte.* Jena, 1890. (F. G. S*.)

Mysore, a native state of Southern India, in political relations with the Governor-General. Owing to the mis-government of the chief, the British assumed the administration in 1831. On his death in 1868, his adopted heir was recognized; and in 1881, when he had reached the age of eighteen, full powers of government were granted to him, subject to conditions specified in the "instrument of transfer." One of these conditions was that the civil and military station of Bangalore should remain under British administration. The new raja, who proved altogether worthy of the confidence placed in him (see below), died in 1894, and was succeeded by his son, then aged ten years. During his minority the maharani acted as regent, while the administration was conducted by the Diwan, assisted by a council.

The total area of the state is 27,936 square miles, subdivided into 9 districts. Population (1881), 4,186,188; (1891), 4,943,604; (1901), 5,538,482, showing an increase of 18 per cent. between 1881 and 1891, and of 12 per cent. between 1891 and 1901; average density, 198 persons per square mile, ranging from 343 in Bangalore district to 124 in Chitaldrug. Classified according to religion, Hindus in 1891 numbered 4,639,127; Mahommedans, 252,973; Christians, 38,135; Jains, 13,278; "others," 91. The proportion of Hindus (93·8 per cent.) is larger than in any province of India, showing how ineffectual was the compulsory persecution of Haidar and Tippu. The Christians largely consist of the garrison at Bangalore, the families of military pensioners at the same town, coffee-planters and gold-miners. The finances of the state have been very successfully managed under native rule, assisted by large profits from railways and gold-mines. The income and expenditure (in tens of rupees) for 1897–98 were:—income, Rx.1,915,972; expenditure, Rx.1,855,090. In accordance with the "instrument of transfer," Mysore pays to the British Government an annual tribute of Rs.35,00,000, as a contribution to military defence; but the full amount was not exacted until 1896. The state maintains a military force, consisting of two regiments of *silladar* cavalry and three battalions of infantry; total, about 4000 men; and also an imperial service transport corps. An interesting political experiment has been made, in the constitution of a representative assembly, which meets annually for the purposes of discussion, without any legislative power. Since 1891 this representative assembly has been elected by local boards and other public bodies. In 1897 the session lasted for five days. The number of members present was 275, of whom 252 were Hindus. The Diwan, as usual, presented a formal report on the administration of the year; and no less than 500 subjects are said to have been discussed. The industry of coffee-planting is not in a flourishing condition, the area under coffee showing no increase during the last ten years of the 19th century. In 1897 the total number of acres was 125,876, compared with 141,528 in the preceding year. Of this total, about one-third belongs to European planters. The annual out-turn of gold from the Kolar mines is about 500,000 oz. (J. S. Co.)

CHAMARAJENDRA WADIAR BAHADUR, Maharaja of Mysore (1862–1894), was the adopted son and successor of Maharaja Krishnaraj, into whose hands as a child the British Company had, after the final defeat of Tipu Sultan, restored the greater part of the territories of Mysore. When Krishnaraj eventually took over the management of his state from his minister Purnaiya in 1812, he received an orderly and contented principality with a surplus of two crores of rupees. Within twenty years he had driven his subjects into rebellion and involved himself and his state in heavy debt. The British Government therefore assumed the government in 1831, and placed it in the hands of commissioners. The revenues in 1832–33 amounted to 55 lakhs; in 1862 they had reached 100 lakhs, in 1881 they grew to 107 lakhs, and in 1894 to 179 lakhs. In 1862 no less than 88 lakhs of state debts and of the Maharaja's own liabilities had been liquidated. The entire administration had been reformed, a revised system of land revenue introduced, and many public works executed. The maharaja therefore pressed his claims to a restoration of his powers, but Lord Canning and the British Government refused the application as incompatible with the true interests of the people of Mysore, and as not justified by any treaty obligation. In the same year Chamarajendra was born of the Bettada Kote branch of the ruling house, and in June 1865 Maharaja Krishnaraj adopted him as his son and successor, although he had been informed, in March 1864, that no adoption could be recognized except to his own private property, already once more heavily weighted with private debts. The maharaja then renewed his request for the recognition of his adopted son, but it was again declined in 1865. In 1867 the policy of Government underwent a change, and it was determined to secure the continuance of native rule in Mysore by acknowledging the adoption upon certain conditions which would secure to the people the continued benefits of good administration enjoyed by them under British control. The old maharaja died on 27th March 1868, and Chamarajendra Wadiar was publicly installed as the future ruler of Mysore on 23rd September 1868. His education was taken in hand, abuses which had grown up in the palace establishment were reformed, the late maharaja's debts were again paid off, and the whole internal administration perfected in every branch during the minority. On the 25th March 1881 Maharaja Chamarajendra, having attained the age of 18 years, was publicly entrusted with the administration of the state. He made over to the British Government, with full jurisdiction, a small tract of land at Bangalore, forming the "civil and military station," and received in return the island of Seringapatam. But the most important incident of the change was the signing of the "instrument of transfer," by which the young maharaja, for himself and his successors, undertook to perform the conditions imposed upon him. To that agreement the maharaja steadfastly adhered during his reign, and the instrument is a landmark in the history of British relations with the protected states of India. The maharaja's first minister was Ranga Charlu, who had been trained in the British administration of Mysore. He signalized the restoration of native rule by creating a "Representative Assembly," composed of 350 representatives of all classes of the community, who, in the absence of special cause, such as plague, meet annually to hear an account of the state administration for the previous year. The assembly has no power to enact laws, to vote supplies, or to pass any resolution binding upon the executive. But it gives to the leading men of the districts a pleasant opportunity of visiting the capital, and to a limited extent brings the force of public opinion to bear upon the minister. In 1883 Sheshadri Aiyar succeeded Ranga Charlu, and to him Mysore is indebted for the extension of railways and schemes of irrigation, the development of the Kolar goldfields, and the maintenance of the high standard of its administration. The maharaja showed his loyalty by placing two regiments of cavalry at the disposal of the Government of India for imperial service. He died at Calcutta, 28th December 1894, universally regretted and beloved by his subjects. His eldest son, Krishnaraj Wadiar, born in 1884, succeeded him, and his widow, Maharani Vanivilas, was appointed regent. Chamarajendra set the first example to India of a constitutional ruler. He was faithful to the terms of the instrument of transfer, contributing a subsidy in lieu of military service, granting facilities for British railways and cantonments, accepting the British coinage and postal system, readily conceding to the paramount Power extradition and foreign jurisdiction, maintaining the laws, regulations, and settlements introduced by the British administration, and leaving his foreign relations and any serious internal difficulties to the arbitrament of the British Government. The restoration of native rule to him marked the final abandonment of the annexation policy, and the instrument of transfer summarizes the obligations of a protected state to the British protecting power. (W. L.-W.)

Mytilene, or MITILINI (classical LESBOS), an island of the Aegean, forming the main part of a sanjak in the Archipelago vilayet of European Turkey. It is divided into the three districts of Mytilene or Kastro, Molyvo, and Kalloni; and the chief towns are Mytilene (15,000) in the east, Molyvo (3000) in the north, Sigri in the west, and Kalloni on the Gulf of Kalloni. The ports are Sigri, Longone in the south, and Olivier near Mytilene. Vessels of large draught cannot enter any of the ports, but there is good anchorage outside. The valleys are fertile, and on the higher grounds there is pasturage for numerous sheep. Oxen are kept mainly for draught, and about 7000 cattle are annually imported from the Anatolian coast for food supply. The native horses are small, and transport is effected mainly by mules, of which large numbers are bred for sale. The fisheries are of considerable importance, especially sardines. The main industry, however, is the pressing of olives in the production of olive oil, there being 45 steam-pressing establishments, and about 100 oil mills worked by hand. The annual value varies greatly according to the season, sometimes amounting to nearly £200,000, and sometimes falling below £100,000; in 1900 it was £400,000. The industry of next importance is the manufacture of soap. Valonea is obtained in the northern part of the island, but only of second-rate quality. Figs and grapes are grown, but hardly in greater quantities than suffice for home consumption. The roads throughout the island were re-made in 1889. There is telegraphic communication on the island, and communication with the mainland by cable to Aivati on the Anatolian coast. In 1900 the number of steamships that entered and cleared was 1182 of 536,326 tons, as compared with 1324 of 596,106 tons in 1898; the number of sailing vessels in 1900 was 3299 of 30,345 tons, as compared with 3042 of 38,148 tons in 1898. The chief exports are olive oil (£119,000 in 1900), soap, valonea, skins, dried figs, and fish (principally sardines). Average rainfall for ten years ending 1899, 24·57 inches. The town of Mytilene is built in amphitheatre shape round a small hill crowned by remains of an ancient fortress, and contains 14 mosques and 7 Christian churches, one of which is the cathedral. It possesses flour-mills, oil-works, soap-works, potteries, tanneries, and cement works, and has a large shipping trade. Population of the sanjak (1890), 107,283, of whom 92,700 were Greek Orthodox, 13,712 Mussulmans, and the remainder Catholics, Jews, and Armenians; (1901), 130,000.

Myxœdema. See PATHOLOGY (*Metabolic Diseases*).

Nabha, a native state of India, within the Punjab. Area, 936 square miles. Population (1881), 261,824; (1891), 282,756; (1901), 297,949, showing an increase of 8 per cent. between 1881 and 1891, and of 5·4 per cent. between 1891 and 1901; average density, 318 persons per square mile. Estimated gross revenue, Rs.7,00,000; military force (including police), 1818 men; no tribute. The raja's imperial service troops did good service during the Tirah campaign of 1897–98. The territory is crossed by the Rajpura–Bhatinda Railway, and irrigated by the Sirhind canal; and the state revenues contributed to the construction of both these works. In 1896–97 the number of schools was 24, with 958 pupils; the proportion of boys at school was 1 out of 162 of the male population.

The town of NABHA has a station on the Rajpura–Bhatinda Railway. Population (1881), 17,116.

Nabua, a town in the extreme southern portion of the province of Ambos Camarines, Luzon, Philippine Islands. It is situated in the district known as La Rinconada, on account of its inaccessibility, and is the centre of a large, level, and fertile agricultural region, which produces rice, Indian corn, sugar, and pepper in abundance. The marketing of agricultural products is, however, interfered with by the difficulties of communication. The language is Bicol. Population, 17,000.

Nachod, a town in Bohemia, Austria, on the Mettau river, at the entrance of the Lewin–Nachod pass, about three miles from the Prussian frontier. The old castle contains a collection of historical paintings and archives, and in the town hall there is a small museum. The castle, which has been the property of the Prince of Schaumburg-Lippe since 1864, was presented to Ostavian Piccolomini in 1634. The important engagements fought near the town on the 27th and 28th of June 1866 opened Bohemia to the victorious Prussians. There are coal-mines in the neighbourhood; and the industry comprises cotton-spinning, dyeing, and bleaching. Population (1890), 6364; (1900), 9899, chiefly Czech and Catholic.

Nachtigal, Gustav (1834–1885), German explorer, son of a Lutheran pastor, was born at Eichstedt in the Mark of Brandenburg, on 23rd February 1834. After a course of medical study at the universities of Halle, Würzburg, and Greifswald, he practised for a few years as a military surgeon. Being of a weakly constitution, and finding the climate of his native country injurious to health, he repaired to Algiers and Tunis, and took part, in the capacity of surgeon, in several expeditions into the interior of Africa. Commissioned by the king of Prussia to carry conciliatory gifts to the sultan of Bornu, he set out in 1869 from Tripoli, and succeeded after two years' journeyings in accomplishing his mission. From Bornu he extended his travels to Baghermi, and proceeding by way of Wadai and Kordofan, emerged from darkest Africa, after having been given up for lost, at Khartum in the winter of 1874. His journey, graphically described in his *Sahara and Sudan* (1879–89), was eminently valuable in its fruits, and placed the intrepid explorer in the front rank of discoverers. On the annexation of Tunis by France, Nachtigal was sent there as consul-general for the German empire, and remained there until 1884, when he was despatched by Prince Bismarck to West Africa as special commissioner, ostensibly to inquire into the condition of German commerce, but really to annex territories to the German flag. On his return voyage he died at sea off Cape Palmas on 20th April 1885, and was buried at Grand Bassa. His remains were later exhumed and conveyed for interment to German Cameroon. In spite of his weak physique, Nachtigal was a daring, resourceful, and strong-willed man, while his amiability, straightforwardness, and modesty made him universally beloved and respected.

Naden, Constance Caroline Woodhill (1858–1889), English author, was born at Edgbaston, 28th

January 1858, her father being an architect. Her mother died just after the child's birth, and Constance was brought up in the home of her grandfather, Mr Woodhill, a retired jeweller. She was a clever girl and quick at learning, and was interested in modern culture in all its forms, artistic, scientific, and philosophical. In 1881 she published *Songs and Sonnets of Spingtime;* in 1887, *A Modern Apostle, and other Poems*. Her poems made such an impression on Mr Gladstone that he included her, in an article in the *Speaker*, as one of the foremost English poetesses of the day. After her grandfather's death Miss Naden found herself a rich woman, and she travelled in the East and then (1888) settled in London. But on 23rd December 1889 she died, as the result of an operation. Since 1876 she had paid increasing attention to the study of philosophy, with her friend Dr Lewins, and the two had formulated a system of their own, which they called "Hylo-Idealism," and which after Miss Naden's death aroused some little discussion. Her main ideas on the subject are contained in a posthumous volume of her essays (*Induction and Deduction*, 1890), edited by Dr Lewins.

Nadia, or Nuddea, a district of British India, in the Presidency division of Bengal. The administrative headquarters are at Krishnagar. Area, 2982 square miles. Population (1881), 1,662,795; (1891), 1,644,108; (1901), 1,667,990; average density, 559 persons per square mile. Classified according to religion, Hindus in 1891 numbered 689,224; Mahommedans, 947,390; Christians, 7297, of whom 106 were Europeans; "others," 197. The land revenue and rates in 1897–98 were Rs.9,62,339; number of police, 721; number of boys at school (1897), 30,708, being 25·5 per cent. of the male population of school-going age; registered death-rate (1897), 26 per thousand. The chief industry is indigo. There are 47 factories, employing 7000 persons, with an out-turn of 2400 maunds, valued at Rs.4,30,000. The district is traversed for about 100 miles by the main line of the Eastern Bengal Railway, leading to the river port of Kushtia, and onward to Darjeeling; and a branch to Krishnagar has been opened. The three so-called "Nadia rivers"—the Bhagirathi, the Jalangi, and the Matabhanga—carried in 1897–98 a total traffic in country boats valued at Rs.1,50,78,428.

Naegeli, Karl Wilhelm von, Swiss botanist (1817–1891), was born on 27th March 1817, near Zürich. He early devoted himself to the study of botany, which he pursued for a time under A. P. de Candolle at Geneva, and graduated with a botanical thesis at Zürich in 1840. His attention having been directed by Schleiden, then professor of botany at Jena, to the microscopical study of plants, he engaged more particularly in that branch of research. Soon after graduation he became *privat-docent*, and subsequently *professor extraordinarius*, in the University of Zürich: in 1852 he was called to fill the chair of botany in the University of Freiburg-in-Breisgau; and in 1857 he was promoted to Munich, where he remained as professor until his death on 11th May 1891. Among his more important contributions to science were a series of papers in the *Zeitschrift für wissenschaftliche Botanik* (1844–46); *Die neuern Algensysteme* (1847); and his *Gattungen einzelliger Algen* (1849); his *Pflanzenphysiologische Untersuchungen* (1855–58), with Cramer; his *Beiträge zur wissenschaftlichen Botanik* (1858–68); a number of papers contributed to the Royal Bavarian Academy of Sciences, forming three volumes of *Botanische Mitteilungen* (1861–81); and, finally, his volume, *Mechanisch-physiologische Theorie der Abstammungslehre*, published in 1884.

The more striking of his many and varied discoveries are embodied in the *Zeitsch. für wiss. Bot.* In this we begin with Naegeli's extension of Robert Brown's discovery of the nucleus to the principal families of Cryptogams, and the assertion of its universal occurrence in plants, together with the recognition of its vesicular structure. There is further his investigation of the "mucous layer" (*Schleimschicht*) lining the wall of all normal cells, where he shows that it consists of granular "mucus," which, at an earlier stage, filled the cell-cavity, and which differs chemically from the cell-wall in that it is nitrogenous. This layer he proved to be never absent from living cells—to be, in fact, itself the living part of the cell, a discovery which was simultaneously made by von Mohl (1846), who gave to the living matter of the plant-body the name "protoplasm." In connexion with these discoveries, Naegeli controverted Schleiden's view of the universality of free-cell-formation as the mode of cell-multiplication, and showed that in the vegetative organs, at least, new cells are formed by division. In the *Zeitschrift*, too, is Naegeli's most important algological work; such as the paper on *Caulerpa*, which brought to light the remarkable unseptate structure of the Siphoneæ, and his research on *Delesseria*, which resulted in the discovery of growth by a single apical cell. This discovery led Naegeli on to the study of the growing-point in other plants. He consequently gave the first accurate account of the apical cell, and of the mode of growth of the stem in various Mosses and Liverworts. Subsequently he observed that in *Lycopodium* and in Angiosperms the growing-point has no apical cell, but consists of a small-celled meristem, in which the first differentiation of the permanent tissues can be traced. One of the most remarkable discoveries recorded in the *Zeitschrift* is that of the antheridia and spermatozoids of Ferns and of *Pilularia*. The *Beiträge zur wiss. Botanik* consists almost entirely of researches into the anatomy of vascular plants, while the main feature of the *Pflanzenphysiologische Untersuchungen* is the exhaustive work on the structure, development, and various forms of starch-grains. The *Botanische Mitteilungen* include a number of papers in all departments of botany, many of them being continuations and extensions of his earlier work. In his *Theorie der Abstammungslehre* Naegeli introduced the idea of a definite material basis for heredity; the substance he termed "idioplasm." His theory of evolution is that the idioplasm of any one generation is not identical with that of either its progenitors or its progeny: it is always increasing in complexity, with the result that each successive generation marks an advance upon its predecessor. Hence variation takes place determinately, and in the higher direction only; while variability is the result of internal causes, and natural selection plays but a small part in evolution. Whereas, on the Darwinian theory, all organization is adaptive, according to Naegeli the development of higher organization is the outcome of the spontaneous evolution of the idioplasm.

More detailed accounts of Naegeli's life and work are to be found in *Nature*, 16th October 1891, and in *Proc. Royal Soc.* vol. li. (S. H. V*.)

Næstved, a market town of Denmark, county Præstö, on the east coast of Sealand, 58 miles by rail south-west of Copenhagen. From 1140 to the Reformation it was one of the most important towns of the kingdom, though dependent upon the monastery of St Peter's (founded here in 1135); its church was restored in 1883–85. The mediæval town hall was restored in 1894. North of the town ($1\frac{1}{4}$ miles) lies Herlufsholm, where Admiral Herluf Trolle founded a Latin school in 1567, which still survives. Population (1880), 4792; (1890), 5502; (1901), 7162.

Naga Hills, The, a district of British India, in the hills division of Assam. Its inner boundaries were laid down in 1882; but some measure of political control is exercised by the deputy commissioner in charge over a tract of country, also occupied by Naga tribes, extending north-eastwards to the frontier of Burma. The administrative headquarters are at Kohima—population (1891), 1781—which is garrisoned by a Gurkha regiment and also by a strong force of military police. Area, 5710 square miles. Population (1891), 122,867; (1901), 102,409; average density, 18 persons per square mile. Land revenue, Rs.51,660, the incidence of assessment being 10 annas per acre; number of police, 741; number of boys at school (1896–97), 275, being 2·94 per cent. of the male population of school-going age. A cart-road is maintained from Nichuguard to Manipur, and a bridle-road from Wokha to Golaghat, in the Brahmaputra valley. The main line of the Assam–Bengal Railway is being extended through the district along the Dhansiri river to Golaghat; and a branch to the Gauhati section will turn off at Lumding. Deep cuttings and tunnels, together with the sparse population and unhealthiness of the country, combine to make this a work of great difficulty. Only slight damage was done by the earthquake of 12th June 1897.

Nagasaki, a town on the south-west of the island of Kiushiu, Japan, situated in 32° 44′ N. and 129° 52′ E., with 107,433 inhabitants, and a foreign settlement containing a population of 1000. This place owed its earliest importance to foreign intercourse. Originally called Fukae-no-ura (Fukae Bay), it was included in the fief of Nagasaki Kotaro in the 12th century, and from him it took its name. But it remained an insignificant village until the 16th century, when, becoming the headquarters of Japanese Christianity, and subsequently the sole emporium of foreign trade in the hands of the Dutch and the Chinese, it developed considerable prosperity. The first port of entry for ships coming from the south or the west to Japan, it lies at the head of an inlet some three miles long, with shores indented by bays and sloping up to thickly-wooded hills. This fjord forms a splendid anchorage, and is largely used by ships coming to coal and by men-of-war of various nationalities. But the opening of Moji for export purposes has deprived Nagasaki of its monopoly as a coaling station, and the visits of war vessels have been reduced owing to the acquisition of Port Arthur by Russia, of Wei-hai-wei by Great Britain, and of Kiao-chow by Germany. It seems probable, indeed, that unless advantage be ultimately taken of its manufacturing facilities, Nagasaki will lose much of its former importance. Up to the present, however, its population and its commerce have shown a substantial growth, especially its population, which was only 55,063 in 1889, and had increased to 107,433 in 1899. The following table exhibits the condition of its foreign commerce during the years specified :—

	Exports.	Imports.	Total.
	£	£	£
1884 . . .	718,310	197,438	915,748
1889 . . .	1,005,367	472,839	1,478,206
1894 . . .	444,839	676,718	1,121,557
1899 . . .	620,777	1,114,751	1,735,528

Marine products, coal, and cotton goods are the chief exports, and raw cotton, iron, as well as other metals and materials used for shipbuilding, constitute the principal imports. There is nothing in the present condition of Nagasaki's foreign commerce to suggest appreciable expansion. Its most important enterprises are represented by the engine works of Aka-no-ura, two large docks and a patent slip, the property of the Mitsu Bishi Company. Steamers of over 6000 tons have been constructed at these docks, which, as well as the engine works, are situated on the western shore of the fjord. The brisk atmosphere of business that pervades them does not reach the town on the eastern side, where, under the shadow of forests of tombstones that cover the overlooking hills, the citizens seem to live in the company of their dead and in the memory of their past. Nagasaki is celebrated for two very incongruous things: the tranquil loveliness of its scenery and the coaling operations that take place in the harbour, where thousands of men, women, and children, trained to mechanical regularity of action, transfer the fuel from lighters to the ship's bunkers with such rapidity that they have been known to put 1360 tons of coal on board a steamer in four hours, being at the rate of 5·7 tons per minute. The coal is obtained chiefly from Takashima, an islet eight miles south-east of the entrance to the harbour, and in lesser quantities from two other islets, Naka-no-shima and Ha-shima, which lie about a mile farther out. These sources of supply do not appear likely to last many years longer. On the north side of the channel, by which the harbour is entered, there stands a cliff called Takaboko, which, under the name of Pappenberg, has long been rendered notorious by a tradition that thousands of Christians were precipitated from it in the 17th century because they refused to trample on the Cross. It has been conclusively proved that the legend is untrue. (F. BY.)

Nagina, a town of British India, in the Bijnor district of the North-Western Provinces; station on the Oudh and Rohilkhand Railway, 48 miles north-west of Moradabad. Population (1891), 22,150; municipal income (1897–98), Rs.10,609. There is considerable trade in sugar, besides manufactures of guns, glass-ware, ebony, carving, hemp-sacking, and cotton cloth. It was formerly the headquarters of the district.

Nagode, a native state of Central India, in the Baghelkhand agency. Area, 450 square miles. Population (1881), 79,629; (1891), 84,097, showing an increase of 6 per cent.; average density, 187 persons per square mile. The revenue in 1897–98 was Rs.1,50,526, of which Rs.99,198 was derived from land. The number of schools is 5, attended by 171 pupils. The chief, whose title is raja, is a Rajput of the Purihar clan. The present raja resides at Benares, while the minister has conducted the administration under British supervision. The state suffered severely from the famine of 1896–97.

The town of NAGODE is 17 miles west of the British station of Sutna. Population (1881), 4828. It was formerly a military cantonment, and has an Anglo-vernacular school and dispensary. The present capital is Unchehra; population (1891), 5442.

Nagoya, capital town of the province of Owari, Japan, on the great trunk railway of Japan, 235 miles from Tôkyô and 94 miles from Kyôtô. Population (1889), 162,767; (1899), 244,145. It is the fourth of the chief cities of Japan. In its vicinity (13½ miles distant) are the celebrated potteries of Seto, where the first glazed pottery made in Japan was produced by Kato Shirozaemon, after a visit to China in 1229. From Kato's time Seto continued, during several centuries, to be the chief centre of keramic production in Japan, the manufacture of porcelain being added to that of pottery in the 19th century. All the products of the flourishing industry now carried on there and at other places in the province are transported to Nagoya, either for sale there or for export to other centres of consumption. Cotton mills have been established, and an extensive business is carried on in the embroidery of handkerchiefs. Another of its celebrated manufactures is *arimatsu-shibori*, or textile fabrics (silk or cotton), dyed so as to show spots in relief from which the colour radiates. It is further distinguished as the birthplace of *cloisonné* enamelling in Japan, all work of that nature prior to 1838—when a new departure was made by Kaji Tsunekichi—having been for purposes of subordinate decoration. Quantities of *cloisonné* enamels are now produced in the town.

Nagpur, a city, district, and division of British India, Central Provinces. The city is 1125 feet above the sea; railway station, 520 miles east of Bombay. Population (1881), 98,299; (1891), 117,014; (1901), 124,599, showing an increase of 6·5 per cent. since 1891. The town is well laid out, with several parks and artificial lakes, and has numerous temples, with fine carving. The suburb of Sitabaldi contains the chief Government buildings, the houses of Europeans, the railway station, and the cantonments, with fort and arsenal. The garrison consists of detachments of European and native infantry from Kamptee. It is the headquarters of two corps of rifle volunteers. Nagpur is the junction of two important railway systems—the Great Indian Peninsula to Bombay, and the Bengal–Nagpur, now opened throughout to Calcutta. The large weaving population still maintain their reputation for producing fine fabrics. Two steam cotton mills, with 1398 looms and 60,000 spindles, employ 4000 hands, and work up 125,000 cwts. of raw cotton in the year; there is also machinery for ginning and pressing cotton. Education is provided by two aided colleges—the Hislop and the Morris, called after a missionary and a former chief commissioner—with 198 students in 1896–97; four high schools, with 1705 pupils; a law school; an agricultural school, with a class for the scientific training of teachers; a normal school; a zenana mission for the management of girls' schools; an Anglican and two Catholic schools for Europeans, with 336 boys and 171 girls. Good boarding-houses and common playgrounds have been established, and inter-school tournaments are encouraged by a field-games association. There are several libraries and reading rooms, and an active Anjuman or Mahommedan society, besides eight printing-presses, issuing one English newspaper and three in Marathi and Hindi.

The district of NAGPUR has an area of 3843 square miles; population (1881), 697,356; (1891), 757,862; (1901), 751,584, showing an increase of 9 per cent. between 1881 and 1891, but a decrease of nearly 1 per cent. between 1891 and 1901; average density, 195 persons per square mile, being the highest rate in the province. The land revenue and rates in 1897–98 were Rs.11,20,876, the incidence of assessment being just over 8 annas per acre; cultivated area (1897–98), 1,247,042 acres, of which 24,388 acres were irrigated from tanks and wells; number of police, 1008; boys at school (1896–97), 15,405, being 31·8 per cent. of the male population of school-going age, the highest proportion in the province; girls at school, 1139, being 2 per cent.; registered death-rate (1897), 50 per thousand. The principal crops are millet, wheat, oil-seeds, and cotton. There are two steam factories for ginning and pressing cotton at Kamptee, which is the chief centre of trade. The district is traversed by the two lines of railway which meet at Nagpur city; total length, 50 miles. It is also well provided with roads.

The division of NAGPUR comprises the five following districts: Nagpur, Bhandara, Chanda, Wardha, and Balaghat. Area, 24,127 square miles; population (1881), 2,758,056; (1891), 2,982,507; (1901), 2,716,748, showing an increase of 8 per cent. between 1881 and 1891, but a decrease of 9 per cent. between 1891 and 1901; average density, 112 persons per square mile, ranging from 197 in Nagpur district to 65 in Chanda.

Nagybánya, a corporate mining town, picturesquely situated in north-eastern Hungary, in the county of Szatmár, with 9842 inhabitants in 1891 and 11,183 in 1901. There are a gymnasium, a Minorite convent, a directory of mines, hospitals, and several other offices and public institutions. Its mines—gold, silver, lead—are useful, and managed by the state. In the beautiful park are many ateliers, frequented in summer by pupils of the painting academy of Munich.

Nagybecskerek, a corporate town of Hungary, capital of the county of Torontál, with 22,370 inhabitants in 1891 and 26,407 in 1901. It has an asylum, supported by the Piarists, an upper gymnasium, a school for apprentices, a theatre, a carpet factory, and several financial institutions. Besides the administrative offices, there are a royal tribunal, a royal district court of justice, and a public prosecutor's office.

Nagyenyed, a corporate town of Hungary, capital of the county of Alsó-Fehér, with 6048 inhabitants in 1891 and 7494 in 1901. Its famous educational institution, the Bethlen College, founded in 1622 at Gyulafehérvár by Gabriel Bethlen, prince of Transylvania, but transferred in 1662 to Nagyenyed, contains a theological academy, an upper gymnasium, a normal school, and an elementary school, with a rich library and interesting collections. There are manufactures of carved-wood furniture and textiles. The town has played an important part in Hungarian history. In the Middle Ages it carried on a flourishing trade, and its celebrated wine cellars still exist.

Nagykároly, a corporate town in the north-eastern part of Hungary, capital of the county of Szatmár, with 13,593 inhabitants in 1891 and 15,382 in 1901. Besides the Government departments and a few educational institutions of higher rank, there is the beautiful castle of the Counts Károlyi, with a large park, and the statue of the celebrated Hungarian poet Francis Kölcsey.

Nagykikinda, a corporate town of Hungary, in the county of Torontál, with 22,923 inhabitants in 1891 and 24,843 in 1901. Being one of the centres of the produce of the famous wheat of the Banat, its traffic is brisk and flour industry important. Besides wheat, it produces also many kinds of fine fruit. It was once the seat of a privileged Servian district of south Hungary, and the moiety of its population is Servian.

Nagyszeben (German, *Hermannstadt*), a corporate town of Hungary, capital of the county of Szeben, with 24,766 inhabitants in 1891 and 29,577 in 1901. Besides several public institutions, there are interesting museums of the Lutheran Church and of the Carpathian Association of Transylvania. It is the seat of an army corps.

Nagyszombat (German, *Tyrnau*), a corporate town of Hungary, in the county of Pozsony, with 12,342 inhabitants in 1891 and 13,181 in 1901. Among its institutions are a Roman Catholic seminary for priests, a gymnasium, an orphanage, and many convents and churches; hence the town is sometimes called Little Rome. It was in this town that the famous archbishop and cardinal Peter Pázmány founded in 1635 the university, which at the end of the 18th century was transferred to Budapest. Among its industrial establishments the most important are a sugar refinery and manufactories of matches and malt.

Nagyvárad (German, *Grosswardein*), chief town of the county of Bihar, Hungary. It is a centre of commerce, industry, and traffic. In its ancient fort several Hungarian kings are entombed. Population (1891), 38,557; (1900), 50,177.

Naini Tal, a town and district of British India, in the Kumaon division of the North-Western Provinces. The town is situated in 29° 22′ N. and 79° 29′ E., 6400 feet above sea-level. Population (1881), 6576; (1891), 12,408; municipal income (1897–98), Rs.2,21,670; incidence of taxation, Rs.5.11.9 per head. Naini Tai is a popular sanitarium, and the summer headquarters of the government of the province. It is situated on a lake, surrounded by high mountains. In 1897 the municipality raised a loan of Rs.1,35,000 for an improved water-supply. The approach from the plains is by the Rohilkhand and Kumaon Railway from Bareilly, which has its terminus at Kathgodam, 22 miles by cart road. There are several European schools, three printing-presses (each issuing an English newspaper), besides barracks and convalescent depot for European soldiers, and a brewery.

The district of NAINI TAL comprises the lower hills of Kumaon and the adjoining Tarai, or submontane strip. Area, 2658 square miles; population (1891), 356,881; (1901), 306,362, showing a decrease of 15·4 per cent.; average density, 115 persons per square mile. Land revenue and rates, Rs.2,59,807, the incidence of assessment being Rs.0.6.9 per acre; cultivated area (1896–97), 262,484 acres, of which 355 were under tea; number of police, 641; vernacular schools, 40, with 1054 pupils; registered death-rate (1897), 37 per thousand.

Nairn, a royal and parliamentary burgh (Inverness group) and the county town of Nairnshire, on the Moray Firth, 15½ miles east-north-east of Inverness by rail. Its dry climate, good beach, and golf-course draw increasing numbers of visitors yearly. New hotels and a large number of new houses have been built, and the burgh boundary has been enlarged; the water-supply is about to be increased, the drainage system extended, and the harbour improved. The public hall contains a museum, reading-room, and library in connexion with an endowed literary institute; there is also a seamen's hall and library, and a convalescent home. New United Free and Established churches have been built. There is a secondary school. Population (1881), 4645; (1891), 4640; (1901), 5105.

Nairnshire, a small maritime county in the north-east of Scotland, bounded on the W. and S. by Inverness-shire, on the E. by Elgin, and on the N. by the Moray Firth.

Area and Population.—In 1891 the barony of Ferintosh, forming part of the parish of Urquhart and Logie-Wester, was transferred to Ross-shire from Nairnshire; of parishes partly in Elgin and partly in Nairn, the parish of Dyke and Moy and part of the parish of Ardclach were given to Elgin; while of parishes divided between Nairn and Inverness, Cawdor was placed wholly in Nairn, Daviot and Dunlichity wholly in Inverness, part of Moy and Dalarossie was added to the parish of Cawdor, and Croy and Dalcross was re-divided. The area of the county (foreshore excluded) is 104,245 acres, or about 163 square miles. The population was, in 1881, 10,455; in 1891, 10,019; in 1901, 9291. On the old area, taking land only (124,968 acres, or 195·3 square miles), the number of persons to the square mile in 1891 was 51, and the number of acres to the person 12·5. In the registration county the population decreased between 1881 and 1891 by 3·4 per cent. Between 1881 and 1891 the excess of births over deaths was 881, and the decrease of the resident population 308. The following table gives particulars of births, deaths, and marriages in 1880, 1890, and 1899:—

Year.	Deaths.	Marriages.	Births.	Per cent. of Illegitimate.
1880	130	37	262	10·6
1890	142	42	205	10·24
1899	149	57	235	8·9

The birth-rate, marriage-rate, and death-rate are all below those for Scotland. The following table gives the birth-rate, death-rate, and marriage-rate per thousand of the population for a series of years:—

	1880.	1881–90.	1890.	1891–98.	1899.
Birth-rate . .	27·26	25·66	23·90	23·48	28·51
Death-rate . .	13·53	16·32	16·56	17·89	18·07
Marriage-rate .	3·85	4·83	4·89	4·70	6·91

In 1891 there were 1894 Gaelic-speaking persons in the county, and one foreigner. Valuation in 1899–90, £36,192; 1899–1900, £37,865.

Administration.—The county unites with Elgin to return a member to Parliament, and Nairn (5105), the county town and only royal burgh in the county, is one of the Inverness group of parliamentary burghs. There are four civil parishes and part of a fifth (Croy and Dalcross), all forming the Nairn combination. The number of paupers and dependents in September 1899 was 304. Nairn forms a sheriffdom with Inverness and Elgin, and a sheriff-substitute sits alternately at Nairn and Elgin.

Education.—Five school boards manage 13 schools, which had an average attendance of 1236 in 1898–99, and two voluntary schools (one Roman Catholic) had 52. There is one secondary school in the burgh of Nairn, and the whole of the county and burgh "residue" grant is spent in subsidizing science and art classes in that school, and cookery classes in the county schools.

Agriculture.—In 1898 the percentage of cultivated area was 24·6. Barley and oats are the principal corn crops, covering about equal areas. A great improvement has been notable in the breed of horses. The following table gives the principal acreages at intervals of five years from 1880:—

Year.	Area under Crops.	Corn Crops.	Green Crops.	Clover.	Permanent Pasture.	Fallow.
1880	26,359	9183	4900	10,010	2188	78
1885	26,152	9338	4695	9,914	2191	14
1890	25,283	9052	4648	9,487	2054	38
1895	25,709	9054	4630	8,626	3337	59
1899	25,748	9022	4601	10,014	2087	22

The following table shows the live stock during the same years:—

Year.	Total Horses.	Total Cattle.	Cows or Heifers in Milk or Calf.	Sheep.	Pigs.
1880	1328	5955	1794	20,108	720
1885	1188	5837	1891	16,438	753
1890	1179	5926	1842	18,441	788
1895	1433	6199	1773	18,335	681
1899	1529	6246	1991	19,360	690

Of the 352 holdings in the county in 1895, the average size was 73 acres; 10·23 per cent. were under 5 acres, 44·32 between 5 and 50 acres, and 45·45 over 50 acres. The number between 50 and 100 acres was 78; between 100 and 300, 75; between 300 and 500, 5; one between 500 and 1000, and one over 1000. There were 12,767 acres under wood in 1895. At the census of 1891, 1130 men and 159 women were engaged in agriculture.

Industries and Trade.—Apart from three distilleries and some sandstone and granite quarries, there is no industry except fishing. In the district of the river Nairn 4600 salmon were caught by fixed nets in 1898.

Authorities.—C. Rampini. *History of Moray and Nairn.* Edinburgh, 1897.—G. Bain. *History of Nairnshire.* Nairn, 1893; *History of the Parish of Auldearn.* Nairn, 1898; *The Culbin Sands.* Nairn, 1899; *Guide to Nairn.* Nairn, 1899—*Book of the Thains of Cawdor* (Spalding Club). Edinburgh, 1859.—J. G. Macneill. *History of Cawdor.* Glasgow, 1893.—W. Leslie. *General View of the Agriculture of the Counties of Nairn and Moray.* London, 1813.—Brodie Cruickshank. *Place Names of Nairnshire,* 1897.—W. Laing. *Ancient Customs, Social and Local.* Nairn, 1899.—M. Macdonald. *The Covenanters of Moray and Ross.* Nairn, 1892.—G. Bain. *The Clova Cairns and Circles.* Nairn, 1899. (W. Wa.)

Najibabad, a town of British India, in the Bijnor district of the North-Western Provinces, 31 miles south-east of Hardwar. Population (1891), 19,410; municipal income (1897–98), Rs.13,161. It was founded in the middle of the 18th century by a Rohilla chief, and still contains several architectural monuments of Rohilla magnificence. It has a station on the Oudh and Rohilkhand Railway, with a junction for the branch to Kotdwara. There is considerable trade in timber, sugar, and grain, and it possesses manufactures of metal-ware, shoes, blankets, and cotton cloth. The nawab of Najibabad was a ringleader during the Mutiny.

Nakskov, a seaport town of Denmark, county Maribo, at the head of a wide bay at the west end of the island of Laaland, 31 miles by rail west of Nykjöbing, with a large sugar factory. The church dates from the beginning of the 15th century; restored in 1859 and 1897. The port was entered by 1016 vessels of 58,385 tons, and cleared by 948 of 57,398 tons in 1899. Population (1880), 5278; (1890), 6722; (1901), 8310.

Namur, a province of Belgium, bordering on the Belgian provinces of Hainaut, Brabant, Liége, and Luxemburg, and on France. It possesses coal mines, employing 2600 workers; iron mines (550 workers); marble, building-stone, and paving-stone quarries, and limestone pits, employing 3400 workers; plastic clays and slates. In general of little fertility, except to the north of the Meuse, the soil produces especially oats, potatoes, rye, beetroot, and fruits (apples and plums). Woods, occupying 27 per cent. of the surface, give cover to the fox, the deer, and the boar. The most noticeable industries are glass, cutlery, and the manufacture of chemical products and of beetroot sugar. The province is divided into three administrative arrondissements, the capitals of which are Namur (32,223 inhabitants in 1900), Dinant (7512), notable for its picturesque situation on the Meuse, and Philippeville (1217). Namur, with an area of 1414 square miles, is one of the least populous of the provinces of Belgium, having (1900) only 346,512 inhabitants, or 245 per square mile. The population, 315,796 in 1876, has thus undergone an increase of 12 per cent., against 27·7 per cent. in the same period for the whole of the kingdom.

Namur, a town of Belgium, capital of the province of the same name, 37 miles south-east of Brussels by rail. Railways connect it with the chief Belgian towns and with France, the duchy of Luxemburg, and Prussia. Population (1880), 25,354; (1900), 32,223.

Nanaimo, a town on Vancouver Island, British Columbia, with valuable coal mines in the immediate vicinity. It is connected with Victoria by the Esquimalt and Nanaimo Railway, and has a daily steamer service to Vancouver. Population about 5000.

Nancy, the old capital of Lorraine and chief town of the French department of Meurthe-et-Moselle, 218 miles from Paris by rail. The population in 1886 was 69,463; in 1896, 83,668 (96,306 in the commune); 102,463 in 1901. It has doubled since 1870 by reason of the large number of Alsatians and of people from Metz (and its district) who transported their families and industries here in order to preserve their French nationality. The town has been made the headquarters of the general command of the 20th *corps d'armée*, owing to the subdivision of the old 6th *corps d'armée* of Châlons-sur-Marne. To facilitate the traffic of the Eastern Railway (the line from Paris to Avricourt and Strasbourg), a circular railway has been constructed skirting the town on the north-east. At the port on the Marne–Rhine canal the shipping totals a tonnage of about 237,400 each year, the goods carried consisting of building materials, iron ore, coal, wood, &c. In 1892 a statue of Claude Gelée, called Lorrain, the celebrated French artist of the 17th century, was erected; in 1896 a monumental obelisk to commemorate the interview between President Carnot and the Grand Duke Constantine of Russia in 1893; in 1885 a pyramid in honour of Dr Crevaux, the explorer of the Amazon; and a statue of Jeanne d'Arc, a reproduction of that erected in Paris, with busts of the caricaturist Grandville and of the satirical poet Gringoire. Nancy has been associated in recent years with the new school of hypnotism, for a discussion of which see HYPNOTISM.

Nandgaon, a feudatory state of India, in the Chhattisgarh division of the Central Provinces. Area, 905 square miles. Population (1881), 164,339; (1891), 183,866; (1901), 126,444; average density, 139 persons per square mile; estimated revenue, Rs.2,61,000; tribute, Rs.70,000. The state owes its origin to a grant from a raja of Nagpur to his family priest in the 18th century. The present chief is a minor, and the administration is under British control. The state has long been well governed, and has derived additional prosperity from the construction of the Bengal–Nagpur Railway, which has a station at Raj-nandgaon, the capital. Here there is a steam cotton mill, with 156 looms and 14,868 spindles, employing 800 hands, and using up 15,528 cwts. of cotton annually.

Nanking, the capital of the provinces of Kiangsu and Anhwei, China. Since 1880 Nanking has been slowly recovering from the state of ruin caused by the Taiping rebellion. Barely one-fourth of the area within the walls has been reoccupied, and though its ancient industries—chief of which was silk-weaving—are reviving, no great progress has so far been made. As the seat of the provincial government, however, which embraces the three provinces of Kiangsu, Kiangsi, and Anhwei, Nanking is a city of first-class importance. The viceroy is the most powerful of all the provincial satraps, inasmuch as he controls a larger revenue than any other, and has the command of larger forces both naval and military. His importance is further enhanced by the fact that, in addition to his other functions, he is superintendent of foreign trade for the southern ports, including Shanghai, a position which gives him great weight in all political questions. Nanking was made a treaty port by the French treaty of 1858, but it was never formally opened. Its proximity to Chinkiang, where trade had established itself while Nanking was still in the hands of the rebels, made its opening of little advantage, and the point was not pressed. It was made a place of call for the landing of passengers by steamer in 1878, and in 1899 it was voluntarily thrown open to foreign trade by the Chinese Government. It contains an arsenal for the manufacture of munitions of war, as also powder mills. A naval college was opened in 1890, and an imperial military college a few years later under foreign instructors. Want of system and of continuity in the method of instruction appears to be nullifying these projects. The population is estimated at 140,000. The only foreign residents are missionaries (mostly American) and employés of the Chinese Government. The only public feature of interest in Nanking is the so-called Ming Tombs, being the mausoleum of Hung Wu, the founder of the Ming dynasty, and one or two of his successors. They lie outside the eastern wall of the city, but they are ill cared for and rapidly going to decay.

Nanning, a treaty port in the province of Kwangsi, China, situated on the West river, 250 miles above Wuchow and 470 miles from Canton. It is the highest point on the West river which is accessible for steam traffic. From Canton, as far as Wuchow, the river has a minimum depth of 8 feet, but on the section from Wuchow to Nanning not more than 3 or 4 feet are found during winter. The town is of considerable size, with a population of 40,000, and constitutes the chief market on the southern frontier. Its opening was long opposed by the French Government, who had acquired the right to build a railway to it from Tongking, by which they hoped to divert the trade through their own possessions. The port has only been lately declared open, but trade is expected to be considerable. Navigation by small native boats is open westwards into Yunnan as far as Posê.

Nansen, Fridtjof (1861——), Norwegian explorer. See POLAR REGIONS and GEOGRAPHY.

Nanterre, town and port on the Seine, arrondissement of St Denis, department of Seine, France, 6 miles west-north-west of the Invalides, Paris, on the railway to St Germain and at the foot of Mount Valérien. The principal manufacture is that of aluminium; it is also noted for cakes, and stone is quarried in the vicinity. Port traffic, 1900, 153,850 tons. The crowning of the Rose Queen, a custom handed down from mediæval times, is annually observed with considerable ceremony. Nanterre (the ancient *Nemptodurum* or *Nemetodurum*) owes its origin to the shrine of Ste Geneviève (420–512), whose name is still associated with various places in the town and district. The combined prison and mendicity depôt for the department is a very large institution, about two miles from the town. The prison is capable of containing 1500 persons, and the mendicity institution 2900. About

7000 men and 2000 women pass annually through the latter establishment. Population (1891), 5056; (1901), 14,140.

Nantes, capital of the department of Loire-Inférieure and the most populous town of Brittany, situated, 247 miles from Paris by rail, on the right bank of the Loire, which here divides into several branches. The maritime port of Nantes, reached by the ship canal from the roadstead of St Nazaire, has been much improved. Booms have been built, and a slipway facilitates the repairing of ships. The port extends over a length of about a mile and a half. The outer port as far as Chantenay has a length of over half a mile. The principal quays extend along the right bank of the branch which flows past the town, and on the western shore of the island of Gloriette. The depth of water alongside these quays varies from 10 to 20 feet; their total length used for trading purposes is 5 miles, and warehouses cover an area of 17 acres. The river port occupies the St Félix and Madeleine branches, and has quays extending 2625 feet, with an average breadth of 130 feet. Finally, on the Erdre is a third port for inland navigation, with a length of 4100 feet and an average breadth of 80 feet. All these quays are bounded by railway lines along the right bank of the river, which the railway to St Nazaire follows. On 31st December 1899 there were 240 ships of 77,474 tons attached to the port, all but 64 being coasting vessels. In 1899, 2814 vessels of 551,701 tons entered and 3029 of 667,355 tons cleared; the foreign trade was represented by 482 entrances of 278,042 tons and by 560 clearances of 309,208 tons, the number of French vessels engaged therein being 188 of 84,058 tons. The value of exports reached £794,796, and that of imports £2,546,000. The chief imports are fine sugar (raw)—Nantes imports more of this commodity than any other port in France—cereals, cocoa, wood for building purposes, coffee, hemp, olive-oil, cellulose pulp, wine, copper, and manure. The exports are grain, flour, and refined sugar. The French colonies, England, Sweden, and Norway furnish the imports—the exports being despatched to England, the French colonies, and Belgium. The chief industries are sugar-refining (30,000 to 35,000 tons are imported, mainly from French colonies), the manufacture of soap (producing 15,000 tons), the husking of rice (9000 tons), and the manufacture of woollen and cotton fabrics, 1507 tons of which are exported. Thirty-three firms manufacture alimentary preserves of fish, especially sardines (4000 to 5000 tons are exported), and of vegetables in tins. The firms engaged in salting lard, beef, and fish export 1000 tons. In 1899, 4,236,000 cubic feet of pine wood imported from Norway and Finland were used in the manufacture of wood pulp, which produced 8800 tons of paper. Several firms manufacture blocks of compressed coal dust, and it is a curious fact that 12,000 tons of coal thus prepared are exported to England. The manufacture of biscuits is important—one firm making 80 tons daily. The millers' trade is of modern establishment. One mill alone treats 400 to 500 tons of wheat daily. One factory sends out annually, amongst other chemical productions, 7000 tons of an acid extracted from the chestnut. Nantes has workshops turning out machinery, boilers, and iron frame-work, and has also shipbuilding yards, foundries, forges, bell-foundries, and tanneries. There are 50 nursery gardens and manufacturers of bottles, stained glass, and tobacco (1800 workmen). Population (1886), 110,638; (1901), 128,349.

Nanticoke, a borough of Luzerne county, Pennsylvania, U.S.A., on the North Branch of Susquehanna river, and on the Central of New Jersey, the Pennsylvania, and the Delaware, Lackawanna, and Western railways, in the eastern part of the state, at an altitude of 540 feet. Its site is level, and its plan fairly regular. It is in the anthracite coal region, is surrounded by mines, and its industries consist chiefly in mining and shipping coal. Population (1880), 3884; (1890), 10,044; (1900), 12,116, of whom 5055 were foreign-born.

Nantwich, a market-town in the Crewe parliamentary division of Cheshire, England, on the river Weaver and the North-Western and Great Western railways. Shrewbridge Hall, formerly a private mansion, was converted into the brine baths hotel for cases of rheumatism, gout, and general debility. Besides its manufactories, the town possesses tanneries and an iron foundry. It is one of the finest fox-hunting centres in the country, being within easy distance of several meets. Population (1881), 7495; (1901), 7722.

Napier, town in Hawkes Bay county, New Zealand, 155 miles east by south of New Plymouth. It has railway communication with Wellington, New Plymouth, and the Wairarapa, Wanganui, and Manawatu districts. Tree-planting, the sinking of artesian wells, and a fine esplanade by the bay have much improved its appearance and comfort. The large breakwater, which will supersede the imperfectly-sheltered Port Ahuriri, is nearly completed. The imports in 1898 were only £181,486, while the exports reached £1,113,242. In 1900 the imports were £219,000, but exports had fallen to £770,000. Population, 9015.

Napier and Ettrick, Francis Napier, Baron [9th Baron Napier of Merchistoun, and 1st Baron Ettrick of Ettrick] (1819–1898), British diplomatist, was born in 1819, and succeeded his father in the peerage in 1834. He entered the diplomatic service in 1840, and was employed in successive posts at Vienna, Constantinople, Naples, Washington, and The Hague. During this time he earned the highest opinions both at home and abroad. In 1860 he became ambassador at St Petersburg, and in 1864 at Berlin. In 1866 he was appointed governor of Madras, and was at once confronted with a serious famine in the northern districts. In dealing with this and other problems he showed great activity and practical sense, and he encouraged public works, particularly irrigation. In 1872 he acted for a few months as Viceroy, after Lord Mayo's assassination; and on Lord Northbrook's appointment to the office he returned to England, being created a baron of the United Kingdom (Baron Ettrick of Ettrick) for his services. He continued, both in England and in Scotland, to take great interest in social questions. He was for a time a member of the London School Board, and he was chairman of the Crofters' Commission in 1883, the result of which was the appointment of a permanent body to deal with questions affecting the Scottish crofters and cottars. He died at Florence, 19th December 1898, leaving a widow and three sons.

Napier of Magdala, Robert Cornelis Napier, 1st Baron (1810–1890), British field-marshal, son of Major Charles Frederick Napier, Royal Artillery, was born at Colombo, Ceylon, on 6th December 1810. He entered the Bengal Engineers from Addiscombe College on the 15th December 1826, and after the usual course of instruction at Chatham, arrived in India in November 1828. For some years he was employed in the irrigation branch of the Public Works Department, and in 1838 he laid out the new hill station at Darjeeling. Promoted captain in January 1841, he was appointed to Sirhind, where he laid out cantonments on a new principle—known as the Napier system—for the troops returning from

Afghanistan. In December 1845 he joined the army of the Sutlej, and commanded the Engineers at the battle of Mudki, where he had a horse shot under him. At the battle of Firozshah on the 31st December he again had his horse shot under him, and, joining the 31st Regiment on foot, was severely wounded in storming the entrenched Sikh camp. He was present at the battle of Sobraon on 10th February 1846, and in the advance to Lahore; was mentioned in despatches for his services in the campaign, and received the medal with two clasps and a brevet majority. He was chief engineer at the reduction of Kote-Kangra by Brigadier-General Wheeler in May 1846, and received the thanks of Government. He was then appointed consulting engineer to the Punjab Resident and Council of Regency, but was again called to the field to direct the siege of Multan. He was wounded in the attack on the entrenched position in September 1848, but was present at the action of Surjkhand, the capture of the suburbs, the successful storm of Multan on 23rd January 1849, and the surrender of the fort of Cheniote. He then joined Lord Gough, took part, as commanding engineer of the right wing, in the battle of Gujrat in February 1849, accompanied Sir W. R. Gilbert in his pursuit of the Sikhs and Afghans, and was present at the passage of the Jhelum, the surrender of the Sikh army, and the surprise of Attock. For his services he was mentioned in despatches and received the medal with two clasps and a brevet lieutenant-coloneley. At the close of the war Napier was appointed civil engineer to the board of administration of the annexed Punjab province, and carried out many important public works during his tenure of office. In December 1852 he commanded a column in the first Hazara expedition, and in the following year against the Boris; and for his services in these campaigns was mentioned in despatches, received the special thanks of Government, the medal and clasp, and a brevet coloneley. He was appointed military secretary and adjutant-general to Sir James Outram's force for the relief of Lucknow in the Indian Mutiny in 1857, was engaged in the actions of Mangalwar, Alambagh, and Charbagh, and the first relief of Lucknow. He directed the defence of Lucknow until the second relief, when he was severely wounded in crossing a very exposed space with Outram and Havelock to meet Sir Colin Campbell. He was chief of the staff to Outram in the defence of the Alambagh position, and drew up the plan of operations for the attack of Lucknow, which was approved by Sir Colin Campbell and carried out by Napier as brigadier-general commanding the Engineers, in March 1858. On the fall of Lucknow Napier was most favourably mentioned in despatches, and made C.B. He joined Sir Hugh Rose as second-in-command in his march on Gwalior, and commanded the 2nd brigade at the action of Morar on the 16th June. On the fall of Gwalior he was entrusted with the task of pursuing the enemy. With only 700 men he came up with Tantia Topi and 12,000 men on the plains of Jaora Alipur, and completely defeated him, capturing all his guns (25), ammunition, and baggage. On Sir Hugh Rose's departure he took command of the Gwalior division, captured Paori in August, routed Firozshah, a prince of the house of Delhi, at Ranode in December, and, in January 1859, succeeded in securing the surrender of Man Singh and Tantia Topi, which ended the war. For his services Napier received the medal with three clasps, the thanks of Parliament and of the Indian Government, and was made K.C.B.

In January 1860 Napier was appointed to the command of the 2nd division of the expedition to China under Sir Hope Grant, and took part in the action of Sinho, the storm of the Peiho forts, and the entry to Peking. For his services he received the thanks of Parliament, the medal with two clasps, and was promoted major-general for distinguished service in the field. For the next four years Napier was military member of the Council of the Governor-General of India and, on the sudden death of Lord Elgin, for a short time acted as Governor-General, until the arrival of Sir W. T. Denison from Madras. In January 1865 he was given the command of the Bombay army, in March 1867 he was promoted lieutenant-general, and, later in that year, appointed to command the expedition to Abyssinia, selecting his own troops and making all the preparations for the campaign. He arrived at Annesley Bay in the Red Sea early in January 1868, reached Magdala, 420 miles from the coast, in April; stormed the stronghold, freed the captives, razed the place to the ground, returned to the coast, and on the 18th June the last man of the expedition had left Africa. He received for his services the thanks of Parliament, the war medal, and a pension. He was raised to the peerage, and made G.C.B. and G.C.S.I. The freedom of the cities of London and Edinburgh was conferred upon him, with presentation swords, and the universities bestowed upon him honorary degrees. In 1869 he was elected a fellow of the Royal Society. He held the command-in-chief in India for six years from 1870, during which he did much to benefit the army and to encourage good shooting. He was promoted general in 1874, and appointed a colonel-commandant of the Royal Engineers. In 1876 he was the guest of the German Crown Prince at the military manœuvres, and from that year until 1883 held the government and command of Gibraltar. In the critical state of affairs in 1877 he was nominated commander-in-chief of the force which it was proposed to send to Constantinople. In 1879 he was a member of the Royal Commission on Army Organization, and in November of that year he represented Queen Victoria at Madrid as ambassador extraordinary on the occasion of the second marriage of the king of Spain. On the 1st January 1883 he was promoted to be field-marshal, and in December 1886 appointed Constable of the Tower of London. He died in London on the 14th January 1890. His remains received a state funeral, and were buried in St Paul's Cathedral on the 21st January. He was twice married, and left a large family by each wife. A statue of him on horseback by Boehm was erected at Calcutta when he left India, and a replica of it was afterwards set up to his memory in Waterloo Place, London. (R. H. V.)

Naples, a city and the chief town of a province, Italy, situated on the north shore of the Bay of Naples, 161 miles by rail east-south-east of Rome. It is the seat of a prefecture comprising the sub-prefectures of Casoria, Pozzuoli, Castellammare, and sixty-eight communes. According to the census of 1881, the population of the province was 1,001,245, and the city 493,115; and in 1901, 1,135,906 and 563,731 respectively. In the later years of this period there was a constant increase of births and a low death-rate (see below). The city proper is about 12 miles in circumference. On the north-east shore of the bay, opposite the ancient site of Pompeii, stands Nuova Pompeii, where is situated the famous sanctuary of the Madonna di Pompeii. On the north-west shore the grotto of Pozzuoli (or Posilippo) has been strengthened by supporting arches, without which it threatened to collapse. Another example of Roman tunnelling is the neighbouring gallery, now dry, bored to convey water to Cumæ from the Lake of Avernus. A tunnel for the railway and steam tramway also runs through the promontory of Posilippo. It is 826 yards long, 13 yards high, 11 yards broad, with pavements for foot passengers 8 feet broad, and with a lift in the centre giving access to the new Parco Savoja. A penal settlement is situated on the island of Nisida, and the Royal Park of Astroni should be mentioned. The Lake of Agnano, as it formerly existed, was also an extinct crater more than two miles in circumference. In 1870, however, it was drained and cultivated, to the great improvement of the air. In 1883 the island of Ischia (famous for its thermal waters) was visited by an earthquake, during which some 4000 inhabitants and visitors were killed. The Via Caracciolo was finally completed in 1891.

The Risanamento.—The curve of the bay is continually being modified by the filling up of the gulf, but indeed, since the cholera epidemic of 1884 the whole city has been rapidly modified by the *Risanamento*, an undertaking designed to purify the city by destroying old houses and *fondaci*, and by constructing large new thoroughfares flanked by hygienic dwellings. Some two-thirds of the work originally planned has been executed, and the remaining third is to be completed at an approximate cost of £1,600,000. The funds for the undertaking were furnished partly by the state, which provided 75,000,000 lire (£3,000,000), and partly by the Risanamento Company, which has a capital of £1,200,000. The work of Risanamento provides labour for a large number of men, but otherwise it confers little benefit upon this class of the population, to whose means the new houses are not adapted. Working-class houses, properly so called, have not been constructed. The old area of 1950 acres has been increased by the districts of Vomero Nuovo, near San Martino. *New Quarters.*—Santa Lucia, near the Castel dell' Ovo; the Sant' Efremo quarter, behind the Albergo dei Poveri; and the districts of Vasto alla Ferrovia; Sirignano alla Riviera; Margherita; the Amedeo Extension; the Avenue Principessa Elena at Mergellina, and the Parco Savoja upon the Posilippo Hill. By degrees the narrow streets and alleys of Porto Mercato, Pendino, and San Lorenzo disappear and are replaced by large thoroughfares, and the famous lanes (Vicoli) of Santa Lucia, with their horrible filth, have also followed suit.

Communications and Lighting.—A more rapid system of city communication corresponds to the growth of the network of streets. The tramway service is exceedingly complete, and on some lines electric traction is employed. Within a short time electricity will be employed throughout the city. The use of electric light is also rapidly extending, and it is already used for the illumination of the theatres, the railway, the hotels, factories, arcades, and the principal streets.

Water-supply.—The cholera epidemic of 1884 led also to the reorganization of the water-supply. Previous to that date concessions had been granted for this purpose. First under the management of an English, and then of a French company, the works which bring the water from the sources of the Serino, on the Avellino Hills, have been completed. The exact spot is the lower source at Urciuoli, 1050 feet above sea-level, which gives a minimum supply of 30,800,000 gallons daily. The higher source at Acquaro has not yet been tapped. The aqueduct, which measures from 5 to 6 feet in diameter, runs for a distance of about 40 miles to Cancello, passing through 49 tunnels of an aggregate length of 10 miles. Thence the water is forced through metal syphons for another 15 miles to the reservoirs of Capodimonte and Scudillo. The gradient is one-half per thousand. Some thirty communes near the line of the aqueduct draw from it their water-supply. The work cost £1,400,000, and the water, which is of excellent quality, is supplied at about 1s. 2d. per 1000 gallons. As a result of the improved water-supply, Naples has been exempt from epidemics, and the average mortality from infectious diseases has fallen to 7·25 per cent., a figure lower than that of any European capital except Brussels, where the average is 6·49 per cent. The reformed sewer system has also contributed to this result. The outfall of sewage is beyond Cape Misenum in the Licola marshes, whither the sewage is carried by two large urban collectors through Cuma and Coroglio.

Castles, Churches, &c.—Castel Capuano, formerly residence of the princes of Anjou, but chosen in 1540 as the Law Courts, is being restored on account of its insecure condition. The Law Courts have therefore been transferred to the Institute of Fine Arts. Castel Nuovo will become the municipal palace as soon as it is freed from the old buildings which surround it. Within niches in the front of the royal palace have been placed, by commission from King Humbert, the statues of Roger the Norman, Frederic II., Charles of Anjou, Alphonso of Aragon, Charles V., Charles III., Joachim Murat, and Victor Emmanuel. The royal palace of Capodimonte was, until the summer of 1900, chiefly used as a modern picture gallery and armoury, but was rarely used as a royal residence, except by Queen Margherita, who retained a small suite of four rooms. Victor Emmanuel III. has, however, made Capodimonte his principal summer palace. He has enlarged the grounds, removed the picture gallery to Caserta, and refurnished the royal apartments. The archbishop of Naples need not necessarily be a cardinal, but is usually of noble birth. The religious houses suppressed in 1868 have been in great part reconstituted, but they no longer figure as recognized corporations. Among the more noteworthy Neapolitan churches should now be mentioned Sant Anna dei Lombardi, with the picture of Christ by Modanino (Guido Paganini); the sacristy of San Domenico Maggiore, with the remains of ten princes of Aragon; and San Severo, containing valuable sculptures by Sammartino Queiroli, Corradini, and Celebrano. There are six non-Catholic churches: English, Scottish, Gallican, German, Greek, and a Jewish synagogue. One of the most noteworthy constructions of modern Naples is the Galleria Umberto I., an extensive arcade inaugurated in 1890 on the site of the squalid Vicolo Campane. The arcade is slightly larger than that of Milan. It has four entrances, a central cupola, and is richly ornamented with gilding and bas-reliefs. Eighty-six shops are in the interior, and ninety on the exterior. A theatre called the Salone Margherita is situated underground.

Libraries and Education.—The libraries number eight. Of these the Nazionale has 600,000 volumes, and that of the Society of Italian History more than 70,000 volumes, dealing with the history, geography, and administration of the Two Sicilies. The foundation-stone of a new university was laid in 1898, but the work of building has not yet begun, as the site is now considered too small for the needs of the city. In 1899–1900, 6000 students were registered, and a similar number were on the books for 1900–1901. Education in general may be said to be steadily progressing, and the number of persons unable to read and write is gradually diminishing. The municipality spends £50,000 for the education of some 25,000 children. The commune of Naples supports 43 day schools and 4 evening schools for boys, 11 evening schools of design, and 40 day schools for girls. Important educational institutions are—(1) The Industrial Museum, supported by the state, the province, and the commune—an institution which comprises several technical schools and schools of art applied to industry; (2) The Vittorio Emanuele Reformatory, founded by the provincial administration; and (3) The Opera Ravaschieri, supported by public subscription, for the education of abandoned children. The Marine Station, of which an account is given under AQUARIA, should also be mentioned.

Charitable Institutions.—The charitable institutions (*opere pie*) have been partially reorganized by grouping together cognate institutions, decreasing the number of employés, and increasing the benefits to the indigent. To the number of those previously existing must be added the new asylum, and the sanatorium for consumptive patients, at San Gennaro di Pozzuoli, generously given to the city by the Duchess Ravaschieri.

New Theatres.—Few changes have taken place in Neapolitan theatres. The *Mercadante* has been renovated and an amphitheatre added; a variety theatre opened at Chiatamone, while the popular *San Carlino* has been demolished in the course of the Risanamento. The *Pulcinella*, also, has disappeared, and has been replaced by small and sparsely-attended music halls.

Shipping.—The improvements in the port and the warehouses have brought Naples up to the level of the principal maritime cities. The minimum depth of water in the harbour is now 19 feet, the average 26 to over 50 feet, though in the small commercial port the depth is only 10 to 13 feet. The old landing-stage of the Immacolatella, near the Custom House, now serves only for small boats, while the new landing-stage, opposite Via Duomo, meets all the requirements of large sea-going steamers. The imports are valued at from 3½ to nearly 5 millions sterling annually, the principal items being cereals, metals, animals and animal foods, stoneware and glass, cottons, and leather wares; and the exports at approximately 2½ millions sterling, live animals and animal produce, cereals, manufactured hemp and flax being the principal. The traffic of the port was in 1900 6,657,185 tons. Italy holds the first place with 2,807,490 tons; Germany comes second with 1,468,290 tons; Great Britain third with 1,298,708; and France fourth with 497,650 tons. Naples is one of the principal Italian ports for the embarkation of emigrants.

Finance.—The financial condition of the municipality of Naples scarcely appears satisfactory. Income amounts to about £950,000 per annum, drawn chiefly from the octrois and from taxes upon comestibles. The octroi is collected by the state, which pays £460,000 per annum to the commune, in addition to which the commune is authorized to collect further indirect taxes to the amount of some £70,000 per annum. The other sources of income, principally direct taxes, yield rather more than £400,000. The total municipal debt, which bears interest at rates varying from 5 to 2 per cent., amounts to £5,500,000, for the service of which £347,612, or rather more than a third of the total municipal revenue, is required. The other items of expenditure are for police, street cleaning, lighting, schools, and the sanitary service.

Industries.—The trade of Naples has undergone some modifications. There are large foundries, iron-works, iron shipbuilding yards at Torre dell' Annunziata, Pozzuoli, and other towns along the shores of the bay. In Naples itself the glove and coral industries have fallen off, but the production of carved wood, bronze and iron bedsteads, goldsmiths' work, lithography, and artificial flowers has, under the influence of the above-mentioned Industrial Museum, considerably increased. This institution, by stimulating work, helps to educate the lower classes by raising their moral and economical condition, and frequently changes the so-called *camorrista* into an honest artisan.

The Camorra.—At the time when the *camorra* existed as an organization young members were known as *garzoni di malavita*, and became later *picciotti di sgarroe*, rising finally to the dignity of *camorrista*. Every quarter of the city had its own special *camorra* jurisdiction, called a *paranza*, with its purser or treasurer, known as the *contatore*. The *camorra* never assumed the form of brigandage, like the Sicilian *maffia*, and very rarely assassinated by order. If weapons were used, they were used in duelling, or *dichiaramenti*, one of the last of which took place in 1892. The *camorra*, indeed, no longer exists in the form of an organized association, but is rather a manifestation of individual bullying, a kind of tax collected by the strong drone from the weak producer. Sometimes, however, it takes the form of obtaining by private initiative redress for injury in cases where official justice is impotent. The word *camorra* is now replaced by the expression *malavita*, the members of which, always armed, or "clothed," according to their slang term, constantly use the revolver and the razor. The revolver is employed between men in a duel; the razor is used to disfigure women in cases of jealousy, or *vendetta*. The authorities have made some efforts to crush out the evil, especially by exiling the worst characters to places of compulsory residence, but they are weak in dealing with the abuse. Of course, as in every large city, thieves and swindlers are plentiful; but they are not necessarily members of the *camorra*, or *malavita*, which is now little more than a legend. It may be said in another sense, however, that the *camorra* has grown upwards, and that highly-placed and well-known *camorristi* infest municipal administration and political life. During elections, both local and general, violence and corruption openly find free play. In the autumn of 1900 revelations made with regard to the power of the *camorra*, in the course of a libel suit, led to the dissolution of the Naples municipality and to the appointment of a royal commissioner. A Government commission of inquiry into the municipal corruption exercised by the *camorra* was also appointed.

The Police Service.—The police service is carried out by 830 policemen (*agenti questurini*), 547 municipal guards, 567 carabineers, and 1195 customs officials. It may be said that the policemen and carabineers alone perform useful service. The absence of respect for authority is noteworthy, and the crowd often takes the part of a criminal in opposition to the police. Criminality, however, shows considerable diminution. In 1899, 4420 thefts (or 1247 less than in 1898), 717 murders (or 53 less than in 1898), and 16,448 cases of wounding (or 2938 less than in 1898) were reported, an improvement which, in the opinion of magistrates, is not to be attributed only to the severity of penalties, but also to a real improvement in the habits of the population. One of the greatest scourges of Neapolitan life is the apparently ineradicable mendicancy of a whole class of paupers, who expose to the public their real or simulated physical woes. The authorities appear impotent to deal effectively with this plague, and the charitable institutions are powerless, because they cannot harbour fictitious paupers who, for their part, have no desire to become inmates of institutions which would prevent them from plying a lucrative and unworthy trade.

The union of Naples with the rest of Italy, while commercially and industrially disadvantageous, has helped to improve the habits, the civilization, and the activity of the Neapolitans. In Naples the upper and middle classes are partisans of unity. The common people are indifferent. The frequency of contact with other provinces is gradually modifying customs and creating a beneficent rivalry. The consciousness of the Neapolitan that he is regarded as an inferior by his countrymen of the North and Centre, while not creating a regionalism proper, doubtless retards the moral and truly national unification of the country.

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Napo. See AMAZON.

Napoléon, Victor Jérôme Frédéric (1862– ——), eldest son of Prince Napoleon (see BONAPARTE) and of Princess Clotilde, was born at the Palais Royal, Paris, on 18th July 1862. Upon the overthrow of the Imperial Government he went into exile with his parents, but was brought back by his father as soon as circumstances permitted, and, notwithstanding his princely quality, received the ordinary public school education of a young Frenchman. By the death of his cousin the Prince Imperial (see BONAPARTE) in 1879 his father became head of the Bonaparte family and the Imperialist party, a considerable section of which, notwithstanding, alarmed at Prince Napoleon's democratic and anti-clerical opinions, wished to depose him in favour of Prince Victor. The latter resisted all attempts to estrange him from his father until 1884, when he consented to place himself at the head of the more conservative, who were probably the more numerous, section of the Bonapartists. Both princes were expelled from France in 1886; the son withdrew to Brussels, the father to Switzerland, and no reconciliation ever took place. By the death of his father in 1891 Prince Victor Napoleon became undisputed head of the Imperialists, though there were some who looked hopefully towards his younger brother Louis, a military officer in the Russian service.

Nara, the first permanent capital of Japan, situated in the province of Yamato, 25½ miles from Osaka (by rail), with a population of 30,539. Up to the beginning of the 8th century the Imperial Court changed its location at the accession of each sovereign, and the court's place of residence naturally became the official metropolis. But Nara remained the metropolis during seven consecutive reigns (709 to 784), and its seventy-five years of favoured existence sufficed for the building and furnishing of several imposing shrines and temples, for the laying out of a noble park, for the casting of a colossal image of Buddha, and for the execution of many other beautiful specimens of applied art. Not much is known of the Nara palace in its original form, but many of the articles and ornaments used by its inmates survive in a celebrated collection which, during nearly twelve hundred years, had been preserved in a store-house connected with the Shôsô-in. This collection cannot be visited by strangers more than once a year, and even then only by special permission. But some of the massive and beautiful temples erected in the days of the city's greatness stand still intact, and their graceful proportions, together with the sculptures and paintings they contain, speak eloquently of a refined and even luxurious civilization.

Not less remarkable was the vigorous growth of the Buddhist creed throughout the Nara epoch. This faith in the 8th century assumed the dimensions almost of a mania, and found outward expression in many striking architectural and artistic works. The best of these, namely, those dating from the first half of the century, show Indo-Grecian affinities, which gradually grow fainter as the end of the epoch approaches. The huge bronze image of Lochâna Buddha in the temple called Todai-ji is often spoken of as the most remarkable of the Nara relics; but however beautifully proportioned the great idol may have been originally, clumsy restorations in consequence of fires and other accidents have so marred it that it can no longer be compared with many smaller examples of contemporaneous and subsequent sculpture. More worthy of close attention are two effigies of Brahma and Indra preserved among the relics of Kobuku-ji, which, with Kasuga-no-Miya, Ni-gwatsu-dô, and Tôdai-ji, constitute the chief religious edifices. These figures, sculptured in wood, have suffered much from the ravages of time, but nothing could destroy the grandeur of their proportions or the majesty and dignity of their pose. Several other works of scarcely inferior excellence may be seen among the relics, and at the shrine of Kasuga is performed a religious dance called Kagura, in which the costumes and gestures of the dancers are doubtless the same as those of twelve centuries back. Although a railway now gives access to the town, Nara has not suffered at the hands of the iconoclast. Every effort is made to preserve all the ancient features in their entirety. A museum has been formed, where many antique objects of great interest are displayed, as well as works from the hands of comparatively modern artists. Nara in the days of its prosperity is said to have had a population of a quarter of a million. (F. BY.)

Narbonne, chief town of arrondissement, department of Aude, France, 37 miles east of Carcassonne by rail. The remains of the ancient fortifications in the vicinity of the railway station have been removed and the site occupied by a new and well-built quarter. An œnological station was formed in 1894. Population (1881), 25,076; (1891), 24,640; (1901), 28,892.

Nares, Sir George Strong (1831-——), British vice-admiral and Arctic explorer, son of Captain W. H. Nares, R.N., of Aberdeen, was born in 1831, and after passing through the Royal Naval College at New Cross, entered the navy in 1846. His first experience of the Arctic regions was in the *Resolute* (1852–54), with Mecham; and he subsequently served in the Crimea, and was employed in surveying work in different parts of the world. Between 1872 and 1874 he commanded the *Challenger* in the famous voyage of deep-sea exploration. In 1875 Captain Nares was appointed to command the *Alert* in the Arctic expedition of that year, in company with the *Discovery* (Captain Stephenson). In the face of unparalleled difficulties he took the ships farther north than had been reached before (82° 27′ N.), and after encountering the greatest difficulties and hardships, he brought the ships both safely home in October 1876. It was on this expedition that Lieutenant (afterwards Admiral) A. H. Markham, with sledges, reached 83° 10′ 26″ N. On their return Nares was made K.C.B.; and in 1878 he was sent in command of the *Alert* to survey Magellan Strait, South America. From 1879 to 1896 he was attached to the Harbour Department of the Board of Trade. He became a vice-admiral in 1892. Sir George Nares published various accounts of his explorations, and a *Naval Cadets' Guide*, which went through several editions. (See also POLAR REGIONS, GEOGRAPHY.)

Narni, a town and bishop's see in the province of Perugia, Umbria, Italy, on a height (1191 feet) above the Nera, 8 miles by rail south-west of Terni. The cathedral dates from the 13th century. There are remains of the bridge of Augustus, and of an ancient aqueduct. The town has mineral springs. Narni was the birthplace of the Emperor Nerva, of Pope John XIII. (965–972), and of the 15th-century condottiere, Erasmus of Narni, known as Gattamelata. There have been bishops since the year 369. Population about 3000.

Narsinghgarh, a native state of Central India, in the Bhopal agency. Area, 623 square miles. Population (1881), 112,427; (1891), 116,280; average density, 186 persons per square mile. Estimated revenue, Rs.5,00,000; tribute to Holkar, Rs.85,000. The chief, whose title is raja, is a Rajput of the Omat clan. The state was founded about 1681 by a minister of Rajgarh, who compelled the ruler of that state to transfer to him half his territory. The present raja is a minor, and is being educated at the Daly College at Indore, while the administration is being conducted under British supervision. The town of Narsinghgarh is situated in 23° 42′ N. and 77° 5′ E. Population (1881), 11,400; (1891), 8561.

Narsinghpur, a town and district of British India, in the Nerbudda division of the Central Provinces. The town is on the river Singri, a railway station 52 miles east of Jubbulpore. Population (1881), 10,222; (1891), 10,220.

The district of NARSINGHPUR has an area of 1916 square miles; population (1881), 365,173; (1891), 367,026; (1901), 313,829; showing a decrease of 14·5 per cent. between 1891 and 1901; average density, 164 persons per square mile, being the highest for any rural district in the province. The land revenue in 1897–98 was Rs.6,28,325, the incidence of assessment being R.0.9.5, the highest rate in the province; cultivated area (1897–98), 545,278 acres, of which 3141 were irrigated; number of police, 355; boys at school (1896–97), 6307, being 22·8 per cent. of the male population of school-going age; registered death-rate (1897), 73·65 per thousand. The principal crops are wheat, rice, millet, pulse, oilseeds, and cotton. There are manufactures of cotton, silk, brass, and iron-ware. At Mohpani is a coal-mine, which employs about 276 persons and has an output of 22,472 tons. The Great Indian Peninsula Railway runs through the district for 70 miles, with seven stations, besides a branch to Mohpani.

Narva (*Rugodiv* of Russian annals, also *Ivan-Gorod*), a seaport and fortress of Russia, government and 100 miles west of St Petersburg, on Narova river, which flows from Lake Peipus or Chudskoye, and enters the Gulf of Finland in Narva Bay (100 miles long and 55 miles wide), 8 miles below this town. Only ships of 7 feet draught can enter the river. The town was founded in 1223 by Danes, and changed hands between Teutonic knights, Danes, Swedes, and Russians until it was taken by Peter I. in 1704, after the Russians had suffered a terrible defeat four years before. Its fortress, built on the right bank of the river, and known as Ivan-Gorod, has lost its importance, and is abandoned. The cathedral and the town hall (1683) contain many interesting antiquities. The population in 1897 was 16,577. There are two gymnasia for boys and for girls, a navigation school, and an Esthonian school. It has several important manufactories on the waterfalls of the Narova—cotton-mills (388,812 spindles, £971,500 yearly returns), woollen cloth mills (12,300 pieces of cloth), flax and jute mills, saw mills, and steam flour mills. The port is visited every year by about a hundred vessels. A wealthy watering-place has grown up at Ust-Narova, or Hungezburg, at the mouth of the Narova.

Narvacan, a town near the centre of the province of South Ilocos, Luzon, Philippine Islands, and a mile from its Pacific coast. It lies in a level valley surrounded by mountains, and has a cool and healthful climate. The soil, not only in the valley, but also on the neighbouring mountain-sides, is very fertile, and produces rice, Indian corn, cotton, tobacco, and sugar-cane. Many of the inhabitants manufacture salt from sea-water, and others cut and market the hard-wood trees of the adjoining forests Cotton fabrics are woven by the women and sold to the pagan mountain tribes. The language is Ilocano. Population, 16,000.

Nashua, a city of New Hampshire, U.S.A., capital of Hillsboro county, on the Nashua river, at its junction with the Merrimac, and on the Boston and Maine Railroad, in the southern part of the state, at an altitude of 120 feet. The city has an irregular plan, is divided into nine wards, and derives its water supply from Pennichuck creek by pumping. Its prominence as a manufacturing city is due to the fine water-power derived from the rivers. Its manufactures are varied, consisting largely of cotton, iron and steel goods, and paper. Population (1890), 19,311; (1900), 23,898, of whom 8093 were foreign-born and 62 negroes.

Nashville, the second largest city of Tennessee, U.S.A., capital of Davidson county and of the state, on both banks of the Cumberland river, which is here navigable, near the centre of the state, and at an altitude, at the Union depôt, of 435 feet. The city is irregularly laid out, on a hilly picturesque site, is divided into 20 wards, has an excellent water supply, owned by the city, and is paved in the business parts with brick and granite blocks, while the residential streets are macadamized. Several lines of the Louisville and Nashville, and the Nashville, Chattanooga, and St Louis railways furnish communication in all directions. Besides the state buildings and institutions, Nashville contains several institutions for higher education. Among them are Vanderbilt University, with, in 1899, 93 instructors and 766 students; the University of Nashville, with 70 instructors and 1306 students; Roger Williams University, with 9 instructors and 130 students; Fisk University (for coloured), with 31 instructors and 249 students; and Central Tennessee College (also for coloured), with 36 instructors and 327 students. All these institutions are co-educational. There are also two colleges for women. In 1890 the manufacturing establishments numbered 420, with a capital of $9,904,295. They employed 8122 hands, and the products had a value of $14,590,823. These products were varied, the only item of importance being lumber. Near Nashville are the Hermitage, the home of General Andrew Jackson; Belle Mead, a famous stock-farm; and a national cemetery. The assessed valuation of property, real and personal, was in 1899, $36,429,396, the net debt of the city was $3,413,500, and the rate of taxation $24.50 per $1000. Population (1890), 76,168, of which only 3794 were of foreign birth and 29,395 were coloured; in 1900, 80,865, of whom 3037 were foreign-born and 30,044 negroes.

Nasik, a town and district of British India, in the Deccan division of Bombay. The town is on the Godaveri river, 4 miles from a railway station, 117 miles north-east of Bombay. Population (1881), 21,660; (1891), 24,429. Nasik is a very holy place of Hindu pilgrimage, being 30 miles from the source of the Godaveri. It has manufactures of cotton goods, brass-ware, and mineral waters, besides a high school, with 375 pupils in 1896–97, and four printing-presses, each issuing a vernacular newspaper.

The district of NASIK has an area of 5940 square miles; population (1881), 781,206; (1891), 843,582; (1901), 819,575, showing an increase of 8 per cent. between 1881 and 1891, but a decrease of 2·8 per cent. between 1891 and 1901; average density, 138 persons per square mile. The land revenue and rates in 1897–98 were Rs.19,80,547, the incidence of assessment being R.0.11.2 per acre; cultivated area (1897–98), 1,830,000 acres, of which 92,309 were irrigated from wells, &c., including 23,312 acres from Government canals; number of police, 947; children at school (1897–98), 16,479, being 1·9 per cent. of the total population; registered death-rate (1897), 54·77 per thousand, being the highest in the province. The principal crops are millet, pulse, wheat, and oil-seeds. Yeola is an important centre for weaving silk and cotton goods; there are flour-mills at Malegaon, and the railway workshops at Igatpuri employ 400 hands. There are cantonments at Deolali and Malegaon. The district is crossed by the main line and also by the chord line of the Great Indian Peninsula Railway.

Nasirabad, or MYMENSINGH, a town of British India, headquarters of Mymensingh district in Bengal, situated on the left bank of the old channel of the Brahmaputra, which is only navigable during the rainy season. It is the terminus of a branch of the Eastern Bengal Railway from Dacca (76 miles), which has been extended to Jagannathganj, on the Jamuna or main stream of the Brahmaputra (56 miles). Population (1881), 10,561; (1891), 11,555. The high school had 290 pupils in 1896–97. The earthquake of 12th June 1897 destroyed the church and the high school, and seriously damaged other public buildings.

Nasmyth, James (1808–1890), Scottish engineer, was born in Edinburgh on 19th August 1808, and was the youngest son of Alexander Nasmyth, the "father of Scottish landscape art." He was sent to school in his native city, and then attended classes in chemistry, mathematics, and natural philosophy at the University. From an early age he showed great fondness for mechanical pursuits, and the skill he attained in the practical use of tools enabled him to make models of engines, &c., which found a ready sale. In 1829 he obtained a position in Maudslay's works, where he stayed two years, and then, in 1834, started business on his own account in Manchester. The beginnings were small, but they quickly developed, and in a few years he was at the head of the prosperous Bridgewater foundry at Patricroft, from which he was able to retire in 1856 with a fortune. The invention of the steam-hammer, with which his name is associated, was actually made in 1839, a drawing of the device appearing in his note-book, or "scheme-book," as he called it, with the date 24th November of that year. It was designed to meet the difficulty experienced by the builders of the *Great Britain* steamship in finding a firm that would undertake to forge the large paddle-wheel shaft required for that vessel, but no machine of the kind was constructed till 1842. In that year Nasmyth discovered one in Schneiders' Creuzot works, and he found that the design was his own and had been copied from his "scheme-book." His title, therefore, to be called the inventor of the steam-hammer holds good against the claims sometimes advanced in favour of the Schneiders, though apparently he was anticipated in the idea by Watt. Nasmyth did much for the improvement of machine-tools, and his inventive genius devised many new appliances—a planing-machine ("Nasmyth steam-arm"), a nut-shaping machine, steam pile-driver, hydraulic machinery for various purposes, &c. In his retirement he lived at Penshurst in Kent, and amused himself with the study of astronomy, even publishing a book on the moon in conjunction with Carpenter. He died in London on 7th May 1890. His *Autobiography*, edited by Dr Samuel Smiles, was published in 1883.

Nasr-ed-Din (1829–1896), Shah of Persia, was born 4th April 1829. His mother, a capable princess of the Kajar family, persuaded Shah Mohammed, his father, to appoint him heir apparent, in preference to his elder brothers; and he was accordingly made governor of Azerbaijan. His succession to the throne, 13th October 1848, was vigorously disputed, especially by the followers of the reformer El Bab, upon whom he wreaked terrible vengeance. In 1855 he re-established friendly relations with France, and coming under the influence of Russia, signed a treaty of amity, 17th December 1855, with that Power, but remained neutral during the Crimean war. In 1856 he seized Herat, but a British army under Outram landed in the Persian Gulf, defeated his forces, and compelled him to evacuate the territory. The treaty of peace was signed at Paris, 4th March 1857, and to the end of his reign he treated Great Britain and Russia with equal friendship. In 1866 the Shah authorized the passage of the telegraph to India through his dominions and reminted his currency in the European fashion. In 1873, and again in 1889, he visited England in the course of his three sumptuous journeys to Europe, 1873, 1878, 1889. The only results of his contact with Western civilization appear to have been the proclamation of religious toleration, the institution of a postal service, accession to the postal union, and the establishment of a bank. He gave the monopoly of tobacco to a private company, but was soon compelled to withdraw it in deference to the resistance of his subjects. Abstemious in habits, and devoted to music and poetry, he was a cultured, able, and well-meaning ruler, and his reign, already unusually long for an Eastern potentate, might have lasted still longer had it not been for the unpopular sale of the tobacco monopoly, which was probably a factor in his assassination at Tehran on 1st May 1896, by a member of the Babi faction. He was succeeded by his son Muzaffer-ed-din.

NATAL.

I. Geography and Statistics.

THE area of Natal was increased at the latter end of 1897 by the annexation of Zululand, including the British Amatongaland Protectorate. The colony comprised in 1901 an area of 31,307 square miles, with a seaboard of 376 miles. Lying between the 26th and 32nd parallels of S. latitude, it was bounded on the N. and N.W. by the Portuguese possessions and the Transvaal Colony (late South African Republic), on the W. by the Orange River Colony (late Free State) and Basutoland, and on the S. by the Cape Colony and Umtamvuna river. The area of the province of Zululand is estimated at 10,456 square miles, including the lake of St Lucia, which is about 680 square miles in extent. Nearly one-third of the province is comprised of a low-lying belt along the sea coast, from 20 to 30 miles in width, extending from the Umhlatuze river to the Portuguese possessions, which form its northernmost boundary. This belt is, for the most part, marshy, sparsely populated, and unhealthy for Europeans, especially during the midsummer months. The remainder of the country consists chiefly of an elevated plateau varying from 1000 to 5000 feet in height, and the climate here is healthy for Europeans. These uplands are abundantly watered, and to a considerable extent are suitable for both pastoral and agricultural purposes, particularly towards the west, south of the Umhlatuze river. Maize and other cereals form the principal articles of cultivation. All the magistracies are connected by waggon road, and regular postal communication is maintained between them by means of native runners.

As the result of the Boer war, a further addition was made in 1902 to the territory comprised in Natal, consisting of a portion of what had previously been included in the Transvaal Republic. The addition resulted from communications which passed between the Natal Government and Lord Milner at the end of 1901, and was sanctioned by the Imperial Government in March 1902. The Natal Government originally made two proposals for annexing new territory :—

1. It was proposed that the following districts should be transferred to Natal, viz., the district of Vryheid, the district of Utrecht, and such portion of the district of Wakkerstroom as was comprised by a line drawn from the north-eastern corner of Natal, east by Volksrust in a northerly direction to the summit of the Drakensberg Range, along that range, passing just north of the town of Wakkerstroom, to the head waters of the Pongola river, and thence following the Pongola river to the border of the Utrecht district. In consideration of the advantage to Natal from this addition of territory, Natal should take over £700,000 of the Transvaal debt.

2. It was proposed to include in Natal such portions of the Harrismith and Vrede districts as were comprised by a line following the Elands river north from its source on the Basutoland border to its junction with the Wilge river, and thence drawn straight to the point where the boundaries of Natal, the Transvaal, and the Orange River Colony meet on the Drakensberg. In consideration of this addition to her territory, Natal should take over a portion of the Orange River Colony debt, to be raised at the end of the war to the amount of £200,000.

The Imperial Government decided to sanction only the first of these two proposals, the reasons for this decision, with the result to Natal, being indicated in the following passage from Mr Chamberlain's despatch in March 1902 on the subject :—"The (1902) existing boundary between Natal and the Transvaal is not marked by strong natural

Sketch Map of Natal.

divisions, and is undoubtedly inconvenient—large wedges of Transvaal territory being interposed between the northern part of Natal and Zululand, while the natives of the districts to be transferred are closely allied to those of the adjoining portions of Natal. With regard to Vryheid this is pre-eminently so. The natives of Vryheid are Zulus, and still, as I understand, consider themselves as part of the nation; and it therefore will be a natural and convenient arrangement that they should be placed under the Zululand administration. The district was only separated from the rest of Zululand in 1883 by a raid of armed Boers, who established a republic, which was incorporated in the late South African Republic in 1888. In handing over this district to the administration which controls the rest of Zululand, His Majesty's Government feel that they are reuniting what ought never to have been separated. With regard, however, to the proposed transfer of territory from the Orange River Colony, the circumstances are different. There is no such historical reason as exists in the case of Vryheid for making the transfer. On the contrary, the districts in question have invariably formed part of the state from which it is now proposed to sever them, and they are separated from Natal by mountains which form a well-defined natural boundary. In these circumstances, His Majesty's Government have decided to confine the territory to be transferred to the districts in the Transvaal. These districts, according to such statistics as are available, appear to contain not less than 8000 white inhabitants and some 50,000 natives, and have an area of upwards of 7000 square miles, which will mean an addition to the white population of Natal of about one-seventh, to her native population of about one-sixteenth, and to her territory of about one-fourth."

Geology.—The geology of Natal and Zululand resembles to a great extent that of Cape Colony. The physical features are also very similar. In both cases the upland plateaux consist of the more or less horizontally bedded rocks of the Karroo formation, with its included coal and iron deposits; and here and there local outcrops of older sedimentary and metamorphic rocks have been exposed by denudation. This formation has produced interesting collections of fossil Reptilian and Batrachian remains, while in its coal-bearing series several genera of plants occur, together with the remains of Palæoniscid fish. Reptilian remains have been found in the neighbourhood of Weston, on the Mooi river and other localities in the Drakensberg, while fossil fish have been reported from the Biggarsberg. The coastal area of Natal and the southern portion of the littoral of Zululand are formed chiefly of Dwyka Conglomerate with the overlying Ecca shales, while the northern littoral of Zululand consists of Recent and Pleistocene sands overlying Mesozoic beds of Upper Cretaceous age. The Dwyka Conglomerate is extensively quarried near the mouth of the Umgeni river near Durban. In places distinct and undoubted evidence exists of the glacial conditions which obtained during its deposition. On the western side of the Inchanga granite this formation forms an extensive outcrop which extends through the colony. To the west of this outcrop the Dwyka and Ecca beds pass under the Karroo formation, and practically exist underlying that formation across the whole South African continent until they again crop out in the district of Kimberley, Griqualand West, and Bushmansland. The country intervening between the upland plateaux and the coastal area consists of granite, metamorphic, and sedimentary rocks which are older than the Dwyka Conglomerate, but which have not yet been satisfactorily correlated with the pre-Mesozoic rocks in other parts of South Africa. Of sedimentary rocks we have the horizontally and false-bedded sandstone series, which form the flat-topped mountains so characteristic of this region, and are classed by Dr Sutherland and Mr Griesbach as Table Mountain sandstones, and by Mr E. J. Dunn as belonging to the Witteberg and Zuurberg series of Cape Colony. Exposures of the fundamental rocks of the colony, granites, gneisses, and schists, occupy a considerable belt of country, passing from the coast near Port Shepstone in a north-easterly direction through Natal by Inchanga and the Noodsberg Mountain, and extending into Zululand, where they are exposed in the valleys, in the western portion of the province as far north as Melmoth, by the denudation of the overlying coal-bearing formation. To the east of Eshowe the Ungoye Mountains are formed of these rocks, and in the neighbourhood of the Hlabisa magistracy a small area of granite occurs. The minerals that are known to occur in the colony have chiefly been discovered in these granitic and metamorphic areas. Representatives of the formations younger than the Karroo are of rare occurrence, and are only present as outliers on the coast. These consist of rocks of Upper Cretaceous age. Wherever they are exposed these rocks contain large quantities of marine organisms. From a comparison of these fossils with those from the Cretaceous rocks of Southern India it has been deduced that they are of the same age as the Trichinopoly series of India. In the case of one form, *Ammonites Gardeni*, its occurrence is common to the Upper Cretaceous of Southern India, Australia, and Vancouver Island, Canada. In the neighbourhood of Lake Sibayi, towards the borders of Amatongaland, beds of Chalk occur, associated with the fossiliferous rocks. From the highest beds of the Karroo formation down to the lowest portion of the Ecca, the whole series is seamed with intrusive dykes and sills of volcanic rock, chiefly of a basaltic type, and rarely showing olivine as a constituent. In the coal-producing areas the intrusion of these basaltic rocks in close proximity to the seams of coal has frequently rendered them of little value by converting them into anthracitic coals of inferior quality or altogether burning them up. There are few, if any, coal-seams which have not locally undergone alteration or destruction from this cause. Natal possesses a valuable coalfield in Klip River county. In 1881 Mr F. W. North, who was engaged by the Government to report on the coalfields of the colony, estimated for the coalfield referred to "a total area of 1350 square miles that may be depended upon for supply." The number of producing collieries in 1898 was seventeen, situated between Elandslaagte and Newcastle.

The comparative outputs in the years specified were:—

1889.	1894.	1898.	1901.
25,609 tons.	141,010 tons.	387,811 tons.	567,460 tons.

A coalfield which will probably be of equal value exists in the coast and northern districts of Zululand, but in the absence of means of transport it is unworked. The area is at present very imperfectly known, but may be about 800 square miles. When opened the coal appears, as a rule, to be harder than in the Klip river coalfields, the general difference in the nature of the coals being somewhat similar to that between the Welsh and North of England coals. Near the Umlalazi river, on the Zululand coast, however, bituminous coals are found. The thickest seam worked on the Klip River coalfields gives 5 feet 3 inches of coal. One seam opened in a shaft near the Ingalazi river in Zululand gives over 40 feet of coal when cut, but diminishes in thickness away from the shaft. Iron ore and limestone are found on both the coalfields mentioned, but no iron-smelting is at present carried on.

Climate.—The following is the mean for the twelve years 1885–96:—

Mean of Temperature.	Degrees.
Maximum	80·42
Mean	71·82
Minimum	61·50
Rainfall in inches	40·19

Population.—The following return shows the increase of population at intervals of five years:—

Year.	Europeans.	Indians.	Natives.	Total.
1874	18,646	6,787	281,797	307,230
1879	24,654	16,999	319,934	361,587
1884	35,453	27,276	361,766	424,495
1889	37,390	33,480	459,288	530,158
1894	45,707	35,411	503,208	584,326
1898	53,688	61,103	787,574	902,365

The returns for 1898 include the population returns for the province of Zululand, viz., Europeans, 1305; Indians, *nil;* natives, 200,330. Of the Indian population, a large number are under indenture of service in the colony. Of the European population, one-fifth approximately is of Boer extraction. The two principal towns of the colony are Durban (*q.v.*) and Pietermaritzburg (*q.v.*). The third in importance is Ladysmith, situate 119¼ miles from Durban on the main line to Johannesburg. It is a military station, and has a population, exclusive of troops, of 1800 Europeans, 1200 Indians, and about 1000 natives. Newcastle, 268 miles by rail from Durban, has a population of about 1200 Europeans and about 1100 coloured people. The four above-mentioned towns have municipal corporations. Other towns are: Dundee, the centre of the coal-mining industry, with a population of about 2000; Verulam, the principal town of Victoria county, distant 20 miles north of Durban, with total population of about 1000; Greytown, Estcourt, Harding, Richmond, Stanger, Howick, Pinetown, Umzinto, Weenen, Port Shepstone, Eshowe (Zululand).

The Registrar-General gave the following returns for 1898:—

Total marriages (by Christian rites)	1211
Total births	2713
Total deaths	1075
Increase of population by births over deaths	1638

The above returns do not include natives or Indians, there being no complete system of registration as far as they are concerned.

The following is an abstract of the religious returns:—

Denomination.	Places of Worship.	Average Attendance.
Church of England	120	10,070
Church of Rome	23	7,040
Wesleyan Methodist	405	26,655
Other	226	18,984

A comparatively small number of the South African natives have embraced Christianity.

Constitution.—The affairs of the colony were administered, under the Royal Charter of 1856, by a Governor assisted by an Executive and a Legislative Council up to 1893, in which year responsible government was established. The Legislative Council, consisting of twelve members, is summoned by the governor in council. The Legislative Assembly is an elective body, and consists of thirty-nine members. There are fifteen electoral districts, including two for the province of Zululand. The ministers, six in number, must hold seats either in the Legislative Council or Legislative Assembly.

Instruction.—Education is not compulsory, nor is it free, except where it is certified that the parents or guardians are unable to pay the school fees. Of the European children, but a very small proportion do not receive education at one or other of the schools. The number of schools under Government inspection is as follows:—

		Attendance.
European	303	8,674
Native	184	10,243
Indian	32	3,214
	519	22,131

Included in the above are the following Government schools:—

		Attendance.
High schools	2	264
Primary schools	18	4834
Model ,,	5	
	25	5098

The number of free pupils attending Government schools during the year 1899 was 470. The school fees paid into the treasury for the year ending 30th June 1899 amounted to £7904. The expenditure by Government on education for year ending 30th June 1899 was £56,048. Although education in Natal is for the most part controlled by Government, there are a good many schools, both primary and secondary, which are not under inspection. These private and denominational schools are mostly doing excellent work. To encourage the instruction of the children of farmers and others who reside so far from a Government or Government-aided school that they cannot avail themselves of the education therein provided, the Government pays grants-in-aid at the rate of £3 for each pupil under Standard VI., and £4 for each pupil in Standards VI. and VII., attending farm schools. An excellent cadet system is in force at all the Government boys' schools, and is very popular. Under this system the boys receive a military training, are taught the use of firearms, and attend an annual encampment.

Finance.—The following are the figures for revenue and expenditure:—

	Revenue.	Expenditure.
1874	£249,249	£254,402
1879	473,478	490,826
1884	610,937	707,529
1889	1,327,105	1,146,080
1895–96	1,169,781	1,148,094
1898–99	2,019,361	1,951,835

The largest items of revenue are derived from the railway, customs, and native hut tax. The public debt, which in 1874 was £331,600, amounted in 1898–99 to £9,019,143.

Defence.—Before the Boer war (1899) a large force of Imperial troops was stationed in the colony, the principal garrison towns being Pietermaritzburg and Ladysmith. The local forces consisted of the Natal Police (650 mounted Europeans, 45 Indian constables, and 900 natives) and volunteers numbering nearly 2000, chiefly mounted. Rifle associations also existed all over the colony. Two batteries, of two 6-inch B.L. guns each, commanded the approach to Durban harbour, the guns being manned by the Natal Naval Volunteers.

Stock.—Generally speaking, it may be said that the country over a belt of fifteen miles along the coast is unsuited for stock-farming. Horse-breeding is successfully carried on in the upper districts. The higher the altitude the healthier the animals and the greater their immunity from disease. Horse-sickness, a kind of malarial fever, which takes an epidemic form in very wet seasons, causes considerable loss. Cattle-breeding is probably the most lucrative branch of stock-farming, the country being pre-eminently adapted for horned cattle. Rinderpest recently swept through South Africa, and probably carried off in Natal from 30 to 40 per cent. of the stock of Europeans, while the natives' losses were even heavier. Serum and bile inoculation were undoubtedly the means of saving a very large percentage of the herds. The farmers soon began to recover from their losses. Attention has been given to improving the breed of cattle by the introduction of Shorthorn, Devon, and Holstein (or Friesland) stock. The principal breed of sheep is the merino, which does well in the higher altitudes. A Scab Act is in force, and is stringently carried out by Government inspectors, with most satisfactory results. The Angora goat thrives well in certain districts. Ostriches do well in the dry, arid valleys of the Tugela and Mooi rivers. Summary of stock on 31st December 1898:—

Description.	European.	Indian.	Native.	Total.
Horses	32,771	593	24,611	57,975
Cattle	155,456	1025	122,077	278,558
Sheep	543,619	7	56,403	600,029
Goats	98,510	2352	351,528	452,390
Pigs	15,081	1124	20,499	36,704
Mules	2,300	...	...	2,300
Donkeys	1,360	...	...	1,360
Ostriches	720	...	...	720
	849,817	5101	575,118	1,430,036

These figures are inclusive of the province of Zululand.

Agriculture.—Mealies (or maize) continue to be the chief crop, forming the staple food of the natives. Tea is now being largely grown in the coast districts, and the industry is likely to increase in importance. Already the annual yield exceeds a million pounds, and it is believed that other districts will be found suitable for the growth of the plant. Sugar continues to be an important coast product; the output of 1898 was 30,000 tons. Large quantities of the black wattle tree (*Acacia mollissima*) are now being grown, the bark forming an important article of export. The value of the bark shipped in 1898 was £57,888; the wood of the tree also commands a ready sale. The cultivation on the coast of tropical fruits, such as pineapples, bananas, mangoes, citrus fruits, &c., is being annually extended. Other fruits—apples, peaches, plums, pears, &c.—do well in some of the midland and upper districts.

Commerce.—In 1898 a Customs Union Convention was concluded between the Governments of the Cape Colony, Orange Free State, and Natal "on the basis, firstly, of a uniform tariff on all imported goods consumed within the union; and secondly, of free trade between the colonies and states in respect of all South African products." The union tariff imposes taxes on imported foods and other goods the like of which is produced within the union, and allows the free importation of articles used in such production. The Transvaal did not join the union, but the Convention made provision for a rebate of the whole or any part of the customs duty on imported goods removed to a country outside the union. Of the total imports of merchandise into the colony, about one-third are entered in transit for the Transvaal. The following are the trade and shipping returns for the years specified:—

Year.	Imports.	Exports.	Customs Revenue.	Shipping.	
				Entered.	Cleared.
	£	£	£	tons.	tons.
1874	1,121,948	770,034	109,725	64,156	62,128
1879	2,176,356	583,711	228,558	207,029	205,054
1884	1,675,850	957,918	179,908	210,181	212,604
1889	4,527,015	1,656,318	369,461	513,360	499,748
1894	2,316,596	1,197,611	193,199	732,997	730,925
1899	5,359,259	3,097,184	430,699	1,367,306	1,381,346
1900	5,912,000	1,135,320	655,040	1,417,539	1,405,180
1901	9,416,000	4,268,820	812,375	1,826,526	1,767,900

In addition there were imported goods overland to the value of £161,000 in 1900 and of £233,000 in 1901. The analysis, as far as can be stated, of the imports for 1901 was as follows:—British manufacture, £6,523,000; colonial and Indian, £1,416,000; United States, £719,000; foreign, £898,000. The exports include goods sent in transit to the Transvaal.

Railways.—There are open for public traffic in Natal 545 miles of rails of single line and of the standard gauge for South Africa, viz., 3 ft. 6 in., the whole being worked by the colonial Government. The main lines extend from the port of Durban to Pietermaritzburg, the capital, 70 miles inland, and from thence to Charlestown, on the border of the Transvaal (309 miles distant from the port), where it connects with the line to Johannesburg and Pretoria. Near Ladysmith (190¼ miles from the port) there is a line of 59½ miles to Harrismith, Orange River Colony, the property of, and worked by, the Natal Government. Among the extensions is one from Pietermaritzburg to Greytown (64½ miles), of which 40 miles have been opened to Dalton. Another extension from Coal Fields, the terminus of the Dundee branch line to the Buffalo river (13 miles), is in hand, and will form the Natal section of the line between Vryheid, in the Transvaal, and Natal. A branch line extends northwards from Durban to the Tugela (70 miles), the terminus of the North Coast extension, at the border of the province of Zululand. Another branch runs from South Coast Junction (5 miles from Durban) to Park Rynie (36 miles), and an extension of that branch to Port Shepstone (about 36 miles) is in course of construction, as well as a branch of 7 miles to Umzinto. The work of railway construction was begun in January 1876, and the sections then authorized were completed in November 1880. Two subsequent sections of 119 and 114 miles respectively were sanctioned, and the last, which completes the main line to Charlestown on the border of the Transvaal, was opened for passenger traffic on 7th April 1891, and for goods traffic on 1st August 1891. The line to Harrismith was opened for traffic on 14th July 1892, with a mileage of 59½ miles, 23½ of which runs through Orange River Colony. Connexion with Johannesburg and Pretoria was opened at the close of 1895. As might be expected in a country possessing the physical features of Natal, the gradients and curves are exceptionally severe. Out of the present mileage not less than 43 miles are upon grades of 1 in 30 and 1 in 35, and curves of 300 to 350 feet radius, while on over 100 miles more there are grades under 1 in 60 and curves of less than 450 feet radius. The main trunk line reaches an altitude of 3054 feet above the level of the sea at a point 58 miles distant from Durban; after falling 1000 feet in its further progress to Pietermaritzburg, it again rises, 12 miles after leaving that city, to a height of 3700 feet above the sea; at a point 134 miles from Durban it has reached an altitude of 5152 feet, but on reaching Ladysmith, 191 miles from Port Natal, the altitude has decreased to 3284 feet. The summit of the Biggarsberg chain is crossed at a point 233 miles from the port, at a height of 4800 feet, and when the border is reached, after crossing the western slope of the Drakensberg mountains, the train will have again gained a higher eminence than ever, the altitude being about 5400 feet. The Orange River Colony line, after leaving Ladysmith, ascends by steep gradients the whole of its own course in Natal territory, and when it gains the border on the summit of the more easterly point of the Drakensberg range, it is 5500 feet above the sea. In view of the great development of South Africa, every possible means is being taken in surveys to get lines with easier grades than the earlier lines, even at an enhanced first cost, it being found that the difficulties and expenses connected with working over steep gradients far outweigh the interest on the additional capital expenditure involved in obtaining better lines.

The following is a summary of railway statistics covering a period of 19 years:—

Year.	Miles of Line open. Average.	No. of Passengers conveyed.	Tonnage of Goods.	Capital invested on Open Lines.	Net Receipts per cent. of Capital.	Revenue.	Expenditure.
1881	98½	427,969	171,081	£1,204,416	£4 18 10	£173,109	£113,587
1885	116	424,367	192,457	£2,594,414	0 5 5	£135,548	£142,592
1890	285	641,648	301,753	£3,650,591	5 4 3	£606,713	£416,396
1895	401	422,002	393,379	£6,117,211	4 1 0	£526,494	£278,756
1899	518	1,428,317	976,987	£7,267,588	4 5 7¾	£940,100	£628,942

Harbour Works.—A very important feature in the progress of the colony is the success of the works undertaken to reduce the difficulties presented by the sandbar at the entrance to Durban harbour. These works comprise chiefly a south breakwater and north pier, narrowing the entrance to 600 feet. Powerful dredgers are also constantly at work on the bar. The effect of these operations has been to treble the depth of water, as will be seen from the following return of average depths on the bar at low water, o.s.t.:—

1874.	1879.	1884.	1889.	1894.	1899.
6′ 5½″	6′ 6¾″	7′ 1¾″	11′ 4½″	11′ 11″	19′ 7½″

The rise of tide is 6 feet at springs, and 4 feet 1 inch at neaps. The tonnage of ships entering the harbour has increased from 59,532 in 1884 (no previous returns) to 1,147,636 in 1899. The length of wharfage has increased from 266 feet in 1874 to 4900 in 1899, and the area covered by wharf sheds is 26½ times greater than it was in 1884, while the port revenue has more than doubled in that time. The annual expenditure on the work required to effect these changes has of course been considerable, and amounted during 1899 to £136,900. No further extension of the outer works is at present contemplated, but the superstructure of the north pier has yet to be finished. The construction of a quay wall with sheds, hydraulic cranes, lines of way, &c., is being rapidly pushed forward. The depth along the quay wall is 23 feet below low water, and it is proposed later to provide a depth of 27 feet alongside at low water. The site of the quay wall and part of the timber wharfage was a few years ago banks dry at half tide: a vessel of 10,200 tons can now be moored at one of the berths of this part of the wharf. There are seven dredgers and two steam hopper barges constantly employed, and the annual output from them is about 3,000,000 tons.

Banking and Credit.

Capital subscribed	£8,255,110
Paid up	3,211,238
Notes in circulation	221,710
Deposits	2,486,330

Money, Weights and Measures.

English, except as regards the muid = 180 lb.

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II. RECENT HISTORY.

At the conclusion of the first Boer war in 1881, the chief engagements of which were fought in the northern extremity of Natal, Sir Evelyn Wood was commander-in-chief of her Majesty's forces. He was also appointed for a short time administrator of Natal, and on his departure for England, after a final arrangement for the cession of the Transvaal, he was succeeded by Colonel (afterwards Sir Charles) Mitchell as administrator. In 1882 Sir Henry Bulwer was sent to Natal with the full title of governor, and in 1886 was succeeded by Sir Arthur Havelock. The feeling of the colonists after the retrocession of the Transvaal was extremely bitter. At Ingogo, Majuba, and Laing's Nek, all of them situated within the colony, British forces had been defeated by the Boers. And the treaty of retrocession was never regarded in Natal as anything but a surrender. Public meetings were held at various towns, and the resolutions passed at them, in the light of subsequent events, are of significance and interest. Thus at Newcastle, on 30th March 1881, a public meeting of loyal refugees and colonists resolved "That the Dutch communities of South Africa, having coalesced, and solicited the assistance of Dutch military officers to help them to establish a Boer Republican Government over the whole of South Africa, it becomes necessary for British-born colonists to organize in self-defence." On 6th April 1881 a resolution was passed at a public meeting in Durban, presided over by the mayor, and cabled to members of Parliament in London. "Durban public opinion: Utter disgust with settlement, British prestige with our natives entirely forfeited. No consideration for loyal Boers nor British residents. Terms of peace simply mean greater bloodshed at no distant date." The protest was vain. The treaty was finally concluded. The Transvaal Republic was established, and the prediction of the practical colonists of Durban, ignored at the time, was afterwards fulfilled to the letter. In justice, however, to the colonists of Natal, it must be recorded that, finding their protest with regard to the Transvaal settlement useless, they made up their minds to shape their policy in conformity with that settlement. But it was not long before their worst fears with regard to the Boers began to be realized, and their patience was once more severely taxed. The Zulu power (see ZULULAND), which had always been a menace to Natal as well as the Transvaal, was broken in 1879 by British forces. After the settlement intestine quarrels arose among the petty chiefs, and in 1883 some Transvaal Boers intervened, and subsequently, as a reward for the assistance they had rendered to one of the combatants, demanded and annexed 8000 square miles of country, which they styled the "New Republic." As the London Convention had stipulated that there should be no trespassing on the part of the Boers over their specified boundaries, and as Natal had been the basis for those operations against the Zulus on the part of the British in 1879, which alone made such an annexation of territory possible, a strong feeling was once more aroused in Natal. The "New Republic" was nevertheless allowed to remain, and in 1887 the British consented to the territory being incorporated with the Transvaal.

In 1884 the discovery of gold in De Kaap Valley, and on Mr Moodie's farms in the Transvaal, caused a considerable rush of colonists from Natal to that country. Railways were still far from the Transvaal border, and Natal not only sent her own colonists to the new fields, but also offered the nearest route for prospectors from Cape Colony or from Europe. Durban was soon thronged; and Pietermaritzburg, which was then practically the terminus of the Natal railway, was the base from which nearly all the expeditions to the gold-fields were fitted out. Waggons and oxen were in great demand, and convoys laden with stores and material for the camps at Moodie's and the new township of Barberton were daily despatched from both Durban and Pietermaritzburg. The journey to De Kaap by bullock-waggon occupied about six weeks. "Kurveying" (the conducting of transport by bullock-waggon) in itself constituted a great industry. Two years later, in 1885, gold was also discovered at the Witwatersrand, and the tide of trade which had already set in with the Transvaal steadily increased. Natal colonists were not merely the first in the field with the transport traffic to the new gold-fields; they became some of the earliest proprietors of mines, and for several years many of the largest mining companies had their chief offices at Pietermaritzburg or Durban.

The demand which the new industry made upon the one port of Natal, Durban, encouraged the colonists to redouble their efforts to improve their harbour. The question of a fairway from ocean to harbour has been a difficult one at nearly every port on the African coast. A heavy sea from the Indian Ocean is always breaking on the shore, even in the finest weather, and at the mouth of every natural harbour a bar occurs. The bar in its natural state is a shallow, shifting, submarine mass of sand, on which fresh sand is continually being deposited, and over which the water is frequently not more than a few feet deep. Over the "bar" the waves break, and often the surf is so high that only surf-boats—that is, barges battened down—in tow of specially-built steam tugs, can attempt to cross it. To deepen the channel over the bar at Durban so that steamers might enter the harbour was the cause of labour and expenditure for many years. Piers and jetties were constructed, dredgers imported, and controversy raged over the various schemes for harbour improvement. In 1881 a harbour board was formed, under the chairmanship of Mr (afterwards Sir Harry) Escombe. It controlled the operations for improving the sea entrance until 1893, when on the establishment of responsible government it was abolished. Success so far crowned their efforts that in 1899 the bar channel was reported to have, even at low water, a depth of about 19 feet. In order to cope with the growing trade, however, the railway system has been continually developing.

For many years Sir John Robinson led a party in Natal which agitated for a responsible form of government. In 1893 a Bill in favour of this change was introduced into the Legislative Council, and passed. The British Government gave their consent to the Bill, and the Constitution Act of 1893 became law. Sir John Robinson, K.C.M.G., was the first colonial secretary and premier under the new constitution, and Mr Harry Escombe, Q.C., the first attorney-general. In the same year the Hon. Sir Walter Hely-Hutchinson was appointed Governor of the colony. In 1898 Natal entered the Customs Union already existing between Cape Colony and Orange Free State.

In May 1899 the Natal Government began to suspect the nature of the military preparations that were being made by the Boers, and their apprehensions were communicated to the High Commissioner, Sir Alfred Milner, who telegraphed on 25th May to Mr Chamberlain, informing him that Natal was uneasy. When war became probable the Governor expressed his views to the Prime Minister that the Natal Government ought to give the British Government every support, and Sir John Robinson replied that their support would of course be given, but at the same time he feared the consequences to Natal if after all the British Government should draw back. Some further correspondence took place, in the course of which the Natal ministers pointed out that as in the event of war Natal would probably become the seat of operations, and would support the British Government, they would incur the "suspicion and unfriendly feelings" of the Free State and Transvaal. The Natal ministers therefore considered that in the circumstances they should not be exposed to attack by the action of the Imperial Government without first having an opportunity of expressing their opinions. In July the Natal ministry learnt that it was not the intention of the Imperial Government to endeavour to hold the frontier in case hostilities arose, but that a line of defence considerably south of the frontier would be taken up. This led to a request on their part that if the Imperial Government had any reason to anticipate the breakdown of negotiations, "such steps may be at once taken as may be necessary for the effectual defence of the whole colony." Sir W. P. Symons, the general commanding the British forces in Natal in September, decided to hold Glencoe. On the arrival of Sir George White from India, he informed the Governor that he considered it dangerous to attempt to hold Glencoe, and urged the advisability of withdrawing the troops to Ladysmith. The Governor was strongly opposed to this step, as he was anxious to protect the coal supply, and also feared the moral effect of a withdrawal. Eventually Sir A. Hunter was consulted, and stated that in his opinion, Glencoe being already occupied, "it was a case of balancing drawbacks, and advised that, under the circumstances, the troops be retained at Glencoe." This course was then adopted.

On 11th October 1899 war broke out. The first act was the seizure by the Boers of a Natal train on the Free State border. On the 12th Laing's Nek was occupied by the Boer forces, who were moved in considerable force over the Natal border. Newcastle was next occupied by the Boers unopposed, and on 20th October occurred the battle of Talana Hill outside Dundee. In this engagement the advanced body of British troops, 3000 strong, under Sir W. Penn Symons, held a camp called Craigside which lay between Glencoe and Dundee, and from this position General Symons hoped to be able to hold the northern portion of Natal. There is no doubt that this policy strongly commended itself to the Governor and ministers of Natal, and that they exercised considerable pressure to have it adopted. But from a military point of view it was not at all cordially approved of by Sir George White, and it was afterwards condemned by Lord Roberts. Fortunately only one Boer division out of three was actually present at the moment of attack, and General Symons was able to inflict a severe defeat upon them at Talana Hill. His bravery cost him his life. General Yule then took command, and an overwhelming force of Boers rendering the further occupation of Dundee dangerous, he decided to retire his force to Ladysmith. On 21st October General Sir George White defeated at Elandslaagte a strong party of Boers, who threatened to cut off General Yule's retreat. He again attacked the Boer forces at Rietfontein on 24th October, and on the 26th General Yule reached Ladysmith with his force in safety. Ladysmith now became for a time the centre of further operations. The Boers gradually surrounded the town and cut off the communication from the south. Various engagements were fought in an attempt to prevent this movement, including the disastrous mishap at Nicholson's Nek, when on 29th October a large British force was cut off and was compelled to surrender, and the battle of Farquhar's Farm on the 30th, during the course of which Captain Hedworth Lambton arrived from Durban with some naval guns and a party of bluejackets. The siege of Ladysmith continued till 28th February 1900, when, after various attempts to relieve the beleaguered garrison, Sir Redvers Buller's forces at last entered the town. During the six weeks previous to the relief, 200 deaths had occurred from disease alone, and altogether as many as 8424 were reported to have passed through the hospitals. The relief of Ladysmith soon led to the evacuation of Natal by the Boer forces, who trekked northwards.

During the Boer invasion the Government and the loyal colonists, constituting the great majority of the inhabitants of the colony, rendered the Imperial forces every assistance. One distinguished colonist, Sir Harry Escombe, widely respected and beloved, died before he could see his country once more freed of the enemy. He had gone at the outbreak of hostilities to Newcastle, where he hoped to be able to make some show of defence, but he was compelled to leave with the rest of the loyal inhabitants, and took part in the retreat from Dundee. The strain was too much for him, and being in delicate health at the time, he died shortly afterwards. In the actual hostilities the Natal Volunteers and other Natal forces took a prominent part. The Imperial Light Horse and other irregular corps were recruited in Natal, although the bulk of the men in the forces were Uitlanders from Johannesburg. As the nearest colony to the Transvaal, Natal was resorted to by a large number of men, women, and children who were compelled to leave the Transvaal on the outbreak of the war. Refugee and Uitlander committees were formed both at Durban and Maritzburg, and, in conjunction with the colonists, they did all in their power to assist in recruiting irregular corps, and also in furnishing relief to the sick and needy. Natal was the theatre of some of the most arduous fighting during the whole course of the war (see TRANSVAAL), and the brunt of it was shared by her colonists with the Imperial forces.

AUTHORITIES.—PEACE. *The Colony of Natal.*—INGRAM. *Natalia.*—PRATT. *Leading Points in South African History.*
(A. P. H.)

Natal, a town and port of Brazil, situated in an estuary of the Rio Grande, and capital of the state of Rio Grande do Norte. It has a naval training school, an agricultural society, four churches, a cotton mill, &c. It is the principal port of the state. The chief exports are cotton, leather, rubber, butter, woods, and sugar. A railway runs from Natal to the frontier of Parahyba, through the most productive part of the state. Population about 60,000.

Natalie, QUEEN OF SERVIA. See MILAN, KING.

Natanz, a minor province of Persia, situated in the hilly district between Isfahán and Kashan, and held in fief by the family of the late Hissám es Saltaneh (Sultan Murad Mirza, died 1882), grand-uncle of the shah. It contains eighty-two villages and hamlets, has a yearly revenue of about £4000, and a total population of about 23,000. It is divided into four districts: Barzrúd, Natanzrúd, Tarkrúd, and Bádrúd. Natanz pears are famous throughout the country. The western part of the province is traversed from north to south by the high-road between Kashan and Isfahán, and has the well-known stations of Kuhrúd (7140 feet) and Só (7560 feet). The capital of the little province is NATANZ, a large village with a population of about 3000, situated 69 miles north of Isfahán, at an elevation of 5670 feet. It has an old mosque, with a minaret 123 feet in height, built in 1315.

Natchez, a city of Mississippi, U.S.A., capital of Adams county, on the east bank of the Mississippi river, and on the New Orleans and North-Western and the Yazoo and Mississippi Valley railways, in the south-western part of the state, at an altitude of 202 feet. Situated in the midst of a rich cotton-producing region, its industries are mainly connected with that staple. It has cotton mills, cotton-seed oil mills, gins, &c., and has a large cotton trade by rail and river. Population (1890), 10,101; (1900), 12,210, of whom 382 were foreign-born and 7090 negroes.

Natick, a town of Middlesex county, Massachusetts, U.S.A., on the Charles river, a few miles west of Boston, in the eastern part of the state, on the Boston and Albany Railroad. It contains a village, of irregular plan, which bears the same name. It has manufactures of varied character, among them boots and shoes and rubber goods. Population (1890), 9118; (1900), 9488, of whom 1778 were foreign-born.

National Debt.—Under the headings for the different countries of the world will be found details concerning the recent history and statistics of their respective public debts. The general subject of National Debts has been treated fully in the earlier volumes of this Encyclopædia (ninth edition, vol. xvii.), and in this supplementary article it will only be necessary to summarize the leading facts concerning the principal nations, and to deal with some of the newer problems which have arisen concerning the National Debt of the United Kingdom.

Debts of the world.

The following table shows the general state of the world's public indebtedness in 1900, divided according to the more important countries, the bracketed figures in black type indicating the position of the country referred to under each heading in the list. The figures in every case are not to be supposed to be absolutely accurate; statistics of national debts differ, often remarkably, and it is practically impossible to give a perfectly satisfactory comparison, owing partly to difficulties of computing the exchange, partly to inaccurate accounts, and partly to the varieties of debt (reproductive or non-reproductive, &c.); but, broadly speaking, the table shows the state of affairs, and may be compared with that given in vol. xvii.

The Principal Public Debts of the World, 1900.

Country.	Population.	Total Debt.		Per Head.		Annual Charge.		Per Head.	
THE UNITED KINGDOM	40,909,925	**(3)**	£628,978,782	**(11)**	£15 7 6	**(4)**	£23,216,657	**(11)**	£0 11 4
BRITISH DOMINIONS OVER SEA—									
India	230,000,000	**(9)**	210,323,937	**(24)**	0 18 6	**(11)**	6,595,732	**(23)**	0 0 6
Australian States	3,707,905	**(10)**	195,324,717	**(2)**	52 13 0	**(9)**	7,595,074	**(2)**	2 1 0
New Zealand	815,820	**(23)**	47,874,452	**(1)**	58 12 0	**(22)**	1,717,910	**(1)**	2 2 0
Canada	5,338,883	**(21)**	53,254,689	**(14)**	10 0 0	**(21)**	2,678,496	**(13)**	0 10 0
Cape Colony	1,527,224	**(24)**	27,884,078	**(8)**	18 5 0	**(23)**	1,331,737	**(6)**	0 17 5
Natal	902,365	**(25)**	9,019,143	**(15)**	10 0 0	**(24)**	350,204	**(16)**	0 7 9
France	38,517,975	**(1)**	1,086,215,525	**(4)**	28 4 0	**(1)**	49,844,652	**(4)**	1 5 11
Russia	129,211,113	**(2)**	656,000,000	**(19)**	5 2 0	**(2)**	29,000,000	**(18)**	0 4 7
Austria	25,886,000	**(6)**	358,438,000	**(12)**	13 16 11	**(6)**	14,067,000	**(10)**	0 11 6
Hungary	19,203,531	**(11)**	184,600,000	**(16)**	9 14 0	**(8)**	11,977,640	**(9)**	0 12 6
Italy	32,449,754	**(4)**	586,000,000	**(9)**	18 0 0	**(3)**	27,000,000	**(7)**	0 16 7
United States of America	76,303,387	**(8)**	292,216,265	**(21)**	3 15 6	**(10)**	6,709,026	**(20)**	0 1 9
Spain	18,089,500	**(5)**	433,283,066	**(5)**	24 1 5	**(5)**	16,742,285	**(5)**	0 18 2
Turkey	23,880,000	**(13)**	170,000,000	**(18)**	7 0 0	**(13)**	5,148,450	**(19)**	0 4 3
Egypt	9,734,000	**(16)**	103,372,000	**(13)**	10 12 4	**(15)**	4,222,379	**(15)**	0 8 8
Prussia	34,472,509	**(7)**	329,584,000	**(17)**	9 7 6	**(7)**	13,923,170	**(17)**	0 7 5
German Empire	56,345,000	**(14)**	118,554,789	**(22)**	2 2 1	**(16)**	3,794,461	**(22)**	0 1 4¼
Portugal	5,049,729	**(12)**	177,192,795	**(3)**	35 0 0	**(14)**	4,434,243	**(8)**	0 15 10
Holland	5,104,137	**(18)**	96,561,287	**(7)**	18 18 0	**(20)**	2,926,553	**(12)**	0 11 1¼
Belgium	6,744,000	**(15)**	104,551,000	**(10)**	15 13 6	**(17)**	3,320,404	**(14)**	0 9 9
Japan	43,759,577	**(22)**	52,903,000	**(23)**	1 4 2	**(18)**	3,176,759	**(21)**	0 1 5
China	390,000,000	**(20)**	55,000,000	**(25)**	0 3 0	**(19)**	3,000,000	**(24)**	0 0 2
Argentina	4,400,000	**(17)**	103,000,000	**(6)**	23 12 0	**(12)**	6,301,419	**(3)**	1 8 7
Brazil	17,000,000	**(19)**	81,710,000	**(20)**	4 16 0		...		...

The total indebtedness of the countries named in the table amounts to £6,311,017,478, and the total indebtedness of the world (*i.e.*, including countries not here mentioned) for the year 1898 was computed by Lord Avebury (*Journ. Roy. Stat. Soc.* vol. lxiv. Part I.) as £6,432,757,000, as against £5,097,910,000 in 1888. This compares (taking figures compiled by Mr Dudley Baxter in *Journ. Roy. Stat. Soc.* March 1874) with a total indebtedness of 4680 millions sterling in 1874 and 1700 millions sterling in 1848. The United Kingdom had diminished its total debt since 1883 by 127 millions, the amount per head by £6, the annual charge by 6 millions, and the charge per head by 5s. 8d. The United States debt was lower by nearly a hundred millions. Japan, Egypt, and Brazil had sensibly improved their positions. But the following countries had increased their debts:—France (by 86 millions), Russia (by some 240 millions[1]), Italy (by 140 millions), Austria-Hungary (by 70 millions), Spain (by 190 millions), Prussia (by 227 millions), Portugal (by 80 millions), Holland (by 18 millions), Belgium (by 32 millions), and Argentina (by 73 millions).

The result is that, whereas in 1883 the total debt of the United Kingdom (756 millions) stood second to that of France (1000 millions), in 1900 it stood third to France and Russia; whereas in 1883 its weight per head of population was third, in 1900 it was eleventh; whereas in 1883 its annual charge stood second, in 1900 it stood fourth; and whereas the weight of the charge per head of population in 1883 was fifth, in 1900 it was eleventh. The indebtedness of the great British dependencies, on the other hand, had increased from 302 millions to 544 millions sterling, or by 242 millions; and the local (municipal) debt of Great Britain had risen from about 100 millions to upwards of 300 millions.

History of British debt.

It is interesting to recall the history of the British National Debt during the 19th century. The debt at the close of the Napoleonic war (1816) was nearly 887 millions sterling, and at the beginning of 1900 this debt had been reduced to 621 millions,[2] or a decrease of 266 millions—notwithstanding interim additions of about 367 millions, which made the gross reduction during that period 633 millions sterling, an amount actually larger than the whole (dead-weight[3]) debt at the end of the century. No country (except the United States, to a smaller amount) has ever redeemed its obligations on such a scale, and this was done while all other European countries of similar standing were piling up debt.

This enormous reduction was effected at different rates of speed. Between 1817 and 1830, when what was known as Pitt's Sinking Fund was in operation (depending upon the devotion of surplus income to the repayment of debt, but much complicated by the raising of fresh loans), a net reduction was made of £29,488,072—an *annual average* of £2,268,313. From 1830 to 1876 the system of using surplus revenue—the so-called Old Sinking Fund—for redeeming debt, was steadily applied, together with the creation of Terminable Annuities (see ANNUITIES, vol. xxv. p. 452), by which definite blocks of debt were cancelled and the whole amount paid off in a term of years. During this period the debt was reduced by £85,175,782, an *annual average* of £1,851,647. In 1876 Sir Stafford Northcote's (Lord Iddesleigh's) New Sinking Fund came into operation, in addition to previous methods of redeeming debt. By this system a definite annual sum was set aside for the service of the debt, the difference between it and the amount required for payment of interest forming a (new) Sinking Fund devoted to repayment of capital. This Fixed Charge was gradually reduced from about 29 millions to 26 millions in 1888, to 25 millions in 1890, and to 23 millions in 1899. The amount paid off during this period by means of Old Sinking Fund, Terminable Annuities, and New Sinking Fund, down to March 1900, was £155,238,639, or an *annual average* of £6,468,276.

It will be observed that the burden of the debt incurred previously to 1817 has thus been borne very unequally by different ages of "posterity." While the generations immediately succeeding the Napoleonic war paid off about £2,000,000 a year, the taxpayers between 1876 and 1900 paid at three times that rate. They did so largely without knowing it, since a large part of the amount was wrapped up in the Terminable Annuities; but it is very questionable justice that so large a proportion of the burden should have been imposed upon them. At any rate, there is clearly a good deal to say on the other side, should present-day financiers argue that posterity (a later posterity still) must not be asked to take its share of the burden of new debt raised to relieve the taxpayers who have been paying so large a proportion of the old one.

Consols.

The great bulk of the funded National Debt consists of what are known as "Consols." This name dates from 1751, when nine different Government annuities at 3 per cent. were consolidated into one, amounting to £9,137,821. These "consolidated annuities" formed the germ of what has since become the type of British Government stock. At the same time some of the annuities at a higher rate of interest were combined and the interest reduced to 3 per cent., and this stock was known as "Reduced," the two 3 per cent. stocks remaining side by side, until in 1854 the $3\frac{1}{4}$ per cent. Government stock was also converted into 3 per cents., under the style of "New Threes." "Consols," "Reduced," and "New Threes" formed thenceforth a solid body of British Three per Cent. stock, until in 1888 the whole amount was converted by Mr (afterwards Lord) Goschen into $2\frac{3}{4}$ per cents. (see NATIONAL DEBT CONVERSIONS). "Consols" were added to from time to time when fresh loans were needed: from 39 millions in 1771 they rose to 71 millions in 1781, to 101 millions in 1783, 278 millions in 1801, 334 millions in 1811, and 400 millions in 1858; but in 1888 they had decreased, by redemptions, to £322,681,035. "Reduced" were also added to: from 17 millions in 1751 they rose to 164 millions in 1815, and then gradually diminished to 102 millions in 1869, and to £68,912,433 in 1887, when they were converted with "Consols" into the New Consols (or "Goschens") at $2\frac{3}{4}$ per cent., to be reduced to $2\frac{1}{2}$ per cent. in 1903.

The lowest price ever quoted for "Consols" was $47\frac{3}{8}$ on 20th September 1797, owing to the mutiny at the Nore; the highest was 114 in 1896, owing to scarcity of stock, the operation of the sinking funds, and the demand for investment of savings bank moneys.

The high premium to which Consols rose towards the end of the century may be briefly explained. *Pari passu* with the reduction of the debt went a dwindling of the amount of Consols open to investors, and hence occurred a continued normal appreciation of the stock. In 1817 the amount of British Government stock per head of the population was £40 10s.; in 1896 this figure had decreased to £14 12s. The ordinary law of supply and demand would therefore in any case tend to increase the price of Government stock. This has always happened. The amount of Three per Cents. diminished from 528 millions in 1817 to 498 in 1827, and to 497 in 1837, and the average prices in these years were 73, 83, and 90; additions were made to the stock, and in 1847 (the amount being 510 millions) the price was $86\frac{3}{8}$; again the amount decreased, and in 1852 (500 millions) the price was 98; then a great conversion raised the amount to 734 millions in 1854, and the price went down to $90\frac{1}{2}$; but by 1887 the amount decreased by about 200 millions, and the price rose well above par; and though the reduction in interest in 1888 set back the price, it rose again as the amount of available stock diminished. Many causes, into which it is not necessary to enter, operated no doubt in keeping up the demand for British Government credit. Moreover, apart from the fact that in 1882 there were 689 millions of Three per Cents., and in 1900 only 501 millions of $2\frac{3}{4}$ per cents. in existence, the amount held by Government departments, and therefore practically locked up from the market, gradually

[1] It is difficult to compute the Russian debt properly, but the figure for 1883 given in vol. xvii. (640 millions) is clearly wrong. It should have been £416,000,000 for interest-bearing debt.

[2] Leaving out of account 8 millions of unfunded debt raised for the Boer war.

[3] The "dead-weight" debt, or national debt proper, excludes what are treated in the public accounts as "other capital liabilities," the interest on which is not included in the fixed charge; but it is taken to include the new debt of all sorts raised in 1900, 1901, and 1902 for the Boer war.

increased, until from this cause alone the amount of available stock was diminished by upwards of 200 millions; and a large amount more was practically locked up by being held by trustees, or by banks, insurance societies, &c. The savings banks deposits, increasing as they did by about £1,000,000 per month (owing partly to the raising in 1894 of the maximum limit), had to be invested in Government securities; and the compulsory activity of the Government as a buyer of Consols, both on this account and also for Sinking Fund purposes (in order to obtain stock to redeem debt on the increased scale already indicated) operated as an abnormal cause for sending the price of Consols high above par. Even at that figure (the average prices for Consols being $101\frac{1}{16}$ in 1894, $106\frac{1}{8}$ in 1895, $110\frac{3}{4}$ in 1896, $112\frac{15}{32}$ in 1897, $110\frac{15}{16}$ in 1898, and $106\frac{7}{8}$—having fallen owing to war prospects—in 1899) it was difficult for the Government brokers to obtain Consols, and it was principally owing to this state of things that in 1899 Sir Michael Hicks-Beach reduced the fixed annual charge for the debt (and *pro tanto* the New Sinking Fund) from £25,000,000 to £23,000,000.

It remains to give the figures for the British National Debt in 1902, after the disturbance due to the South African war. During the years 1900 and 1901 the new sinking fund was suspended, as well as the payments on the Terminable Annuity debt applicable to repayment of capital (except in so far as annuities to individuals were concerned); so that the debt was not reduced, as it would otherwise have been, by £4,547,000 in 1900 and by £4,681,000 in 1901. On the contrary, it was increased by fresh borrowings. Consols were raised (in 1901 and 1902) to the extent of £92,000,000; a "War Loan" of $2\frac{3}{4}$ per cent. stock and bonds, redeemable in 1910, was raised (1900) to the amount of £30,000,000; $2\frac{3}{4}$ per cent. exchequer bonds were raised (in 1900) to the amount of £24,000,000, and Treasury bills (in 1899 and 1900), £13,000,000. The total war borrowing amounted accordingly to £159,000,000, raised at a discount of (£6,585,000) 4·14 per cent. This includes the whole new borrowing in 1902, a portion of which was intended after the peace to be paid back in the current year; but for this no allowance can here be made. The accompanying table shows the totals for the "dead-weight debt" in 1900, 1901, and 1902, and, for convenience, also the "other capital liabilities."

	"Dead-weight Debt."	Chief Cause of Difference.[1]	"Other Liabilities."
31st March 1900	£628,978,782	+"War Loan," £30,000,000	£10,186,482
" 1901	690,992,621	+Exch. Bonds, 24,000,000	
		+Treas. Bills, 5,000,000	14,731,256
" 1902	747,876,000	+Consols, 60,000,000	20,532,000
July 1902	779,876,000	+Consols, 32,000,000	

"Other liabilities" it must be remembered, represent money advanced (generally by Terminable Annuity) on reproductive objects—telegraphs, barracks, public works, Uganda railway, &c.—and they could not, obviously, be properly included in the National Debt unless at the same time a set-off were made for the valuable assets held by the British Government, such as the Suez Canal shares, which in 1902 were alone worth upwards of £26,000,000. (H. CH.)

National Debt Conversions.—The great bulk of the funded debt of the United Kingdom consists of annuities, which are described as perpetual, because the state is under no obligation to pay off at any time the capital debt which they represent. All that the public creditor can claim is to receive payment of the instalments of annuity as they fall due. On the other hand, the Government has the right to redeem the annuities ultimately by payment of the capital debt; though it may, and frequently does, bind itself not to exercise that right as regards a particular stock of annuities until after a definite period. So long as a stock is thus guaranteed against redemption, the only way in which the annual charge for that portion of the debt can be reduced is by the Government buying back the annuities in the open market at their current price, which may be more or may be less than the nominal debt, according to general financial conditions and to the state of the national credit. The liability of the stock to redemption at par, when the period of guarantee has expired, prevents its market price from rising materially above that level. To enable the right of compulsory redemption to be enforced, it is only necessary that the Government should have command of sufficient funds for the purpose of paying off the stockholders, or should be able to raise those funds by borrowing at a rate of interest lower than that borne by the stock. Any circumstances which might tend to raise the price of the stock above par would also assist the Government in raising its redemption money on more favourable terms. When the amount of stock to be dealt with is large, the raising by a fresh loan of the amount required for redemption would occasion great disturbance. A more convenient method is the conversion of the existing stock to a lower rate of interest by agreement with the stockholders, whose reluctance to accept a reduction of income is overborne by their knowledge that the power of redemption exists and will be put in force if necessary. The opportunity for conversion may be looked for when the price of a redeemable stock stands steadily at or barely above par. Observation of the movements in the price of other securities will serve to show whether this stationary price represents the real market value of the stock, or whether that value is subject to depression owing to an expectation of the stock being converted or redeemed. Accordingly, the course of prices of other Government stocks which are free from the liability to redemption, of the stocks of foreign countries and the colonies, and of the large municipalities, must be watched by Government in order to determine, first, whether the conversion of a redeemable stock is feasible, and, secondly, to what extent the reduction of the interest in the stock may be carried.

The credit for the first measure of conversion belongs to Walpole, though it was carried through by Stanhope, his successor as Chancellor of the Exchequer. In
1717.
1714 the legal rate of interest for private transactions, which had been fixed at 6 per cent. in the year of the Restoration, was reduced to 5 per cent. by the Act 12 Anne, stat. 2, c. 16. But the bulk of the national debt still bore interest at 6 per cent., the doubtful security of the throne and the too frequent irregularities in public payment having hitherto precluded any considerable borrowing at lower rates. Walpole saw that the first requirement was to give increased confidence to the public creditors. Three Acts were passed dealing respectively with debts due to the general public, to the Bank of England, and to the South Sea Company. Three separate funds—the General Fund, the Aggregate Fund, and the South Sea Fund—were assigned to the service of the several classes of debt, each of these funds being credited with the produce of specified taxes, which were made permanent for the purpose; and it was further provided that any surplus of the funds, after payment of the interest of the debts, should be applied in reduction of the principal Such was the success of this measure that, in spite of the reduction of interest from 6 to 5 per cent. which was also enacted, the passing of the Acts was followed by a rise in the price of stocks. A curious preliminary to the introduction of these measures was the passing of a resolution by the House of Commons, which invited advances not exceeding £600,000, to be repaid with interest at 4 per cent. out of the first supplies of the year. The result showed that the time was not ripe for such a reduction of interest, as only a sum of £45,000 was offered on those terms. A further resolution was then passed, substituting 5 per cent.

[1] Other causes are redemption of land tax, variation in capital value of Terminable Annuities, and minor Treasury operations.

as the rate of interest, and the whole sum was at once subscribed. Besides accepting the reduction of interest on their own debts, the Bank of England and the South Sea Company agreed to assist the Government by advancing $4\frac{1}{2}$ millions at the reduced rate, to be employed in paying off any of the general creditors who might refuse assent to the conversion. The assistance was not required, as all the creditors signified assent. The debts thus dealt with amounted altogether to about $25\frac{3}{4}$ millions, and the annual saving of interest effected (including that upon a large quantity of Exchequer bills for which the Bank had been receiving over 7 per cent.) was £329,000.

Walpole had a further opportunity of effecting a conversion in 1737. In the meantime much of the 5 per cent. *1749.* debt had been reduced to 4 per cent. by arrangements with the Bank of England and the South Sea Company, and further borrowings had taken place at that rate, and even at 3 per cent. In 1737 the 3 per cents stood above par, and Sir John Barnard proposed to the House of Commons a scheme for the gradual reduction of the 4 per cents. As a financial measure the scheme would doubtless have succeeded; but Walpole, moved apparently by consideration for his capitalist supporters, opposed and for the time defeated it. A scheme on similar lines was carried through by Pelham as Chancellor of the Exchequer in 1749, and embodied in the Act 23 Geo. II. c. 1. By that Act holders of the 4 per cent. securities, amounting to nearly £58,000,000, were offered a continuance of interest at 4 per cent. for one year, followed by $3\frac{1}{2}$ per cent. for seven years, during which they were guaranteed against redemption, with a final reduction to 3 per cent. thereafter. It was necessary to continue the rate of 4 per cent. for the first year, as any objecting stockholders could not be paid off without a year's notice. Three months were allowed for signifying assent to the proposal. At first it was viewed with disfavour, and both the Bank and the East India Company opposed it. But the pens of the Government pamphleteers were busily occupied in showing the advantages of the offer, and at the close of the three months acceptances had been received from the holders of nearly £39,000,000 of the stocks, or more than two-thirds of the whole. A further opportunity was afforded to waverers by a second Act (23 Geo. II. c. 22), which allowed three months more for consideration; but for holders accepting under this Act the intermediate period of $3\frac{1}{2}$ per cent. interest was reduced from seven years to five. These terms brought in an additional £15,600,000 of stock; and the balance left outstanding, amounting to less than $3\frac{1}{2}$ millions, was paid off at par by means of a new loan. The annual saving of interest on the stock converted was at first £272,000, increasing to £544,000 after seven years.

For nearly three-quarters of a century no further conversion was attempted. In that period the total debt had *1822.* been increased tenfold, and the practice of borrowing in times of war by the issue of an inflated capital, bearing nominally a low rate of interest, prevented recourse to conversion as a means of reducing the burden after peace was restored. But in 1822 Mr Vansittart—who four years earlier had effected a conversion in the opposite direction, turning £27,000,000 of stock from 3 into $3\frac{1}{2}$ per cent., in order to obtain from the holders an advance of £3,000,000 without adding to the capital of the debt—was able to deal with the 5 per cents. These stocks amounted to £152,000,000 out of a total funded debt of £795,000,000. The prices at which the chief denominations of Government stocks stood in the market in the early part of 1822 indicated a normal rate of interest of more than 4 but considerably less than $4\frac{1}{2}$ per cent. In these circumstances, to propose the conversion of the 5 per cent. stocks to $4\frac{1}{2}$ per cent. would probably have been futile, unless the new stock were guaranteed for a long period, as holders would have stood in fear of a speedy further reduction. Nor could the Government hope to succeed in a reduction to 4 per cent. Mr Vansittart's plan was to offer £105 of stock bearing 4 per cent. in exchange for £100 of 5 per cent. stock, thus adding slightly to the capital of the debt, but effecting a large annual saving in interest. These terms were highly successful. Holders of nearly £150,000,000 accepted, leaving less than £3,000,000 of the stock to be paid off, and the annual saving obtained was £1,197,000. The new 4 per cent. stock was made irredeemable for seven years (Act 3 Geo. IV. c. 9).

There were, however, other 4 per cent. stocks, amounting to £76,000,000, which were not secured against redemption. Two years later, the conditions being favourable for their conversion, the Act 5 Geo. IV. c. 24 *1824.* was passed, offering holders in exchange a $3\frac{1}{2}$ per cent. stock, irredeemable for five years. The offer was accepted as regards £70,000,000, and the remaining £6,000,000 paid off, the annual saving on interest being £381,000.

In 1830 the guarantee given to the 4 per cent. stock of 1822 had expired, and the stock stood at a price of $102\frac{1}{2}$. Mr Goulburn decided to attempt its conversion without delay, and accordingly by the Act 11 Geo. *1830.* IV. c. 13 holders were offered in exchange for each £100 of the stock, either £100 of a $3\frac{1}{2}$ per cent. stock, irredeemable for ten years, or £70 of a 5 per cent. stock, irredeemable for forty-two years, these two options being considered of approximately equal value. No difficulty was found in securing assent. Over £150,000,000 of the stock was converted, almost wholly into the $3\frac{1}{2}$ per cent. stock; the balance of less than £3,000,000 was paid off, and an annual saving of £754,000 in interest was the result.

It was again Mr Goulburn's fortune to carry out a large and successful conversion in 1844. At that date the Funded Debt was made up of 3 per cent. and *1844.* $3\frac{1}{2}$ per cent. stocks in the proportions of about two to one, the only other denomination being the trifling amount of 5 per cent. stock created in connexion with the conversion of 1830. The price of 3 per cent. Consols ranged about 98, and that of the new $3\frac{1}{2}$ per cents, created in 1830, about 102. A reduction straightway from $3\frac{1}{2}$ to 3 per cent. was not to be looked for, but it was hoped to ensure that reduction ultimately by offering $3\frac{1}{4}$ per cent. for the first few years and a guarantee against redemption for a long term. Accordingly the holders of the several $3\frac{1}{2}$ per cent. stocks were offered an exchange to a new stock bearing interest at $3\frac{1}{4}$ per cent. for ten years and at 3 per cent. for the following twenty years. Practically the whole of the stock, amounting to £249,000,000, was converted on these terms, only £103,000 being left to be paid off at par. The immediate saving of interest was £622,000 a year for ten years, and twice that rate in subsequent years (Acts 7 and 8 Vict. cc. 4 and 5).

Mr Gladstone's only attempt at the conversion of the debt was made in his first year as Chancellor of the Exchequer. His primary purpose was to extinguish *1853.* some small remnants of 3 per cent. stocks which stood outside the main stocks of that denomination. The Act 16 Vict. c. 23 offered to holders of these minor stocks, amounting altogether to about $9\frac{1}{2}$ millions, the option of exchanging every £100 for either £82, 10s. of a $3\frac{1}{2}$ per cent. stock guaranteed for 40 years, or £110 of a $2\frac{1}{2}$ per cent. stock guaranteed for the same period, or else for Exchequer bonds at par. In the result stock to the amount of only about £1,500,000 was converted, and the remaining £8,000,000 had to be paid off at par, with some apparent loss of capital, as the current market price of the 3 per cents was less than par. The failure was largely owing to the fact that, between the initiation and the execution of the scheme, the train of events leading up to the Crimean war had become manifest, with unfavourable results to the public credit. Mr Gladstone had also included, as an optional portion of his plan, liberty to holders of the larger 3 per cent. stocks to exchange into the new 3½ and 2½ per cents. Very little advantage was taken of this permission, but the small amount of 2½ per cent. stock then created has been largely added to in later years by the conversion of stocks of higher denominations held by the National Debt Commissioners for the savings banks and other Government funds.

1884. Little better was the result of a more ambitious attempt made by Mr Childers in 1884. His offer (Act 47 and 48 Vict. c. 23) extended to the holders of all the 3 per cent. stocks, amounting to more than 600 millions, but no attempt was made to compel acceptance. There was offered in exchange for each £100 of 3 per cent. stock either £102 of a stock at 2¾ per cent., or £108 of a stock at 2½ per cent., both irredeemable for twenty-one years. But the amount exchanged into the new stocks was only 22 millions, of which more than one-half was stock held by Government departments.

1888. The most important of all the conversions of the British debt was effected by Mr Goschen in 1888. It applied to the whole of the 3 per cent. stocks, amounting to a total of £558,000,000, made up as follows:—£323,000,000 of Consols, a stock which dated from 1752, when it was formed by the consolidation of a number of minor stocks; £69,000,000 of Reduced 3 per cents, of which the nucleus was the stock reduced from 4 to 3 per cent. by Pelham's conversion in 1749; £166,000,000 of New 3 per cents resulting from the conversion of 1844. All the three stocks were, and had been for a considerable time, well over par. But for the past few years they had remained in almost a stationary position, relatively to the upward movement shown in the prices of the Government 2½ per cent. stock, and of the stocks of foreign governments, of British colonies, and of the leading municipalities. It was clear that the anticipation of a conversion or redemption scheme was weighing down Consols. Direct evidence of this fact was afforded by the course of a new 3 per cent. stock, the Local Loans stock, which Mr Goschen had created in 1887. Though bearing the same interest and resting upon the same ultimate security as Consols, this stock, which had been made irredeemable for twenty-five years, rose at once to a higher level of price. The opportunity for a great scheme of conversion had evidently come. The risk to be incurred by Government in undertaking the liability to pay off such an enormous body of stock, though less in comparison with the resources of the nation than that which Mr Goulburn had faced in 1844, was still very great, and it was rendered more formidable by the fact that holders of Consols and of Reduced 3 per cents were entitled at law to a year's notice before their stocks could be redeemed. If that right of notice were to be enforced as regards any large proportion of the stocks, no precaution could adequately guard against the risk of untoward circumstances arising to affect the operation before the year expired. Mr Goschen proposed to offer to the holders of each of the three stocks an exchange at par into a new stock bearing interest at 3 per cent. for the first year, at 2¾ per cent. for the next fourteen years, and at 2½ per cent. for twenty years thereafter, the stock to be irredeemable for the whole of that period, namely till 1923. Acceptance was made compulsory for holders of the New 3 per cents, with the alternative of being paid off at par, as they had no claim to receive notice; but it was made optional for the holders of the other two stocks, and a bonus of 5s. per cent. was offered to them as an inducement to forgo their right of notice. These provisions were duly embodied in the Act 51 Vict. c. 2. The terms were accepted by practically all the holders of the New 3 per cents and by the great majority of the holders in Consols and Reduced 3's, the amount left outstanding being only £42,000,000. To enable that balance to be dealt with, an Act was passed providing for the compulsory redemption or conversion of the outstanding stock at the expiry of the statutory notice. The funds required for this further operation were raised by the issue of Treasury bills and Exchequer bonds, by temporary advances from the Bank and from the National Debt Commissioners, and by the creation of an additional half-million of the new stock. In the result it was only necessary to find cash for paying off dissentients to the amount of £19,000,000. The final outcome of the whole operation was a saving in the annual charge of interest of £1,412,000, increasing to twice that amount after fourteen years.

The conversion of the Consols and Reduced 3 per cents was greatly facilitated by the exercise of a power, which the Act conferred, to pay to recognized agents, such as stockbrokers, bankers, and solicitors, a commission of 1s. 6d. per cent. on stocks in respect of which they lodged their clients' assents. These agents were thus afforded an inducement to give their clients explanation and advice, without which many of the fundholders would probably not have moved in the matter. The commissions paid amounted to more than £234,000, representing stocks to the amount of over £312,000,000. The Government will not again be confronted with this difficulty of having to give long preliminary notice of the intention to convert or redeem a large portion of the debt, as it is provided by the Conversion Act, 1888, that the present Consols shall be redeemable after 1923 on such notice and in such manner as Parliament may direct.

See *Report of the Proceedings of the Commissioners for the Reduction of the National Debt*, Parliamentary Paper C—6569 of 1891.—E. W. HAMILTON. *Conversion and Redemption.* London, 1889. (W. BL.; E. W. H*.)

Naturalism.—"Nature" is a term of very uncertain extent, and the "natural" has accordingly several antitheses, often more or less conflicting, and only to be learnt from the context in which they occur. Thus, though Man and the World are often opposed as respectively subject and object, yet the word nature is applied to both: hence Naturalism is used in both a subjective and an objective sense. In the subjective sense the natural, as the original or essential, is opposed to what is acquired, artificial, conventional, or accidental. On this opposition the casuistry and paradoxes of the Sophists largely turned; it determined also, at least negatively, the conduct of the Cynics in their contempt for the customary duties and decencies; and it led the Stoics to seek positive rules of life in "conformity to nature." This deference for the "natural" generally, and distrust of traditional systems of thought and even of traditional institutions, has played a large part in modern philosophy, especially British philosophy. It was perhaps the inevitable outcome of the reaction, which began with the Renaissance, against the mediæval domination of mere authority. "L'homme qui médite est un animal dépravé," said Rousseau; and again, "Tout est bien sortant des mains de l'auteur des choses, tout dégénère entre les mains de l'homme."[1]

In psychology and epistemology, "no one," as Green has said, "is more emphatic than Locke in opposing what

[1] Quoted by Eisler, *Wörterbuch der philosophischen Begriffe*, 1899, s.v. Naturalismus.

is real to what we 'make for ourselves'—the work of nature to the work of the mind. Simple ideas or sensations we certainly do not 'make for ourselves.' They therefore, and matter supposed to cause them, are, according to Locke, real. But relations are neither simple ideas nor their material archetypes. They therefore, as Locke explicitly holds, fall under the head of the work of the mind, which is opposed to the real."[1] This opposition again led Hume, in the first place, to distinguish between natural and philosophical relations—the former determined simply by association, the latter by an arbitrary union of two ideas, which we may think proper to compare—and then, in the next, to reduce identity and causality, the two chief "philosophical relations," to fictions resulting from "natural relations," that is to say, from associations of similarity and contiguity. Subjective naturalism thus tended to become, and in the end became, what is more commonly called *Sensationalism* or *Associationism*, thereby approximating towards that objective naturalism which reduces the external world to a mechanism describable in terms of matter and motion—a result already foreshadowed when Hartley connected ideas and their association with brain vibrations and vibratiuncles. In ethics, also, the striving to get back to the natural entailed a similar downward trend. From the Cambridge Platonists, from Locke and Clarke, we hear much of rational principles of conduct, comparable in respect of intelligibility with the truths of mathematics; but already we find that in Shaftesbury the centre of ethical interest is tranferred from the Reason, conceived as apprehending either abstract moral distinctions or laws of divine legislation, to the "natural affections" that prompt to social duty;[2] and when we reach Bentham, with pleasure and pain as "sovereign masters," and the Mills, with love of virtue explained by the laws of association, all seems to be non-rational.[3] There is much resemblance, as well as some historical connexion, between the naturalism of moralists such as Shaftesbury and Hutcheson and the Common-Sense metaphysics of Reid and his school.[4] Hence Kant, distinguishing between a "naturalistic" and "scientific" or critical method in metaphysics, styles Reid and his followers "naturalists of pure reason," satirically comparing them to people who think they can settle the size and distance of the moon by direct eyesight better than by the roundabout calculations of mathematics.

So far we have seen the natural approximating to the non-rational. But when used in a subjective sense in opposition to the supernatural, it means the rational as opposed to what is above reason, or even contrary to reason. It is in this sense that the term Naturalism most frequently occurs; and it was so applied specially to the doctrines of the English Deists and the German Illuminati of the 17th and 18th centuries: those of them who held that human reason alone was capable of attaining to the knowledge of God were called theological naturalists or rationalists, while those who denied the possibility of revelation altogether were called philosophical naturalists or naturalists simply.[5] In these controversies the term Naturalist was also sometimes used in an objective sense for those who identified God and Nature, but they were more frequently styled Spinozists, Pantheists, or even Atheists. But it is at once obvious that dispute as to what is natural and what supernatural is vain and hopeless till the meanings of reason and nature are clearly defined. "The only distinct meaning of the word" [natural], said Butler, "is *stated*, *fixed*, or *settled*; since what is natural as much requires and presupposes an intelligent agent to render it so, *i.e.*, to effect it continually, or at stated times, as what is supernatural or miraculous does to effect it for once. And from hence it must follow that persons' notion of what is natural will be enlarged in proportion to their greater knowledge. . . . Nor is there any absurdity in supposing that there may be beings in the universe, whose capacities . . . may be so extensive, as that the whole Christian dispensation may to them appear natural, *i.e.*, analogous or conformable to God's dealings with other parts of His creation; as natural as the visible known course of things appears to us."[6]

The antithesis of natural to spiritual (or ideal) has mainly determined the use of the term Naturalism in the present day.[7] But current naturalism is not to be called materialism, though these terms are often used synonymously, as by Hegel, Ueberweg, and other historians of philosophy; nor yet pantheism, if by that is meant the immanence of all things in one God. We know only material phenomena, it is said; matter is an abstract conception simply, not a substantial reality. It is therefore meaningless to describe mind as its effect. Moreover, mind also is but an abstract conception; and here again all our knowledge is confined to the phenomenal. To identify the two classes of phenomena is, however, impossible, and indeed absurd; nevertheless we find a constant concomitance of *psychosis* and *neurosis*; and the more sensationalist and associationist our psychology, the easier it becomes to correlate the psychical and the physical as but "two aspects" of one and the same fact. It is therefore simplest and sufficient to assume an underlying, albeit unknown, unity connecting the two. A monism—so far neutral, neither materialistic nor spiritualistic—is thus a characteristic of the prevailing naturalism. But when the question arises, how best to systematize experience as a whole, it is contended that we must begin from the physical side. Here we have precise conceptions, quantitative exactness, and thoroughgoing continuity; every thought that has ever stirred the hearts of men, not less than every breeze that has ever rippled the face of the deep, has meant a perfectly definite redistribution of matter and motion. To the mechanical principles of this redistribution an ultimate analysis brings us down; and—beginning from these—the nebular hypothesis and the theory of natural selection will enable us to explain all subsequent synthesis.[8] Life and mind now clearly take a secondary place; the cosmical mechanism determines *them*, while they are powerless to modify it. The spiritual becomes the "epiphenomenal," a merely incidental phosphorescence, so to say, that regularly accompanies physical processes of a certain type and complexity. (See also PSYCHOLOGY.)

This absolute naturalism, as we may call it, the union, that is, of psychological and cosmological naturalism, is in fact a species of Fatalism, as Kant indeed entitled it.[9] It is the logical outcome of a sensationalist psychology, and of the epistemology which this entails. As long as association of ideas (or sensory residua) is held to explain judgment and conscience, so long may naturalism stand.

The naturalistic work of chief account at the present day is E. HAECKEL's *Die Welträtsel, Gemeinverständliche Studien über*

[1] T. H. Green, *Prolegomena to Ethics*, 1883, § 20.
[2] Cf. Sidgwick, *History of Ethics*, 1886, p. 181.
[3] Cf. W. R. Sorley, *The Ethics of Naturalism*, 1885, pp. 16 ff.
[4] Cf. W. R. Scott, *Francis Hutcheson; His Life, Teaching, and Position in Philosophy*, 1900, pp. 121, 265 f.
[5] See article RATIONALISM, *Ency. Brit.* vol. xx.; Kant, *Religion innerhalb der Grenzen der blosen Vernunft*, Hartenstein's edition, vi. 253; and Lechler, *Geschichte des Englischen Deismus*, 1841, pp. 454 ff.
[6] *Analogy*, part i. chap. i., end. Cf. also J. S. Mill, *Logic*, book iii. chap. xxv. § 2, and *Essays on Religion*.
[7] In æsthetics we find Naturalism used in a cognate sense: the Flemish painters, such writers as Flaubert or Zola, for example, being called naturalistic or realistic, in contrast to the Italian painters or writers like George Sand or the Brontës.
[8] Cf. Spencer, *First Principles*, 1867, p. 398.
[9] Cf. *Prolegomena*, § 60.

monistische Philosophie, 5te Ausgabe 1900, of which an English translation has appeared. Effective refutations will be found in the works of two of Haeckel's colleagues, O. LIEBMANN, *Zur Analysis der Wirklichkeit*, 3te Ausgabe 1900; R. EUCKEN, *Die Einheit des Geisteslebens in Bewusstsein und That der Menschheit*, 1888; *Der Kampf um einen geistigen Lebensinhalt*, 1898. There is also in English Mr A. J. BALFOUR's well-known *Foundations of Belief*, 8th edition, 1901; and *Naturalism and Agnosticism*, 1899, by J. WARD. (J. W*.)

Naturalization.—Prior to the Naturalization Act of 1870, 33 and 34 Vict. c. 14 (see ALIEN and ALLEGIANCE in *Ency. Brit.* vol. i. 9th ed.), the allégiance owed to the British Crown was regarded as indissoluble, and down to 1868 the same doctrine was held in the United States. Almost at the same time both countries, through conventions with each other, treaties with other foreign Powers and by Acts of the legislature within, abandoned this position and opened a free exchange of nationality with foreign states. Naturalization, being a sovereign act, is not governed by the rules of international law, but by those of the public law of each individual state concerned. The Naturalization Act of 1870, sec. 7, subsec. 3, defines and regulates the position of naturalized British subjects, and provides that an alien to whom a certificate of naturalization has been granted shall enjoy all political and other rights, powers, and privileges, and be subject to all obligations to which a natural-born British subject is entitled or subject in the United Kingdom, *provided that he shall not, when within the limits of the foreign state of which he was a subject previously to obtaining his certificate of naturalization, be deemed to be a British subject unless he has ceased to be a subject of that state in pursuance of the laws thereof, or in pursuance of a treaty to that effect* (and the same rule obtains also in the case of statutory aliens, *i.e.*, natural-born British subjects, to whom certificates of readmission to British nationality have been granted). The italicized clause here referred to is applicable to the very numerous cases where naturalization has been effected in fraud of military service in countries where this is compulsory. Thus naturalization, whilst investing the new citizen with equal rights with one naturally born, does not extinguish the claims which are still in force in the state to which he has hitherto owed allegiance. In such cases the flag of the country of adoption will not protect the naturalized subject, on returning to the country of his birth, from the pains, penalties, and forfeitures visited for such default. (Calvo, *Dictionnaire de Droit International, s.v.* Naturalisation: "La naturalisation n'altère en rien les droits acquis avant son accomplissement, ni même les conséquences légales qui découlent de ces droits antérieurs.") In Germany no permission is given to persons between the ages of seventeen and twenty-five, and liable to conscription, to change their nationality, unless they satisfy the military authorities that they do not seek to divest themselves of German citizenship in order to escape from military duty; and such permission is likewise refused to officers in active service or reservists called upon to rejoin the colours.

The position of infant children of naturalized British subjects is still obscure. The Naturalization Act referred to provides that where the father, or the mother (being a widow), has obtained a certificate of naturalization in the United Kingdom, every child of such father or mother who during infancy has become resident with such father or mother in any part of the United Kingdom, or *with such father while in the service of the Crown out of the United Kingdom* (58 and 59 Vict. c. 43), shall be deemed to be a naturalized British subject. Mr W. E. Hall (*Foreign Jurisdiction*, p. 27) says: "The Act is silent as to children, whether born before or after naturalization, who are not, or at least have not been, resident with the father or mother in the United Kingdom. It is to be presumed that they remain aliens."

In most countries a lengthened sojourn is a condition precedent to naturalization. In Belgium, the United Kingdom, North America, and Russia the period of such sojourn is fixed at five years, in France, Greece, and Sweden at three, in the Argentine Republic two, whilst in Portugal a residence of one year is sufficient. In Germany, Austria, and Italy no period of residence is prescribed. In France a residence for ten years qualifies for naturalization without further ceremony; whilst in Austria a ten years' residence confers *per se* the rights of citizenship.

As regards naturalization in British colonies, the Naturalization Act provides that all regulations duly made by the legislature of any British possession for conferring the rights of naturalization shall, *within such limits*, have the authority of law. It seems well established that such a Colonial Act has only the force of law within the particular colony, and cannot invest a naturalized person with the character of British subject in foreign states; but says Hall: "The Naturalization Act does not seem to have been read quite in this sense, and it has been the practice to issue passports to the owners of colonial certificates of naturalization and to protect them in all foreign countries, other than their country of origin." Naturalization in India, which is not mentioned in the Act, is provided for by local statute, and the position of a person naturalized under such local ordinance is the same as that of a person naturalized in the colonies. In order to avoid the appearance of wishing to protect the naturalized subject who has become a British citizen *in fraudem legis*, all naturalized British subjects are described as such in the passports issued to them, and all applications for passports must be accompanied by the certificate of naturalization, in addition to those of identity and recommendation, and passports cannot be issued abroad to a colonial naturalized British subject except for a direct journey to the United Kingdom or to the colony in which he has become naturalized.

It is still a vexed question whether British subjects can divest themselves of their nationality in non-civilized countries, but the better opinion seems to be that the permission given to British subjects by the Naturalization Act to assume the nationality of a foreign state has regard only to such states as have a definite political organization. In all others British subjects remain amenable to British laws.

AUTHORITIES.—v. BAR. *International Law.*—DICEY. *Conflict of Laws.* London, 1896.—HALL, W. E. *Treatise on the Foreign Powers and Jurisdiction of the British Crown.* Oxford, 1894.

Naucratis.—The site of Naucratis was discovered by Professor Flinders Petrie in 1884; it is situated on the eastern bank of a canal, about 10 miles to the west of the present Rosetta branch of the Nile. In ancient times it was approached by the Canobic mouth, which was farther to the west. The identification of the site is placed beyond doubt by the discovery of inscriptions, with the name of the town, and of great masses of early Greek pottery, such as could not have existed anywhere else. The site was excavated in 1884–86 by the Egypt Exploration Fund, and a supplementary excavation was made by the British School at Athens in 1899. A list of the temples of Naucratis is given by Herodotus (ii. 178); they were the Hellenion, common to all the colonizing cities, and those dedicated by the Æginetans to Zeus, by the Samians to Hera, and by the Milesians to Apollo. A temple of Aphrodite is also mentioned by Athenæus. Traces of all these temples, except that of Zeus, or at least dedications coming from them, have been found in the excavations, and another has been added to them, the temple of the Dioscuri. The two chief sites to be cleared were the temples of Apollo and of Aphrodite, in both of which successive buildings of various date were found. Both were remarkable for the great mass of early painted pottery that was found; in the temple of Apollo this had been buried in a trench; in that of Aphrodite it was scattered over the whole surface in two distinct strata. A great deal of it was local ware, but there were also imported vases from various Greek sites. In addition to these temples, there was also found a great fortified enclosure, about 860 feet by 750, in the south-eastern part of the town; within it was a square tower or fort; a portico of entrance and an avenue of rows of sphinxes was added in Ptolemaic times, as is shown by the foundation deposits found at the corners of the portico; these consisted of models of the tools and materials used in the buildings, models of instruments for sacrifice or ceremonies, and cartouches of King Ptolemy Philadelphus. Professor Petrie naturally supposed this great enclosure to be the Hellenion or common sanctuary of the Greeks, but in the most recent excavations Mr Hogarth found traces of another great walled enclosure to the north-east of the town, together with pottery dedicated τοῖς τῶν Ἑλλήνων θεοῖς, and he claims with reason that this enclosure is more likely than the other to be the Hellenion, since no early Greek antiquities have been found in the southern part of the town, which seems rather to have been a native settlement. The cemetery of the ancient town was found on two low mounds to the north, but was mostly of Ptolemaic date.

Apart from the historic interest of the site, as the only Greek colony in Egypt in early times, the chief importance of the excavations lies in the rich finds of early pottery and in the inscriptions upon them, which throw light on the early history of the alphabet. The most flourishing period of the town was from the accession of Amasis in 570 B.C. to the Persian invasion of 520 B.C., when the contents of the temples must have been destroyed. The earlier chronology has been much disputed. There are clear traces of a settlement going back to the 7th century, including a scarab factory, which yielded numerous scarabs, not of native Egyptian manufacture, bearing the names of the kings that preceded Amasis. Among these were fragments of early Greek pottery. It seems a fair inference that the makers of these were Greeks, and that they probably represent the early Milesian colony, settled here in the time of Psammetichus I., before the official assignment of the site by Amasis to the Greek colonists of various cities. The most important of the antiquities found are now in the British Museum.

See W. M. F. PETRIE, &c. *Naukratis I.* Third Memoir of the Egypt Exploration Fund, 1886.—E. A. GARDNER, &c. *Naukratis II.* Sixth Memoir of same, 1889.—D. G. HOGARTH, &c. *Annual of the British School at Athens*, 1898–99. (E. GR.)

Naugatuck, a borough of New Haven county, Connecticut, U.S.A., on the Naugatuck river, and on the New York, New Haven, and Hartford Railroad, south-west of the centre of the state. It obtains water-power from the river for its manufactures, which comprise boots and shoes, woollen and rubber goods, cutlery and agricultural implements. Population (1880), 4274; (1890), 6218; (1900), 10,541, of whom 3432 were foreign-born.

Nauheim, or BAD-NAUHEIM, a watering-place of Germany, in the grand-duchy of Hesse-Darmstadt, situated on the north-east slope of the Taunus Mountains, 24 miles by rail north of Frankfort-on-Main. Its warm waters (84° to 95° F.) attract nearly 20,000 visitors annually; but, although known for centuries, they were prior to 1835 only employed for the extraction of salt (now about 2000 tons annually). The town has several parks, the largest being the Kurpark (125 acres), in which are the elegant Kurhaus and the two chief springs. The waters, which are saline, strongly impregnated with carbonic acid, and to a less extent with iron, are principally used for bathing. Three smaller springs, situated outside the Kurpark, supply water for drinking. In 1899–1900 a new spring (saline) was tapped at a depth of 682 feet. Another attraction of the place is the wooded surroundings, including the Johannesberg (773 feet), immediately overlooking the town. Population (1900), 4505.

Naumburg, a town of Prussia, province of Saxony, 29 miles south by west of Halle by the railway to Weimar, on the river Saale, near the confluence of the Unstrut. The cathedral (restored in 1883) was provided with a fourth tower in 1894, the gift of the Emperor William II. The town church possesses two pictures by Lucas Cranach the elder. The annual "Hussites feast" is still held here, but its supposed origin in a joyous festival held after deliverance of the town from the Hussites is fabulous, it having been proved that the Hussites never came to the walls of Naumburg. Close by is the pretty little watering-place of Kosen, famed also as the annual meeting-place of the representatives of the German students' corps. Population (1885), 19,107; (1900), 23,187.

Nautilus. See CUTTLEFISH and MOLLUSCA.

Navarra, or NAVARRE, a province of northern Spain, area 4046 square miles. It is divided into 15 administrative districts and 269 parishes. Its population was 304,184 in 1877, 304,051 in 1887, and 302,978 in 1897. The birth-rate is 3·47 per cent., the death-rate 2·79 per cent., and the proportion of illegitimate births 3·05 per cent. of the total births. Many of the inhabitants emigrate to South America and to France, where thousands of able-bodied lads from 19 to 22 years took refuge during the colonial and American wars of 1895–98, to avoid the conscription. A railway runs through the province to join the main line from Madrid to France at Alsasua junction. All the roads, like those of the three Basque provinces, are kept in excellent repair by the provincial council, assisted by the municipalities. Both bodies attend with some zeal to the primary schools, institutes, and normal schools. The province is agricultural rather than industrial. The wine trade is active, and the products of the vineyards are in great demand in south-west France and at Passages in Guipuzcoa for mixing with the French wines—the famous *coupages* that Spain now aims at carrying on in many of her ports. The industries include manufactures of arms, paper, chocolate, candles, alcohol, leather, coarse linens and cloths. The exports both by rail and by the passes in the Pyrenees consist of live stock, oil, wine, wool, leather, and paper. The forests have attracted the attention of foreign and native enterprise. Narrow-gauge railways convey the timber to the main lines. In 1897, 144,867 acres were devoted to wheat crops; 71,417 acres to rye, barley, oats, maize; 38,565 acres to pod-fruit, 134,382 acres to vines, and 22,875 acres to olive groves. The live stock included 16,320 horses, 17,447 mules, 14,617 asses, 40,568 cattle, 521,858 sheep, 50,476 goats, and 26,949 pigs. For its area, Navarre is one of the richest provinces of Spain in live stock. There are zinc, copper, iron, and lead mines giving employment to 352 hands. The works employ a few hundred hands, and turn out about 4000 tons of iron and steel, and 5272 tons of pig-iron.

NAVIES

I. Political and Economical Changes 1870–1900.

With the exception of the Russo-Turkish war of 1878, the year 1870 marks the last of the great European struggles, and is therefore a convenient starting-point to consider the subsequent growth of naval armaments. The period witnessed the advent of a new maritime, commercial, and colonial power in the federation of the kingdoms and states known as Germany. The final unification of Italy, with Rome as the capital, was also accomplished; and in the same year there began in Japan the rapid assimilation of an Eastern race to Western civilization. The opportunity of the Franco-German war enabled Russia to abrogate the treaty clauses providing for the neutrality of the Black Sea. It is not without significance that the denunciation of these clauses should have taken place in the year following the opening of the Suez Canal. Seven years later the Russo-Turkish war forced the conviction on Russia that a strong navy was necessary to the expansion of her empire. There thus resulted one of the most interesting events in history, where a strong navy was built up by a military power which possessed but an insignificant sea-borne trade and commercial marine, and suffered under the most striking disabilities, owing to its fleets in the Baltic, Black Sea, and Far East being widely separated. Not only could fleets thus situated seldom afford each other efficient co-operation, but many of the ships were of small dimensions, so as to operate on the shallow coasts, and sacrificed the coal supply which might otherwise have enabled them to effect a junction. The Black Sea fleet was further hampered by restrictions intended to prevent warships from passing through the Dardanelles. A temporary difficulty lay in the experience of corruption which nearly all navies have undergone, since they deal so largely in consumable and perishable goods. The numerous Black Sea courts-martial in 1900 gave indications of methods which vitally affect the preparedness of a navy. In Russia, owing to the same class controlling the Government, the navy, and dockyards, and pursuing its way without the safeguard of public criticism, the danger resulting from corruption is not one to be lightly estimated. These, however, are factors for which men have to form their opinions independently. While we cannot ignore them in comparing the strength of navies, they can only reveal their full effects under the supreme test of war. In other directions, however, we can measure Russian maritime interests very completely. It is significant that, in spite of the most determined efforts to support the mercantile marine by navigation laws and a monopoly of the coastal trade, it increased but slightly. There are no statistics available prior to 1895, but in that year Russia (exclusive of Finland) possessed 323,000 tons of sailing vessels and 206,000 tons of steamers; and in 1899, 268,000 tons of sailing vessels and 334,000 tons of steamers. This small increase is not a matter for surprise, for, if we except the island of Saghalien, Russia could communicate by land with the whole of her extensive empire.

In another continent, the United States of America was rapidly recovering its financial stability after the disastrous Civil War. It was building up industries and commerce destined to excite the apprehension of Europe by the end of the 19th century; an apprehension founded not alone on the effects of industrial rivalry, but also on the expansion of America into the chief markets of the world. This expansion was necessarily though tardily followed by the growth of the United States navy, and by the acquisition of transmarine territories in the West Indies, Philippines, Hawaii, and Samoa. The naval organization of 1898 was strained to such an extent, by the war with the third-rate naval Power of Spain, that the Navy Department refused to allow the battleships to be risked in an attack on the Spanish cruisers inside the fortified harbour of Santiago, and the United States was generally believed to have been saved from European naval intervention by the action of the British Cabinet. A determined effort was then made to bring the United States into the front rank of naval Powers. At the same time, it was recognized that naval operations were conducted under great difficulties, owing to the vast distances separating the squadrons on the Pacific and Atlantic coasts. Inquiries and negotiations were opened with the view of cutting a canal either by the Panama or Nicaraguan routes, and an arrangement was made with Great Britain by which the expense, maintenance, and defence of the canal should be in the hands of the United States.

II. The Growth of New Maritime Powers.

These, then, were some of the underlying factors which influenced the maritime rivalry characterizing the closing years of the 19th century. Whereas it might almost be said in 1870 that France and the United Kingdom possessed the only two great fleets of ironclads, the British First Lord of the Admiralty declared that the estimates for 1900–1901 were framed after a careful consideration of the navies of six great maritime Powers—viz., France, Russia, Germany, Italy, Japan, and the United States. Beyond the navies of the seven Powers, it cannot be said that there existed any vessels fit to lie in the line of battle. This in itself marks a profound change from the period of the Napoleonic war, when battleships cost one-thirtieth of what they did in 1902. When small Powers, like Denmark and Portugal, were able to afford the outlay on battleships, the action of their fleets was always a source of anxiety to the British Government. The rapidity with which sailing vessels could be built, and the facility with which small craft could be turned into privateers, had to be taken into consideration. At the end of the 19th century, though considerable progress had been made in the rapidity with which steel ships were built, the rate was not one which would enable the great maritime nations to fight for at least a year after the outbreak of war with any but the ships which were then completed or nearly so. In fact, the most rapid achievements, in favourable circumstances, in the building of battleships, were the *Majestic* and *Magnificent*, which were built and commissioned (1895) in twenty-two and twenty-four months after they had been laid down.[1] At the same time the special requirements of warships, and the tendency to give armour to even moderate-sized cruisers, had very considerably differentiated them from merchant vessels. While all the naval Powers provided for using some of the latter as auxiliaries, it was never contemplated that they should be required to fight vessels specially built for war purposes.

The net result of these changes was to enhance the predominance of the great maritime Powers, and while there had been a period when the national navy saved Denmark from Germany, and Turkey from Russia, that state of affairs was no longer possible at the end of the 19th

[1] Exceptional efforts were made in the case of these vessels, in order that early experience might be gained from their trials.

century. The great maritime Powers acting in concert, or remaining neutral whilst one of their number was engaged in a demonstration against Turkey, Greece, or China, or any other nation, could always enforce decisions with their ships, or were free to send troops over a sea on which their transports could move unmolested. So far as maritime strength was concerned, there could only exist groups of the seven naval Powers. Fighting amongst each other the smaller nations could engage in naval operations, as, for instance, when Japan fought China in 1895. It was inevitable that Japan should yield the chief fruits of her victory when Russia, Germany, and France interfered, while Great Britain and the United States lent her no active support. From that moment it became the settled ambition of the Japanese to become a great naval Power, and six first-class battleships were built in England between 1895 and 1902. In the latter year an alliance was concluded with Great Britain. The Japanese navy at the commencement of the war with China had consisted of only 30,000 tons of warships, while at the beginning of 1901 the aggregate amount was 260,000 tons. In bringing about this increase of the Japanese navy, it is probable that the necessity of gaining colonies for the surplus population of the islands and the expansion of Russia to the sea-coast opposite Japan were leading causes. The increase was in some respects as remarkable as the growth of the German navy, for the first ironclad Japan had possessed was a small one, the *Stonewall Jackson*, purchased from the United States Government in 1866.

The growth of naval armaments in the opening years of the 20th century became almost feverish, though Italy, crippled financially, tended to drop out and leave the field to the remaining six Powers. With the exception of Italy, we find the vote for new construction for each of the great naval Powers rising to the highest on record; and while Great Britain resorted to the policy of yearly programmes, Germany brought forward an ambitious scheme in 1900 which extended to the year 1916, though subsequent events pointed to the desire to complete it by a much earlier date. France and Russia also framed their programmes for a number of years ahead. Only one attempt had been made to check the rising tide of naval armaments, and that was the Tsar's Peace Conference at The Hague in 1899. Prior to the assembly of the Conference the First Lord of the Admiralty, from his place in the House of Commons on 9th March 1899, said:—

> We have been compelled to increase our expenditure as other nations have increased theirs, not taking the lead, not pressing on more than they. As they have increased, so we have increased. I have now to state on behalf of Her Majesty's Government that similarly, if the other great naval Powers should be prepared to diminish their programme of shipbuilding, we should be prepared on our side to meet such a procedure by modifying ours. The difficulties of adjustment are no doubt immense, but our desire that the Conference should succeed in lightening the tremendous burdens which now weigh down all European nations is sincere. But if Europe comes to no agreement, and if the hopes entertained by the Tsar should not be realized, the programme which I have submitted to the House must stand. It is constructed on the basis on which the House itself has always expected us to rest it. It is the lowest which can be justified by the existing expenditure on shipbuilding of other countries; it is the lowest by which we can secure the object which the people expect of the navy.

The Conference was fruitless so far as any reduction of naval armaments was concerned, the years 1900 and 1901 having each marked a fresh advance—in some cases considerable—in the naval budgets of the Powers.

III. The Evolution of Warships.

In 1870 Great Britain and France each had thirty-six ironclads built or building. Ship for ship, the advantage with the former Power was by no means great, and in the number of heavy guns she was inferior. By the end of the 19th century all the ships of 1870 had vanished from the sea-going squadrons. The British Admiralty at that time reckoned 4 per cent. per annum as the depreciation of a battleship, so that her life was estimated at twenty-five years. This obsolescence of ships is caused by the progress of marine engineering and the rivalry between gun and armour (*q.v.*). Until 1885, when chrome steel shot were invented, the advantage had been with the compound armour. Then came the face-hardening process, and the *Majestic* was the first ship in the world actually completed with Harveyed armour (1892). In 1901 the U.S. Naval Intelligence Department were able to report in their *Notes on Naval Progress* that the armour-plate once more held the advantage. At that time British naval practice, as in the battleship *Queen* and the cruisers of the *Kent* class, was to put 9-inch armour on to the sides of the battleships and 4-inch on to the sides of the cruisers. In 1901 a British Committee on Explosives recommended the adoption of a powder enabling higher velocities to be obtained, and consequently greater penetration (see Gunnery), thus foreshadowing the probability of the advantage resting with the existing thickness of armour for only a few years longer. The following year the old *Belleisle* of the British navy was fitted up with the armour then used, in order to be actually fired at by modern guns.

Few tasks are more difficult or more empirical than comparisons of naval strength. The most modern type of 12-inch gun at the end of the 19th century fired twice as fast as and was superior in all respects, including accuracy of shooting, to the $13\frac{1}{2}$-inch gun mounted in other battleships; while the latest type of 6-inch gun could perforate twice as much armour as an earlier type of 6-inch gun in another ship; and, again, there was much greater rapidity of fire. When we come to the armour question our difficulties are increased. At the end of the 19th century there were several varieties of armour in the first-class battleships. The usual formula was to assume that Krupp cemented armour was equal to 2·4 times its thickness in wrought iron, Harveyed or Krupp non-cemented to twice, and compound or steel armour to 1·7 times the thickness in wrought iron. The evolution of the armour is well and concisely illustrated by the following table, which is taken from the American *Notes on Naval Progress*:—

Armour Protection of British Battleships.

Date.	Ship	Thickness of Armour, in inches.	Weight of Armour, in tons.	Displacement of Vessel, in tons.	Percentage of Armour to Displacement.	Length of Vessel, in feet.	Length of Belt, in feet.	Percentage of Length of Belt to Length of Vessel.	Depth of Main Armour.
									Ft. in.
1881	Inflexible . .	16-24, iron	2450	11,880	20·8	320	110	34·3	15 8
1886	Collingwood . .	8-18, compound	1780	9,500	18·7	325	140	43	15 8
1892	Royal Sovereign .	Do.	2900	14,150	20·5	380	248	65·2	15 1
1895	Majestic . . .	9, Harvey	2790	14,900	18·9	390	217	55·6	15 0
1899	Canopus . . .	6, Harvey	1740	13,090	13·3	390	198	50·7	14 0
1900	Duncan . . .	7, Krupp	2000	14,000	14·3	405	285	70·3	14 0

The importance of these details in comparisons of naval strength may be illustrated by comparing some of the British Mediterranean battleships in 1902 with the French Mediterranean battleships of the *St Louis* class built at the same time. In the British ships the 6-inch guns of the secondary batteries were protected by 6-inch face-hardened armour, whereas the *St Louis* class had only 3-inch ordinary steel armour to protect their 5·5-inch guns. All the 6-inch guns in the British battleships could have perforated the French armour at 3000 yards not only with a direct hit but with a shot striking at an angle of 30° to the normal. On the other hand, even at the torpedo range of 2000 yards, a better gun than the French ships possessed could not have perforated the 6-inch face-hardened armour of the British ships. In October 1901 the French Minister of Marine was reported in *The Times* as saying at the launch of the *Léon Gambetta:* "The duty of the French navy is above all to secure superiority of fighting type for French units. Regard should be had to the fighting value of ships rather than to their numbers." So, in 1901, the French Government followed the British policy of large dimensions for battleships, it being recognized that the requirements of a ship fit to lie in the line of battle as then constituted and to have the coal endurance in order to be able to join the line of battle at a distance from a coaling base, could not be satisfactorily met on a dimension of less than 13,000 tons. On the other hand, it was always hoped that the necessity for relying on coaling bases might be obviated by some system of coaling whilst under way, and in 1902 experiments were satisfactorily carried out by the battleship *Trafalgar* which tended to show that a vessel could be coaled at a fair rate from a collier in tow. The need for large dimensions in battleships would still, however, exist in the necessary provision of armour and armament. Thus the 9·2-inch gun was introduced into the secondary armament in 1902 on board battleships in addition to the 6-inch gun, since it might be expected to perforate 6-inch face-hardened plates at 3000 yards and over at nearly all angles of impact. This of course meant increased weight. We find provision was made for battleships in Great Britain in 1902 of 16,500 tons, for Japan 15,200 tons (built in England), France 14,865 tons, Italy 13,500 tons, Russia 13,600 tons, and the United States 17,581 tons. The dimensions of battleships laid down by Germany continued to be 11,800 tons until, in 1901, vessels of 13,000 tons were laid down. The chief departures from the British type of battleships were some built in the United States with what were known as superposed turrets. The British system of placing the secondary armament in casemates (abandoned in 1902) was not so largely adopted by other countries. In addition some countries used triple screws and burned liquid fuel.

IV. Reconstruction of Ships.

We have a further source of complication in comparing the relative strength of navies. All nations in varying degrees have reconstructed vessels to bring them up to modern ideas. In such cases the life would probably be prolonged beyond the twenty-five years which we stated to be the British Admiralty's estimate in 1900 for a battleship. While at a later date the expenditure may be regretted, the system frequently offers a quicker accession of naval strength than is to be obtained by devoting the money to new construction. Both in France and Germany extensive reconstructions were at different times carried out, particularly about 1900–1902, and it appears to have been recognized that the most valuable are those undertaken sufficiently early in the vessel's career. Some of the most remarkable alterations were those of the *Hagen* class in Germany. These coast-defence ironclads were cut in two and lengthened by 27 feet. The increase of tonnage from 3500 to 4114 tons enabled the vessels to be generally improved, especially with reference to coal endurance. The experiment was regarded as successful. It was a characteristic of all German reconstructions that woodwork was, as far as possible, removed and steel substituted. The British trials of the *Majestic* firing at the *Belleisle* in 1900 were considered in Great Britain to have proved that there is no danger from fire where wood decks are bolted over steel. As showing the expenditure sometimes involved by reconstruction, it may be stated that the mere alterations from above-water torpedo tubes to submerged tubes in the *Brandenburg* were estimated to cost £46,000. Though Great Britain lagged behind France and Germany in the attention devoted to reconstruction, it should be remembered that all her recent battleships had certain advantages in the earlier adoption of submerged tubes and face-hardened armour. Thus we have seen that the *Majestic*, completed in 1895, was the first ship with face-hardened armour, and the enormous gain over the *Royal Sovereign* is illustrated by the remark that it was possible to increase the area protected by 50 per cent. for the same weight. In Germany, the *Aegir*, completed in 1897, or two years after the *Majestic*, and in France, the *Bouvet*, completed in the summer of 1898, were the first ships of the respective nations to have face-hardened armour, and this only on the thickly plated barbettes and belt. It thus results that the *Carnot*, *Jauréguiberry*, *Charles Martel*, and *Masséna*, all completed in 1897 and 1898, had nickel-steel armour, which was not nearly so efficient as face-hardened armour. While on the subject of reconstructions, it may be mentioned that in 1902 the policy was inaugurated in Great Britain of strengthening the armament and protection of ten battleships and fifteen protected cruisers. At the same time, owing to the congestion of work in the royal dockyards, the First Lord of the Admiralty intimated the intention of carrying out a great deal of the repair work of the navy in the private yards.

The fact that Great Britain was in advance of the nations in adopting essential improvements formed a significant change from the period of the 'seventies, when all the European navies adopted breech-loading ordnance, whereas in Great Britain the *Ajax*, launched in 1880, was armed with muzzle-loading guns. This vessel was removed from the effective list in 1902, at which period the Admiralty appear to have finally determined on removing the reproach from the British navy that could have been levelled at the beginning of 1901, to the effect that, except for four muzzle-loading guns in the Italian navy, the British navy was the only one possessing the obsolete armament to the extent of over 300 guns. These were confined to some sixteen third-class battleships, a few coast-defence vessels, and obsolete cruisers which were not in commission in 1900, and they did not affect the superiority in the total number of breech-loading guns which Great Britain possessed over the second and third navies combined, as can be seen from Table F. These vessels, including the *Agamemnon* and *Ajax*, built in 1879 and 1880 respectively, were gradually eliminated in 1901 and 1902.

V. The Naval Policy of the Powers.

The British Empire.—To the student of naval history it is difficult to understand how the predominant naval power, with traditions from the Armada and Trafalgar periods, should have included coast-defence vessels in the British shipbuilding programmes in 1870 and subsequently. When, however, we consider the history of the controversies raging round imperial defence, we perceive that the coast-defence vessels were but a symptom of false ideals which had swept over Great Britain under the influence of the doctrine that "steam had bridged the Channel." It was one Sir Robert Peel had coined and Palmerston passed into circulation. "Our great reliance," St Vincent had said, "is on the vigilance and activity of our cruisers at sea, any reduction in the numbers of which, by applying them to guard our ports, inlets, and beaches, would, in my judgment, tend to our destruction." "The opinion of Sir Francis Drake," wrote Howard to Walsingham in 1558, "Mr Hawkyns, Mr Frobisher, and others that be men of greatest judgment (and) experience is that (the) surest way to meet with the Spanish fleet is upon their own (coast) or in any harbours of their own and there defeat them." No wisdom of the past could stand against a plausible formula that "steam had bridged the Channel." The state of affairs in Great Britain throughout this period 1870–85 was summarized by Sir George Clarke and Mr J. R. Thursfield in the preface to their work on *The Navy and the Nation*:—

The strength of the navy was allowed to decline till the annual vote for shipbuilding was equalled or exceeded by that of France, who within a few years of the disasters of 1870–71 began steadily to increase her fleet. It is indisputable that the vast expenditure upon measures of passive defence which was inaugurated in 1859 checked and stunted the growth of the navy. Too much, however, may be made of this point, and the actual expenditure is of small account in comparison with the warping of the national policy and the establishment of false standards, which only a great war can efface. After many millions had been uselessly squandered, the scares of 1878 and of 1885 were widely felt. It was realized that the nation was quite unprepared, and that measures of passive defence, however academically successful, were quite unsuited to the needs of war.

On the 21st November 1888 a committee consisting of Admirals Sir W. Dowell, Sir Vesey Hamilton, and Vice-Admiral Sir F. Richards, reported to the Admiralty on the naval manœuvres of that year. It is a report marked by unusual directness of language, in which the issues are very plainly stated, while it exercised a great influence on British naval policy. We quote some paragraphs:—

The main lesson which these manœuvres emphasize is that Great Britain, whose maritime supremacy is her life, is very far from being as strong as she should be on the seas, either in *personnel* or *matériel*. . . . We are decidedly of opinion that no time should be lost in placing her navy beyond comparison with that of any two Powers.

England ranks among the great Powers of the world by virtue of the naval position she has acquired in the past, which has never been seriously challenged since the close of the last great war.

The defeat of her navy means to her the loss of India and her colonies, and of her place among the nations.

Without any desire to question the sums annually granted by Parliament for the maintenance of the services, we cannot but note the disproportion in the appropriation when the magnitude of the issues involved is taken into consideration.

It would, in our opinion, be far more in consonance with the requirements of the nation by the provision of an adequate fleet to render invasion an impossibility than to enter into costly arrangements to meet an enemy on our shores (instead of destroying his "Armada" off our shores), for under the condition in which it would be possible for a great Power successfully to invade England, nothing could avail her, as, the command of the sea once being lost, it would not require the landing of a single man upon her shores to bring her to an ignominious capitulation, for by her navy she must stand or fall.

While due allowance is made for the influence of experts and writers, it cannot be doubted that the extraordinary growth of British maritime interests led to anxiety on the part of the commercial community which had a great deal to do with the determination to maintain the two-Power standard, or equality in battleships with the two next maritime Powers. This standard came into vogue in England in 1889. Thus the foreign trade of the United Kingdom had increased from 547 million sterling in 1870 to 870 million in 1901, exclusive of the enormous trade in bullion, specie, diamonds, and stock exchange securities. The earnings of British shipping alone in a single year were over 60 million sterling. The imports of corn, sugar, wool, and timber had each more than doubled in the three decades; and as these articles are so bulky, and the return cargoes of coal had increased fourfold from 11½ million tons in 1870 to 44 million tons in 1900, there was naturally an immense development in the mercantile shipping which is so absolutely dependent on naval protection in war time. Thus in the year 1870, 73,198,600 tons of shipping employed in the foreign and coastal trades had entered and cleared in the ports of the United Kingdom, whereas in 1900, 208,777,000 tons had entered and cleared. This last was exclusive of 1,572,000 tons employed in the transport of troops and stores for the South African war, which it was seen could never have been carried out had not the Royal Navy safeguarded Great Britain from any likelihood of hostile intervention. These figures and statements give, however, but an inadequate measure of the wealth and growth of those maritime interests which the British navy had to protect. Even when we have added the coastal trades and the growing foreign trades of the great dependencies and colonies of the British empire, there still remains the British shipping employed by other nations. As stated by the Shipping Federation in their petition to Parliament in May 1899, only one-third of British shipping was employed for the requirements of the United Kingdom. Then again, some 70 per cent. of the submarine cables of the world were owned by Great Britain, and she had become dependent not only for cotton (as in the Lancashire cotton famine of 1861–64) and for timber, but also for food, iron ores, and all raw materials of manufacture, on countries separated from her by the sea, which in war can tolerate only one master, and becomes a multiplying power to the strong and an enslaving tyranny to the weak. These necessaries for existence were brought to Great Britain, or were being paid for by return cargoes, in about 6500 British vessels in winter and 7500 in summer, which would be actually ploughing their way through the ocean on any one day of the year, exclusive of all in port loading with cargoes, and exclusive also of foreign vessels.

With such stupendous maritime interests to protect, it almost defies investigation as to why there should ever have been a cause for naval scares, and as to how it came about that a country with a past steeped in successful naval tradition should, in the plenitude of her strength, have had ministers who attempted to provide localized substitutes for the mobile naval defence. The British empire had a coast-line of 43,000 miles, or 10 times that of Germany or Italy, 5 times that of France, and 2½ times the coast-line of Russia or the United States. From such facts it may be inferred that, when once the essential basis of their faith in the sea had been sapped, the argument that fortifications and garrisons could be substituted for naval defence applied all along the coast-line. As might have been anticipated, with a limited sum of money available for the purposes of defence, when expenditure was unduly diverted to localized defences, the main issues on the sea, on which everything depended, were lost sight of. It was this false doctrine of localized defence which largely militated against the mother country obtaining any substantial aid towards the navy from the outlying empire, as under its spell the idea of Australia and Canada being defended in the Mediterranean appeared inconceivable.

The position was so bad at one time that even the actual ships provided were starved for want of ordnance. Up to 1888 the Ordnance Department was under the War Office, and for years the Admiralty demands had been systematically reduced. The following table, extracted from Sir Vesey Hamilton's *Naval Administration*, speaks for itself :—

	Asked for.	Granted.
1881–82	£647,759	£360,000
1882–83	877,001	616,033
1883–84	707,002	500,491
1884–85	899,602	500,000
1885–86	1,145,000	850,000
1886–87	1,516,887	1,000,000

In 1889 the sum of £1,717,561 was transferred from the army to the navy estimates for the ordnance vote, and with the augmentation of the navy this vote has considerably increased since that date.

The navy estimates of foreign countries embraced details of coast defence, and, as in the French estimates, subsidies for fishing-vessels, &c. With the transfer of the Artillerie et Infanterie de la Marine to the War Department as the colonial army, the French navy estimates were considerably reduced, and it is necessary to bear in mind this fact when comparing the growth of expenditure. The British navy estimates were net expenditure after deducting the appropriations in aid and any special provision for permanent works like docks. Thus, owing to the great increase in the navy of vessels of a larger type, it was found desirable to add docks at the following places, provision being made by special Naval Works Acts :—

	Docks.
Chatham	1
Malta	2
Gibraltar	2
Bermuda	Floating dock.
Cape of Good Hope	1
Hong Kong	1

In the ten previous years (1889–99) Great Britain had only added two docks at Portsmouth and one at Malta. During this period the longest cruisers had increased from the 400 feet of the *Northumberland* to the 500 feet of the *Terrible* class, and the battleships from 345 feet for the *Trafalgar* to 400 feet for the *Formidable*. Even with this development the largest battleships were from 200 to 300 feet and the largest cruisers 100 to 200 feet shorter than the largest passenger steamers, such as those employed in the Atlantic trade. In the same period the Mediterranean squadron had been doubled from 96,000 tons in 1889 to 205,000 tons in 1899, the Channel fleet increased fourfold from 37,000 tons to 155,000 tons; the China squadron was nearly trebled, and the remaining squadrons doubled. Hence the urgent necessity for special expenditure granted apart from the normal navy estimates.

From 1870 to 1885 the British navy estimates were maintained at from £10,000,000 to £12,000,000 sterling, and the *personnel* dwindled from 61,000 to 57,000 officers and men. The subsequent course of events is shown in Table C. It is characteristic of the haphazard methods pursued, that with the increase of ships provided for in 1885 no provision was made for increasing the *personnel*, and the then Board of Admiralty were accused by the succeeding First Lord of having neglected to provide even the money for the ammunition and torpedoes for the ships built. Again, with the Naval Defence Act of 1889, when provision was made for doubling the navy and everything pointed to a scarcity of officers in the future, the number of entries into the *Britannia* was actually reduced by one-fifth. Where foresight, organization, and business-like methods were vital, the administration of the British navy during those periods of its expansion does not show to advantage beside the carefully thought-out plan by which the German Admiralty proposed to carry out the vast increase of the Imperial Navy. In the latter case we find the expansion of the dockyards, *matériel*, and *personnel* of the navy going on hand in hand. The faults of the British system were obvious, and had been condemned by the highest authorities in the Government. "The exercise of the Treasury's powers," said the Prime Minister in 1900, "in governing other departments of the Government is not for the public benefit." On 24th November 1901 the First Lord of the Admiralty declared that if business men were appointed to the Admiralty, they would find "that under an infinite variety of sub-heads they had, fifteen months beforehand, to state what they were going to spend fifteen months hence, and that they could not, in the course of business, transfer sixpence from one sub-head to the other without the consent of a totally different firm." Nothing could more conclusively prove that the fault lay in the system than the fact that we should so often find First Lords of the Admiralty committing mistakes that they themselves had condemned. It would be difficult to believe that the author of the following words, extracted from "the statement of the First Lord explanatory of the navy estimates 1887–88," was the same First Lord who reduced the navy estimates in 1887 and 1888, and was forced by "popular pressure" to bring in the Naval Defence Act of 1889. Yet so it was, and we quote his words in full, since they afford a statesmanlike review of a lesson from which Great Britain appeared to have profited but little :—

A careful review of the expenditure of the past six years is necessary, in order that the significance of our present position, and the causes at work in establishing it, may be understood by Parliament and the country. In the period between 1881 and 1885 every naval Power in Europe, save England, largely increased its naval expenditure. The introduction of slow-burning powder, and the alterations in the design of heavy ordnance which it entailed, while giving increased velocity and accuracy to guns of all calibres, produced a corresponding development in the defensive power of armour-clads and protected vessels. Speed in the performance of naval tactics became an even more essential factor than before, and was so recognized abroad; and on vessels of comparatively small displacement successful efforts were made to realize, by engineering ingenuity, a speed wholly unknown to the smaller craft of a few years back. These developments of speed and power necessitated increased expense. England was the last naval Power to recognize these new conditions. In 1885, under popular pressure, the Government of that day admitted the insufficiency of its previous arrangements, and, with the assent of all parties in the State, Lord Northbrook, the then First Lord of the Admiralty, proposed to expend, in addition to the ordinary shipbuilding programme, a sum of £3,100,000 in the building of ships by contract in private yards. An additional sum of £1,600,000 for guns was also proposed to be added to the ordnance votes of the navy, which are included in the annual estimates of expenditure of the War Office [since transferred].

If this great sum had been spread over this period of six years more evenly, and if consideration and a continuous policy had attended its disbursement, the navy at this moment would be far stronger than it is. On the other hand, the increase of strength which this sum will ultimately give would have been more economically attained if hurry and scare had not attended its outlay. The conclusion to be drawn will, I trust, not be lost sight of by subsequent Administrations and by Parliament.

It may be said that from 1885 the British navy, supported by the public, was fighting against the inertia of previous years, and even the necessary Naval Intelligence Department which was formed in 1887 had a struggle for existence. In 1901 it consisted of 14 officers, as against 17 for the German Naval Intelligence Department.

By 1901 the evolution of naval opinion had reached as enlarged a conception of the functions of the British navy as Moltke possessed concerning the functions of the German army. Moltke's method was, on a careful estimate of the situation, to organize the army to suit what would be the probable situation in war, without reference to the possibilities which alarmists are prone to place in the foreground of their pictures. In 1901 the First Lord of the Admiralty laid down the true standard on which naval strength should be based, viz., "The navy ought to be so strong that it can have a reasonable certainty of success in the performance of any duty which it is reasonably probable that it will be called on to perform." This was emphasized in the House of Commons on 22nd February 1902, by the Financial Secretary of the Admiralty, who said, "Their duty was to have a naval force which should certainly not be less than the standard of two other Powers, and should be equal to any reasonable emergency with which we might expect to be confronted. This of course involved a power not only equal to, but in excess of, the standard of two Powers."

The tables accompanying this article show the progress achieved. From these it will be seen that in the 10 years ending 31st December 1900, or the closing decade of the 19th century, Great Britain had built or commenced 38 battleships, France 17, Russia 18, Germany 19, Italy 6, the United States 16, and Japan 6, making a total of 120 battleships built or commenced since 1890. If we exclude Japan, and so confine our attention to those nations likely to wage war on the Atlantic, we find that in 1902 one in three of the modern completed battleships was British. When we reflect that the average tonnage of these vessels was higher than that of any of the other Powers by nearly 1000 tons, the position of Great Britain appears to have been a fairly satisfactory one. The same apparently favourable position existed as regards the armoured and protected cruiser classes and the mercantile auxiliaries. Since 1890 Great Britain had built or laid down 96 armoured or protected cruisers, as compared with 41 for France, 19 for the United States, 18 for Japan, 16 for Italy, 15 for Germany, and 13 for Russia. The requirements of the British empire, with its 43,000 miles of coast-line, connected by shipping routes which have to be protected, and the necessity this protection imposes of persistently watching the enemy's ports, pointed to the need for larger supplies of cruisers than mere comparisons with other nations might suggest. Considering the matter as one of insurance, although there is very little strategic relation between the defence provided and the extent of interests which have to be defended, it is interesting to note that a Parliamentary Paper in 1899 gave the naval expenditure per ton of mercantile shipping as in Great Britain £2, 11s. 3d., France £14, 8s. 1d., and Russia £14, 18s.

It was a subject of controversy at the beginning of the 20th century whether the strain maintained on the British navy during peace was not an unnecessarily severe one, owing to the policy carried out by Great Britain alone of maintaining large squadrons in every part of the world. The opinion was held by many that the British navy would gain both in organization and training if these ships were more concentrated during peace. The growth of Italy, the important colonies which France had acquired in North Africa, and finally the opening of the Suez Canal, had brought about a concentration of French naval force in the Mediterranean. The Franco-Russian alliance induced the British Government to place their Mediterranean fleet on what was practically a war footing, and a great deal of expenditure was incurred at Gibraltar in the attempt to make it an efficient dockyard. In view of the proximity of the Spanish shore, and the fact that the home dockyards were distant only five days' steaming at moderate speed, this expenditure was very seriously called in question, on the ground that it could have been more usefully applied in other directions. The same law holds good as regards navies as in commerce, that large concentrated resources, such as great naval yards like Plymouth and Malta, work far more efficiently and rapidly than the necessarily small resources of an intermediate and expensively created dockyard such as Gibraltar promised to be. Therefore it is only a superficial view which would develop Gibraltar merely because naval actions might be fought in its vicinity. There is nothing to show in St Vincent's expressed opinions that even in his day, when England was so distant in time, he attached any value to Gibraltar beyond the opportunity of anchorage and ordinary supplies which it gave. There is the very good reason that he abandoned the Mediterranean when the over-anxious Admiral Mann carried his squadron to England, to show the real and concrete value which he attached to actual fighting ships. Millions had been diverted from direct naval expenditure on ships and men in the British empire to what was merely superficial, of local utility, or only supported by the plausible argument that resources and defences were being provided which enabled the fleets to operate more freely.

It appears to be difficult for men to understand that warships are built to fight ships of their class, and are quite unsuited for the direct attack of fortifications. The threat of interruption when attacking land defences—as occurred at Lissa, in the war between Italy and Austria—deters them from using their ammunition supply, which is even more limited in quantity than was the case in the past. The ammunition supply and the life of the gun have to be husbanded for the purpose of fighting the enemy's ships. It follows, therefore, that the sedentary defence need only be of moderate dimensions, except where it is contemplated, as was done by Lord Palmerston when he initiated the Portsmouth fortifications, that the sedentary defence *should defend the fleet itself*. This position was no longer contemplated in British naval policy at the beginning of the 20th century. It should also be remembered that no amount of defence on shore can safeguard the communications of bases like Malta unbacked by continental territory. Large supplies of coal could not be accumulated because of deterioration, so that the communications of the base in war might easily be of equal importance with the base itself. British naval operations must therefore, apart from the fortifications, provide for the defence of the base and its communications. In this connexion the answer of Moltke, when urged to build fortifications on a certain line of march, may be cited. He replied that if the enemy were to go that way the forts might doubtless be useful, but they would be unnecessary, as he should meet the enemy with the field army; but, he added, if the enemy takes another route, the men in the fortifications and the money which had been spent on them would be lost to the field army. Applying this lesson to the British navy, it was contended by some authorities on imperial defence that the scale on which shore defences were necessary to the British Empire was dictated solely by the probable raids of a few fast vessels and torpedo craft. In the absence of any fortifications, these vessels might otherwise be willing to incur the risk of capture for the sake of the damage which they might hope to inflict before they could be interfered with.

It was also contended that the sedentary garrison should be organized in such a way as not to interfere with the free movement to other parts of a large proportion of the troops. Both in South Africa and in China, in 1899 and 1900, naval forces had to be landed, and the ships denuded of their fighting complements, because the troops could not be sent without grave delays. The Benin expedition of 1897 was another case in point, where ships were denuded of their crews to undertake an inland expedition. When all the facts came out concerning the bombardment of Alexandria in 1882, they did not add to the prestige of the navy, but the final comment must be that the navy was called upon to perform work which was essentially military in its nature, and in which the fleet ought only to have played an indirect part. If in circumstances of peace Great Britain had so often to employ the navy on military work, the question was suggested by Sir John Colomb as to where the naval commander-in-chief would find the military forces to co-operate with the navy in capturing vessels in a harbour which is secured against attack by sea, but not against a landing-party. And yet it is the case that in offensive operations a military force, capable of being rapidly transferred by sea, is of the greatest assistance to the work of a predominant navy. Hence there arose a demand at the beginning of the 20th century for arranging that the coaling stations should be under naval control, so that the admiral should have at his disposal the military units which might be quartered on shore, as also the use of the shore guns on board the ships if he should require them.[1]

In respect of the sense of proportion which enables a statesman to consider the whole of a question before the parts are dealt with, it is doubtful whether imperial defence had made much progress in England or her colonies at the end of the 19th century. The whole system of Parliamentary procedure blocked the way to progress, for no member of Parliament would be in order who attempted to refer to the navy in a debate on the army estimates, or *vice versâ*. No discussion could take place as to the Cabinet Committee of Defence, which was supposed to deal with the whole question of imperial defence, for no salary attached to the secretary or the members of the Committee.

If British naval policy betrayed want of clear thinking, it must be confessed that France was even worse served. The Ministry of Marine changed its chief more than thirty times in thirty years, and was subjected to repeated commissions of inquiry, which only tended to create confusion. Numerous changes took place in the system of the administration, preparation for war, and policy. As regards shipbuilding, the navy estimates for 1900–1901 made provision for expenditure on six battleships. In the previous year (1899) the reporter of the French Budget Committee said that he approved, "without reserve, the decision of the Minister of Marine to suspend for 1899 the ordering of a new battleship, so as to concentrate all available resources on cruisers, torpedo-boats, and submarine vessels." It has been the prevailing characteristic of French naval policy in the past, that it seldom exhibited any stability of purpose, such as is stamped on the carefully thought-out German programme. In introducing the estimates for 1900, the French Minister of Marine pointed out that the programme of 1871 had been repeatedly modified, and yet was not completed. "The Government considers that it is indispensable to do away with such errors, and to lay down in definite form what should be the organization of the navy, adapting it, like that of the army, to the needs of defence on the one hand, and to the resources in men and money on the other." The failure of many ships he attributed to repeated modifications, and hence the origin of a fixed programme to be completed in 1906 or 1907. The Minister of Marine might have added that the programmes of 1891 and 1896 were arrested within three years of their being first sanctioned.

In the above remarks the French Minister of Marine laid down the limiting conditions of national and imperial defence. No resources can provide for safety at all points. To find out the vital needs of the probable theatre of war, and to take care that in a limited expenditure of men and money the whole is not sacrificed to the part,—these are the conditions on which the maritime supremacy of Great Britain can be maintained. To attempt to provide for all the possibilities of war is to disperse resources and to court defeat. The British empire would start a maritime war with immense advantages in her favour through the geographical position of Great Britain, the chains of coaling stations supplied from South Wales with the best smokeless steaming coal, and the possession of the greatest mercantile marine and shipbuilding yards in the world. France must ever labour under the disadvantage of her coast-lines being separated by the Iberian peninsula, while Russian fleets in the Baltic and Black Sea are separated by thousands of miles of foreign coast-line, and can only obtain access to the sea through narrow channels. The Sound, the Belts, and the Dardanelles are easily blockaded by a Power which holds the supremacy of the seas. The Baltic and Vladivostok are impeded by ice during the winter months. Port Arthur, closed to the sea by a superior fleet, is isolated except for a long and uncertain line of railway traversing 4500 miles to St Petersburg. On the other hand, the necessity imposed on the British navy of keeping the sea involved greater risks of navigation. This fact is one which can be deduced from history. In the French revolutionary war of 1793–1802 the British losses from causes other than fighting amounted to 18 sail of the line, 3 fifty-gun ships, and 43 frigates; the allied nations of France, Spain, and Holland only lost from these causes 10 sail of the line and 9 frigates. This is a somewhat remarkable fact, when we consider the inexperience and disorganization of the French and Spanish navies. As with those navies at the end of the 18th century, so at the end of the 19th, France and Russia combined lacked the advantages which belong to a homogeneous force. No naval alliance in history has ever been successful against an efficient navy except when the allies were numerically far stronger than the homogeneous force, or originated from a common stock speaking the same language. New inventions, such as liquid fuel, aërial navigation, and submarine vessels, may exercise a modifying influence, but a nation which is so conditioned by surroundings as to ensure unity of purpose in her policy must have an immense advantage in all circumstances.

Germany.—The German Navy Bill of 1900 for doubling the navy in sixteen years, while allowing for the obsolescence of vessels, was heralded by the following New Year's speech of the German emperor to his generals:—"As my grandfather did for the army, so will I for the navy, carry out the work of reorganization. The navy must be equal to the army. Then I shall be enabled to procure for Germany the place among foreign nations which she has not yet obtained." At the same time, possibly fanned to a certain extent by the growth of anti-English feeling, an extraordinary outburst of enthusiasm for the navy swept across the Fatherland. The German Navy League (founded on 30th April 1898, in imitation of the British Navy League, started on 1st January 1895), with H.R.H. Prince Henry of Prussia as patron, soon had 600,000 members and an income of £25,000 a year. A few days after the emperor's New Year speech some German vessels were seized by British cruisers off Delagoa Bay on suspicion of carrying arms and ammunition to the

[1] In connexion with the above remarks the speech of the First Lord of the Admiralty in the debate on Wei-Hai-Wai in the House of Lords may be quoted from *The Times*, 19th March 1902. After stating that he had the concurrence of his Board in his remarks, Lord Selborne said: "Bricks and mortar as applied to naval expenditure are an evil, very often a necessary evil, but they are an evil. What we want are more ships, and every penny that is spent in bricks and mortar and land fortification which could be spent on more ships is money unnecessarily and badly spent. Every garrison that we have to lock up hundreds and thousands of miles away from this country is an evil, very often a necessary evil, but an evil to be reduced to the smallest dimensions possible. . . . The number of these bases and the money spent on them should be limited in the strictest manner to the absolute necessities of the navy."

Boer forces. A wave of angry feeling swept throughout Germany, and the emperor telegraphed to the king of Würtemberg his hopes that "the events of the last few days have convinced wider and wider circles that Germany's honour, as well as her interests, must be protected on distant seas, and that for this purpose Germany must be strong and mighty at sea as well as on land." When the Navy Bill was passed the emperor telegraphed to the directors of the North German Lloyd, which owned the greatest mercantile fleet of any country in the world, that when the work of building up the imperial navy was complete "we shall be able to impose [*gebieten*] peace on sea as well as on land." When the Navy Bill was being discussed in the Reichstag, a secret session of the Budget Committee was held, respecting which *The Times*' correspondent pointed out that the subsequent public debate revealed that British maritime and imperial power had been the chief subject of discussion *in camera*. On 19th June 1901 the emperor made a speech in which he said that "our future is on the sea." This sentiment, "Unsere Lukunft liegt auf dem Wasser," had been used as a motto for the German nautical display at the Paris Exhibition of 1900.

In February 1902 a German socialistic paper, which had on more than one occasion published secret papers, came out with the announcement of an increase in the navy estimates which the German Government contemplated presenting in the following year to the Reichstag in extension of the huge programme of 1900. Only the Bill of 1900 is included in the details given below. They are alone sufficient to mark the sacrifices which were being demanded of the German people and the development of national aims since the Navy Bill of 1897, when the Chancellor declared that the proposals he then brought were directed only to "the speedy completion of an unfinished institution. . . . *We do not dream of rivalling the great naval Powers.*" The Bill would "form the basis of our fleet for many years to come." No one can complain of this development of national aims. It is, on the contrary, a subject for admiration that a nation in half a century should have reached such high aspirations, for in 1848 Moltke was despairing of his country, and the Prussian navy had consisted of but one corvette and two gunboats. The quotations are simply made with the view of showing the trend of German policy, apart from the more practical outlays involved in the £93,000,000 sterling voted for the navy and the expansion of the dockyards, and apart from the expenditure on the Kaiser Wilhelm Canal, which enabled ships to pass from the North Sea into the Baltic in ten hours. The proceedings as a whole form a record of triumph for the emperor over what had been once the hostile opinion of the public. This feeling he himself virtually expressed on 18th October 1899, when he launched the battleship *Kaiser Karl der Grosse*: "If the increase in the navy which I demanded with urgent prayers and warnings had not been stubbornly refused me during the first eight years of my reign—I did not even escape derision and mocking at the time—in how different a manner should we now be able to promote our prosperous commerce and our interests oversea! But my hopes that the German will brace himself to the task have not yet disappeared, for great and mighty is his love of his country."

By 1901 the *personnel* consisted of 31,038 officers and men, as against 28,204 officers and men in 1900. It should be remembered that the fixed defences of two of the naval ports were in the hands of the navy, and a certain number of soldiers were occasionally given sea experience by embarkation in the manœuvres. An increase of 33,000 officers and men was intended to take place during the next nineteen years to 1920.

In 1901 the *matériel*, including ships under construction, was made up as follows:—

Battleships, 21—
  Of which 8 first-class completed,
    8 building,
    5 third-class completed.
Coast-defence ships, 8.
Armoured cruisers, 6—
  Of which 3 completed (2 were obsolete battleships),
    3 building.
Protected cruisers, 6.
Small cruisers, 32—
  Of which 28 completed,
    4 building.

The following programme was proposed in 1900:—

	Cost of Unit.	
28 battleships	£1,225,000	
18 large cruisers	882,000	
45 small ,, ...	269,500	
16 torpedo-boat divisions . . .	294,000	
Total cost of programme		£67,007,500
To complete vessels previously voted . .		6,630,000
Total cost of new construction . . .		£73,637,500

Allowing for certain reductions, the annual cost, spread over the sixteen years to 1916, works out at £4,900,000. To the £74,000,000 for the active navy, a sum of about £20,000,000 has to be added for the increase of the dockyards.

The following was the official scheme for building new vessels to replace old tonnage. The names of the vessels becoming obsolete for each year are given below, and, disregarding these vessels, the German navy by 1916 was intended to consist of 38 battleships, 20 large cruisers, 45 small cruisers, and 16 torpedo-boat divisions. As passed, this was reduced by 6 large and 7 small cruisers. It does not follow that because vessels are labelled obsolete in this look ahead, and left out of the above list, they are not still serviceable, and there was nothing in the scheme to prevent the official programme from being completed long before 1916. As far as could be ascertained in 1902, the last but one of the new battleships would be laid down in 1905.

Become Obsolete.

Year.	Battleships and Armoured Coast-Defence Vessels.	Large Cruisers.	Large ships required to replace yearly.
1901	Bayern, Sachsen, Würtemberg, Baden	König Wilhelm, Kaiser, and Deutschland	7
1906	Oldenburg . . .	...	1
1908	...	Kaiserin Augusta .	1
1912	Siegfried . . .	...	1
1914	Kurfürst Friedrich Wilhelm, Brandenburg, Weissenburg, Worth, Beowulf, Frithjof	...	6
1915	Hildebrand . . .	Freya, Victoria Louise, Hertha, Fürst Bismarck	5
1916	Heimdall, Hagen .	Vinetta, Hansa .	4
1917	Ægir, Odin . . .	...	2
		Total . .	27

Apart from the obsolete ships, the German navy was intended to consist of 29 battleships by 1908, in addition to 20 large cruisers, 51 small cruisers, and 16 torpedo divisions, which should make it stronger than France expects to be in 1907. The shipbuilding resources of France had fallen so far behind those of Germany in 1902, that there did not appear to be a likelihood of any other nation, excepting the United States, entering into active rivalry with Germany in the race for the position of second maritime Power in point of strength. Unquestionably Germany was possessed of great resources, using the imperial dockyards at Danzig, Kiel, and Wilhelmshaven, in addition to a number of private yards. Five of the dockyards in 1900 ranged from Danzig, employing 4900 men, to Kiel employing 11,700. In all there were 42 dockyards of various dimensions, the 39 private yards employing nearly 25,000 men. The great Krupp iron-works, which controlled dockyards, iron-works, and coal-mines, employed nearly 47,000 men. Whilst these resources gave Germany a great advantage over France, Russia, and Italy, resort had still to be made very largely by German shipowners to Great Britain, there being building in Great Britain for Germany some 200,000 tons of shipping in 1901. When, however, we consider the insignificance of German shipbuilding until 1884, when Bismarck subsidized the great lines on condition that certain ships were built in Germany, the progress made in the later period is seen to be very great.

It is necessary to recall facts like these, for it must be remembered that the burden of naval armaments is not one that is lightly borne by the great maritime islands, which depend wholly on their navy to keep open their sea communications; and Germany, vitally dependent as she is for the defence of long land frontiers on her army, may find it difficult to face the joint burden in time of great trade depression. This, however, appears to be fully realized by the Government. For the two years 1899 and 1900 the Government spent beyond the estimates £800,000. In presenting the estimates for 1901, Baron von Thielmann said in the Reichstag that the estimates in future years would be much harder to balance, owing to "the daily augmenting sums due for pensions, and the yearly increasing demands for the expansion of the navy." On 8th January 1902 Baron von Thielmann said: "The Imperial finances have turned out to be even more unfavourable than could be foreseen a year ago. The advance which characterized the last years of the past century has not only become slower, but a depression has taken its place which has been accompanied by a great collapse of important banking institutions and other undertakings. This could not fail to have an unfavourable effect on the financial situation." The strength and consistency of German policy are a product of the passion of the nation for history. A noted French deputy, M. Jules Roche, in 1895, when comparing the French and German armies and the tradition in Germany in favour of taking the offensive in war, said: "Our neighbours breathe the air of history. They never break the chain of the past. In their conversation and their literature, events of the last century are to them as if they happened only a few years ago. What concerns Barbarossa interests them as much as contemporary events, and they make a scientific and political theory out of the consequences they deduce from historic events which for us would seem to have utterly faded away." In the German navy British naval history was closely studied, and the naval programme was framed with the view of taking the offensive, as had always been advocated by the great British sailors.

The principle which animated the German Government in its policy was that naval strength is part and parcel of maritime expansion. For this reason, no detail connected with the opening up of harbours or waterways was too insignificant for the Government. Both the *personnel* of the mercantile marine and the imperial navy are the recipients of the royal favour, and the highest honours have been paid alike to the founder of the North German Lloyd and to the mercantile captain who brought the *Bulgaria* home after great privations. While liberty was conceded in peace to the shipping, in war the Government had the power compulsorily to charter for their own purposes any vessel they might require.

The old law derived from history, that the sea will have only one master, indicates that there can be no finality to naval expenditure. When the Navy Bill of 1900 was being considered, the Secretary of State for the Imperial Marine, Vice-Admiral von Tirpitz, thus defined German policy:—"The geographical position of Germany, the absence of coaling bases, and the consequent necessity for replenishing at sea, make a large battle-fleet necessary. The North Sea and Baltic coasts are so much enclosed that a war against commerce only, advantageous as it may be to other nations, is not possible for us, even if our cruisers succeeded in making the open ocean; they would be unable to return with their prizes; and where could they obtain coal? The fleet of a Power like Germany can never be the same as that of France, for instance, whose coast-line forms a projecting angle into the ocean."

The preamble of the Navy Bill expressed the opinion that "the enemy's cruisers on the chief trade routes in the Skager Rak, in the English Channel, on the northern coasts of Scotland, at the entrance to the Suez Canal, and at the Cape of Good Hope could make German navigation almost impossible." Great Britain, alone among the Powers, could operate against commerce over this wide sphere, so that we may assume as correctly expressing German views the statement of Vice-Admiral Valois in a pamphlet published in Germany in 1899, that the naval preparations were directed against Great Britain. In these circumstances it is difficult to imagine the German Navy Bill of 1900 as likely to be the last word in the regrettable rivalry of naval armaments.

The coast-line of Germany is about one-tenth that of the British empire, but the coast-line is a factor which bears very slight relation to naval operations until a nation is in a position to establish blockades. The smallness of the German coast-line, and the concentration of over 50 per cent. of the commerce by sea in the single port of Hamburg, would have made it a simple operation for a Power in command of the sea to arrest the whole of the direct sea commerce of Germany. This commerce at the time amounted to about 40 per cent. of Germany's total commerce, but a higher figure was often given through the inclusion of trade by Holland and Belgium. It was evident, therefore, that if Germany contemplated a struggle on the sea and the maintenance of her shipping, there could be no alternative but, either by her own unaided efforts or in conjunction with allies, to continue at an increasing pace the sacrifices which she was making in 1902. We may add that for years past Germany had been making these sacrifices, for in the period 1869–97, prior to the Navy Bills, the annual naval and military expenditure of Germany increased by $21\frac{1}{2}$ millions sterling, as compared with Great Britain $17\frac{1}{2}$, France $13\frac{1}{2}$, and Russia 20 millions sterling. Only an increasing population and a thriving trade would enable fresh burdens to be easily borne, and this the German Government assumed (whether erroneously or not time must show) would be the case.

France.—In the section dealing with British naval policy reference has been made to the vacillation of the French administration as compared with that of Germany. This vacillation, reflected as it was by the political changes involving a new Minister of Marine on an average of once a year, affected shipbuilding, coast defence, war training, the direction of maritime affairs, and the future conduct of campaigns. It is related of Moltke that he expressed the opinion that though a general might choose a plan of campaign which was inferior to several others, concentration of purpose in carrying it through would be more likely to bring success than to attempt first one and then another of the wiser courses. It is because the most consistent idea held in common by the majority of French naval officers at the beginning of the 20th century was the old one of the *guerre de course*, which failed in the French Revolutionary and Napoleonic wars, that a brief mention of it must be made. At the same time it should be stated that attacks on commerce (when not brought about by the regular process of attaining command of the sea) require the dispersal of warships so as to attack at many points. The fact that in 1902 a concentration of French men-of-war was effected, so that the whole of the Pacific and Indian Oceans was confided to one squadron, might be taken as a virtual abandonment of the policy of the *guerre de course.*

In discussing the British navy estimates on 9th March 1899, the First Lord of the Admiralty said:—

> I want to call the attention of the House very briefly to the fact that some of our rivals are practically giving up the idea that they would be able to meet us in the open sea, or, if they were able to meet us in the open sea, that at all events the better policy would be to endeavour to wear out the patience of this country by prolonged attacks upon our commerce, our food supply, and our sources of production. They think that while our battleships would be lying opposite their ports they would be able to sweep down upon our commerce, until this country tired of the uncertainty and the injury inflicted upon us, and of the flag being transferred to other nations. It has been avowed in the most distinct terms. Scientific and professional writers and politicians and statesmen have all commended this plan, and, what is more, they have acted upon it. The plan now is to build very fast cruisers which shall prey upon our commerce, and which shall inflict that damage upon us which I have attempted to describe. We cannot sit still in the face of the construction of cruisers intended for that purpose. We know that purpose, and it is our bounden duty to defeat it.

There can be no doubt that this summary of French naval policy was in agreement not only with the expressed opinions of French naval officers, but also of responsible statesmen. M. Delcassé, when out of office, said, on 12th December 1896: "We [the French] must avoid general actions with the same perseverance that England will try to bring them about, and direct our efforts to where she is most vulnerable. For that purpose the first quality we require is a high rate of speed, and the power of steaming a long way without having to take in a fresh supply of coal." M. Lockroy, who had been Minister of Marine, said that "by launching some fast cruisers or torpedo boats on the great trade highways it would be possible for us to starve Great Britain, to suppress her commerce, and to ruin her industries."

This policy can, of course, only be judged on historical evidence. During the last French wars, when the same policy was tried, the British mercantile marine, during the twenty years of active war, lost to the French on an average 543 vessels yearly. The British mercantile marine varied during this period from 21,000 to about 25,000 vessels. Taking the average as 23,000 vessels, the loss was 2·36 per cent. As Great Britain added to the register 925 vessels per annum during that period, and in 1810 there were no less than 4023 prize ships which had been admitted to the British Registry, there was ample tonnage to replace the waste of war, time, and navigation. There were errors of detail in the Registry in those days, and there were undoubtedly nominal captures of British ships for the purpose of smuggling goods into French territory duty free, but these limiting considerations do not alter the main conclusion to be drawn from history that the *guerre de course* as an operation of war leads to the dispersal of resources, and cannot hope to assist the main end in view, which is to bring a war to a successful conclusion. To those who examined the list of French vessels at the end of the 19th century, it was familiar knowledge that there were none available for the attack of commerce if the requirements of the battleships in scouts and look-out vessels were to be met.

The budget of 1901 provided for 20 additional submarine boats of a speed of 8 knots. When all the submarines provided for in the budget of 1902 were laid down it was calculated that France would have, built or building, no less than 44 of these vessels, or more than the programme of 1897 contemplated. A great deal of the enthusiasm for submarine boats was undoubtedly caused by their apparent cheapness, varying from £14,000 for the defence class to about £40,000 for the offensive class. It had long been realized in France that if Great Britain's sea power was to be overthrown, then, to adopt a military expression, some "turning" movement in naval armaments must be executed which would circumvent the strength of the battleships. In Great Britain, in 1900, the First Lord of the Admiralty had quoted the reporter of the French Budget Committee, who stated that in building battleships materials in France cost 40 per cent. more than in England, and labour 10 per cent. more. It was evident that a competition in battleships would be ruinous to France, although the estimate above quoted appears to have been an exaggerated one. Much of the enthusiasm for torpedo-boats at one time, and submarine boats for defence purposes at a later date, may be attributed to this cause. It was thought that these would prevent hostile ships from operating on the coast, and so the seas would be open for the commerce destroyers. Vice-Admiral Fournier (an officer of distinction on the active list of the French navy) had advocated in *Le Flotte Necessaire* a navy of 117 armoured cruisers of 8300 tons, which, associated with 300 torpedo-boats, he thought could destroy British commerce and maritime power. The Budget Committee of 1894 considered that battleships, cruisers, and torpedo craft were all necessary, a due proportion consisting of three battleships, two cruisers, a torpedo vessel, and a number of torpedo-boats. The reporter of the French Budget Committee (1899) stated that he approved "without reserve the decision of the Minister of Marine to suspend for 1899 the ordering of a new battleship, so as to concentrate all available resources on cruisers, torpedo-boats, and submarine boats." M. de la Porte, in his report on the budget for 1900, declared that French naval policy would involve an offensive defence by small craft on the coast of France, and commercial war carried on by numerous fast cruisers possessing great coal endurance. By 1901 the policy of building all types was again predominant, possibly owing to the growing naval armaments of Germany, which nation had steadfastly refused to order submarine boats, while exhibiting considerable interest in the problem of aërial navigation.

The French programme of 1900, which superseded the one of 1896, was designed so that by 1907, subsequently altered by the Chamber to 1906, the French fleet would consist of—

	Total.
4 squadrons of 6 battleships, with a reserve of 1 battleship for each squadron	28
Armoured cruisers, 8 divisions of 3 cruisers each	24
Commerce destroyers (consisting of second and third-class cruisers) about	36
Torpedo gunboats	21
Destroyers	52
Torpedo boats	263
Submarine boats	38

(The programme of 1900 authorized only 26 submarine boats, but 44 were built or begun by 1902.)

In all the new battleships it was proposed to follow the British plan of large dimensions.

The United States of America.—While it is difficult to trace any clearly thought-out policy in the appropriations made by Congress for the United States navy at the end of the 19th century, the increase in the expenditure serves to indicate a determination to play a great part among the nations. Having regard to the enormous surplus of revenue, amounting in the fiscal year ending 30th June 1902 to over $90,000,000, it would be difficult to place a limit to the ambitions of the United States. The result of the successful war with Spain had made the United States a colonizing power. The report of the Secretary of the Navy, 4th November 1901, dealing with the further increase of the navy proposed for 1902, involving an additional expenditure of over £4,000,000, had referred to the responsibilities incurred in connexion with the transmarine territories of Porto Rico, Hawaii, the Philippines, and Cuba. "If we are to have a navy at all," the report stated, "it must be commensurate with these great extensions—greater in international even than in territorial importance. This necessarily involves the construction of more naval vessels, their manning, exercise, and maintenance." About the same time President Roosevelt emphasized certain doctrines absolutely dependent on armed force for their ultimate sanction. "The United States must not shrink from playing its part among the great nations. We cannot avoid hereafter having duties to do in the face of other nations. We do not intend to sanction any policy of aggression by one American commonwealth at the expense of any other, nor any policy of commercial discrimination against any foreign Power whatsoever. Commercially, all we wish is a fair field and no favour, but if we are wise we shall strenuously insist that under no pretext whatsoever shall there be any territorial aggrandizement on American soil by a European Power, and this no matter what form such territorial aggrandizement may take."

In order to be able to trace clearly the leading idea behind this outline of policy, we may quote from the subsequent speech of President Roosevelt at the Naval Academy, 2nd May 1902: "We all of us hope that the occasion for war may never come; but if it has to come, then this nation must win, and the prime factor in securing victory over any foreign foe must of necessity be the navy. If the navy fails us, then we are doomed to defeat, no matter what may be our material wealth or the high average of our citizenship. It should therefore be an object of prime importance for every patriotic American to see that the navy is constantly built up and, above all, is kept at the highest point of efficiency both in *matériel* and *personnel*."

In the days of wooden ships the American timber supply had given to the United States a great position in the shipping trade, and there appeared to be no reason why a similar position should not be won in the opening years of the 20th century. Stress was laid on this point by President Roosevelt in his message to Congress in 1901. The production of coal and iron, which had been the source of Great Britain's power, had reached a point in the United States at which the coal was cheaper (after due allowance had been made for its lower calorific power), and the production exceeded that of Great Britain by many millions of tons. The annual output of pig-iron was twice as large, and an even greater superiority had been won in steel production. At the end of the 19th century the United States paid to foreign and American shipowners £346,000 for the carriage of the mails. The coasting trade, as formerly, remained an exclusive monopoly for American vessels. Proposals from time to time came before Congress for encouraging American shipping by the payment of bounties, and the fact that 322 steamers were utilized in the Civil War, and over a hundred in the war with Spain in 1898, was not lost sight of as an argument in favour of encouraging the ownership of vessels under the Stars and Stripes. Mercantile auxiliaries were the outcome of the high organization of modern naval war requiring colliers, distilling ships, cold storage and provision ships, hospital ships, ammunition ships, telegraph ships, and parent ships for torpedo craft. It was recognized that most of these could be improvised from the mercantile marine if the details were settled beforehand. Such arrangements should prevent the transfer of desirable vessels to other flags at the moment they are likely to be required. This actually occurred in the case of the American cable-ship *Grappler* just prior to the American-Spanish war. An instance of the resort which might be made to auxiliary vessels was afforded in the American-Spanish war by the voyage of the U.S. battleships *Oregon* and *Iowa* from the West Indies to the Pacific. They took with them five colliers, one distilling ship, and one cold storage ship, so as to be self-supporting. Apart from auxiliary ships of this nature, the U.S. Government armed 11 fast steamers, 28 yachts, and 28 tugs. The United States has never been a party to the Declaration of Paris concerning privateering, though the Naval War Code (issued in 1900 to the U.S. navy under the approval of the President) lays down very clearly the rules which are to be acted upon as regards belligerent and neutral property. Apart from this, however, the policy of arming auxiliary merchant vessels has been acted on by all nations since the Prussian Government created a volunteer fleet in the war of 1870–71. These ships, it will be remembered, were officered and manned from the mercantile marine under naval discipline, and flew the national flag. While, however, it was recognized in the United States that fast auxiliaries could relieve cruisers of much of the work of scouting, communications, and could fight vessels of their own class, it was never contemplated that they could form efficient substitutes for armoured ships on other occasions. The real object aimed at, after the provision of a mercantile marine as a factor of commercial prosperity and an adjunct of the navy, was the development of the shipbuilding resources of the country. The importance of this consideration may be illustrated by the statement that it was possible in 1902 confidently to predict that the shipbuilding resources of the United States and Germany would enable those nations to take the second and third places in the navies of the world within the decade, in spite of any efforts of France and Russia based on the national shipbuilding resources. The development of resources is of great importance to a country circumstanced as is the United States. The geographical position and the absence of any vital point of attack conferred a power of prolonging a conflict which a country like Great Britain could not obtain except by successful action on the part of the organized fleets. In Great Britain there existed perfect free trade, and in Germany an approximation to free trade for anything to do with the materials of shipbuilding. Whether as a result of Protection, or of other causes, the fact remained that the cost of construction was in 1902 considerably higher in the United States than in Great Britain and Germany.

It had for a long time been a blot on the United States navy that so large a proportion of the *personnel* consisted of aliens, or naturalized aliens, instead of native-born Americans. While all the officers of commissioned rank were native-born Americans, 35 per cent. of the whole enlisted force in 1899 was of foreign extraction. In the annual report of the Chief of the Bureau of Navigation, we are told on 30th June 1899 there were 14,500 men in the United States navy, classified as follows :—

7380	native-born.
2441	naturalized.
1290	"alien, but declared."
622	alien residents of the United States.
544	alien non-residents.
2002	native-born apprentices.
187	foreign-born apprentices.

Fifty-six per cent. of the petty officers were native-born. To increase the proportion of native-born men, efforts were made to train landsmen for the purpose, and in 1901 the Bureau of Navigation was enabled to report that "the training system for landsmen has greatly added to the facility and economy with which the complements of the vessels of the Asiatic station have been kept as nearly full as practicable." One of the chief lessons derived from the war with Spain was the necessity of a large reserve to provide for expansion in war. This necessity was rendered greater owing to the excessive cost of the *personnel*, amounting to nearly six times as much per head as that of the German navy, and nearly twice as much per head as that of the British navy. It was felt that by devoting special attention to the training of a proportion of men, these could be used to stiffen the vast increase of *personnel* which experience had shown would take place on the outbreak of war. The utility of devoting special attention to the training of the select few was negatively shown by the results of the battle of Santiago, where out of 9474 rounds fired from the American ships only 124 rounds, or 1·3 per cent., hit the fleeing Spanish vessels. The tendency, however, is one which could be carried too far, and that this had been done was strenuously pointed out by the chief of the Bureau of Navigation in his report issued in 1901. The report said: "It has always been the policy of the Government to regard its regular establishment of the navy and army as a nucleus about which a larger establishment would be formed in case of war. The present establishment, however, can no longer be considered as an effective nucleus for such a purpose. It barely sufficed for the Spanish war; and were the fleet to be manned with full complements, as it would necessarily be if called upon to fight a first-class European Power, the present *personnel* would form barely one-fourth of the total establishment." Outspoken criticisms of this nature by the heads of the different naval departments were a characteristic of the American naval administration, and afford some indication of what might have been the case in the British navy had the recommendation of the Hartington Commission been carried out, that annual reports from the different Sea Lords of the Admiralty should be issued.

The position of that vast territory of 3½ million square miles, with a population double that of the United Kingdom, bordering on two oceans which were destined to be brought into closer union by an Isthmian canal, was a source of anxious thought in every quarter of Europe at the beginning of the 20th century. It was difficult to avoid the conclusion that when such a nation exhausted the tempting investments afforded by its own internal expansion, capital must overflow the borders in an era of maritime expansion and in the development of transmarine territory involving an increasing reliance on its fleet. To the British empire American capital might mean much, just as British capital in the past had been the prime factor in the development of the United States. In that case American capital might go far to enable the vast colonies and dependencies of Great Britain to come to the support of the maritime power of the mother country, over and beyond the insignificant contribution of £317,600 which they made in 1902. A cause for fear, however, remained to Great Britain in the probability of the American system of registry being made free enough to enable American combinations to buy up the principal British shipping lines and sail them under the United States flag. It had once been the case, about the middle of the 19th century, that President Pierce was able to report to Congress that "the United States foreign commerce has reached a magnitude and extent nearly equal to that of the first maritime Power of the earth, and exceeding that of any other" (1854). At this time American shipping was supreme in the Atlantic, though its doom was already sealed for a period by the advent of iron shipbuilding. The subject of its decay was the cause of repeated messages to Congress. On 4th December 1882 President Arthur wrote: "The Secretary forcibly depicts the intimate connexion and interdependence of the navy and the commercial marine, and invites attention to the continual decadence of the latter and the corresponding transfer of our growing commerce to foreign bottoms. This subject is one of the utmost importance to national welfare." The remedy which is indicated by the lessons of history appeared in President Cleveland's annual message in 1894: "The ancient provision of our law denying American registry to ships built abroad and owned by Americans appears in the light of present conditions not only to be a failure for good at every point, but to be nearer a relic of barbarism than anything that exists under a permission of a statute of the United States. I earnestly recommend its prompt repeal."

Personnel.

The following statistics for the great maritime Powers show their strength so far as the *personnel* of their navies is concerned :—

France (1901).

Officers	3,032	*Authority*—Estimates 1901
Men	111,961	
Dockyard riggers	2,000	Estimates
	116,993[1]	
Numbers for coast defence	14,181	
Remainder	102,812	

The navy had the following *personnel* available for coast defence :—

	Officers and Men.	Inscrits Maritimes.[2]
For manning batteries and providing signal-men for the same	...	7,000
For manning the torpedo boats of the "défense mobile"	5169	
For manning submarine boats	333	
For manning the "défenses sous-marines" and "défenses fixes"[3]	903	
Customs guards	493	
Semaphore service	283	

The French naval system of manning divides itself into three categories. (1) The Inscription Maritime nominally brought in 139,310 men in 1850 and 114,000 in 1894. It was becoming increasingly evident towards the end of the 19th century that a compulsory system could not adequately provide for the skilled mechanical work of the ships. (2) Volunteers. These chiefly supply the mechanic ratings, and a system of state schools was adopted to obtain them in 1901. (3) Army recruits, drawn by

[1] 51,243 in permanent force of the navy voted.

[2] These were formed into companies at the naval arsenals, and are supplied by the "inscrits" enrolled under category F (volunteers), men aged between thirty and thirty-three years. In 1900 there were 120,000 men of from 18 to 50 years of age on the rolls of the Inscription Maritime.

[3] These services included mine-fields, booms, searchlights, and a number of steam launches fitted with torpedo tubes or spar torpedoes. These latter were manned by "marine veterans," who in peace time manned the dockyard launches and performed other duties in connexion with the naval yards. They numbered about 2000, and only a small proportion would have been available in war time.

lots at an age of entry from eighteen to twenty years. For the purpose of the Inscription Maritime the Newfoundland fisheries were kept up at considerable expense to the nations in subsidies, although the number of fishermen was less than one-half the number of British fishermen in Newfoundland who were left untouched by the British navy, until in 1900 fifty were embarked for training. The French navy could only rely on obtaining the services of these men in the latter half of the year, the boats beginning to arrive in June and continuing to come in until Christmas time. On the other hand, the British consul at Bordeaux estimated that not less than 1300 men annually retired from the fisheries and were available for service in the navy. The actual number of French fishermen employed in the Newfoundland cod fisheries in 1898 was 5105.

Russia.

	Officers.	Warrant Officers and Men.
Total *personnel*, 1901	2131	57,957
Personnel employed in coast defence	*nil.*	

Italy.

	Officers.	Men.
Total *personnel* proposed in estimates for 1901–1902	1780	25,000
Of these there were to be employed in coast defences	...	3,489

Germany.

	Officers and Men.
Voted, 1901	31,157
Naval forces available for coast defence—	
4 divisions of seamen artillery (men only)	2,295
2 battalions marine infantry (all ranks)	1,273
2 depot companies and 1 field depot company for Kiaochow (strength variable)	...

This force was distributed among naval garrisons. These units have very large reserves, numbers not available.

The following rate of increase is fixed by law :—

Year.	Executive Officers.	Other *Personnel.*	Total.
1900	876	22,476	23,352
1905	1,179	31,187	32,366
1910	1,482	39,898	41,380
1915	1,785	48,609	50,394
1920	2,088	57,320	50,408
Total increase 1900 to 1920	1,212	34,844	36,056

It is evident that the increase fixed by law was considerably accelerated.

United States.

	Officers and Men.	Marines.	Total.
Actually serving, 30th June 1901	22,432	5845	28,277

	Men.
Garrison at Dry Tortugas, Florida	42
Guam (includes forty seamen)	145

In his annual report (1901) the Secretary of the Navy said :—"The results of the Spanish-American war were such as to assure every one having knowledge of naval matters that steps should at once be taken to meet the one certain and positive requirement which will face the nation upon an outbreak of war—the immediate necessity of that exigent time, if it comes, of a large increase in the men of the navy from an existing reserve—an increase which must, in the main, be made from the seafaring class, who, having acquired the habit of the sea, are at home on the water. There is no better way of insuring such a reserve than by the measure now urged. Our pressing need is for such a reserve—a body to go to the front on board ship at once upon the outbreak of war, or when it is imminent. Next to this will come the defence of the coast, and for such purpose the Naval Militia will be essential. I see reasons for both organizations, and have heretofore done all possible to aid the one now existing, the Naval Militia, and to convince Congress of the necessity for the authorization of the other, the National Naval Reserve."

Japan.

	Officers.	Men.
Total *personnel*, 1900	2027	21,815
Numbers employed in coast defence	Not known.	

Length of Service.

France.—(*a*) The length of service afloat in 1902 was forty-seven months, with a further thirteen months on "unlimited leave," during which men were liable to recall at any moment.

(*b*) In addition to (*a*) men were bound to serve in the first reserve for two years, and the second reserve for twenty-five years.

The conditions under (*a*) were regulated by the minister, according to the requirements and state of foreign affairs.

Russia (1902).—Five to seven years in active fleet, and then complete fifteen years' total service in the reserves.

Italy (1902).—Four years in active fleet and then complete twelve years' total service in the naval reserve, followed by seven years in the militia, but on unlimited leave during both the latter periods.

Germany (1902).—(*a*) Active service, three years; (*b*) reserve, four years. The men then join the "Seewehr" until completing their thirty-ninth year.

United States (1902).—(*a*) Active service four years; (*b*) there is not any naval reserve at present.

Japan.—Two methods, volunteers and conscripts. Volunteers—eight years in active fleet, four years in second reserve. Conscripts—four years in active fleet, three years in first reserve, five years in second reserve.

It is stated that half the seamen and two-thirds of the stokers are volunteers.

Great Britain (1902).—Voluntary service for twelve years. Voluntary re-engagement for ten years to qualify for pension. All pensioners are liable to be called upon to serve in times of emergency. There were two schemes for forming reserves. The Royal Naval Reserve scheme drew men from the mercantile marine and fishing population of the United Kingdom. The Royal Fleet Reserve scheme, introduced in 1901, while it gave a better system of training to the pensioners, was mainly designed to obtain the services in war of the men who had quitted the navy after the expiration of their twelve years' service. In 1902, 122,500 officers and men were voted for the permanent force, which means that by 1st April 1903, or the end of the financial year, it was hoped to attain that figure. In the Reserves, Class B of the Royal Fleet Reserve (which embraces the men who quitted the navy after twelve years' service) had reached a total of 1768 men on 1st March 1902, consisting of 861 seamen, 262 stokers, and 516 marines. These men were given a week's training in their former duties every year. On 31st December 1901 there were in the Royal Naval Reserve 1500 officers for combatant duties, 400 engineers, 20,627 seamen, and 3714 firemen.

The grand total of the whole force voted in 1902–03, including reserves and pensioners available for service, was 166,249, as compared with 161,640 in 1901–02.

In consequence of a series of articles in *The Times* in 1901–02, assailing the war training of the navy, in which an important count was the number of executive officers serving on shore or engaged in service other than sea service in modern fighting-ships, the First Lord of the Admiralty in 1902 issued the following interesting table of the distribution of officers :—

On 31st December 1901.	Captains.	Commanders.	Lieutenants.	Supplementary Lieutenants.	Sub-Lieutenants.	Midshipmen.	Total.
Serving in sea-going ships	101	145	718	112	154	679	1909
Employed on shore	54	116	192	18	...	...	380
On passage	3	2	26	2	...	...	33
At college, *Excellent*, *Vernon*, &c.	12	10	73	...	190	...	285
Other Government service	...	2	4	...	...	...	6
Full pay leave, or waiting employment	29	29	23	1	7	15	104
Not wishing employment for private reasons, sick, &c.	5	5	35	1	3	11	60
Total	204	309	1071	134	354	705	2777

The Extent to which Navies take Part in Coast Defences.

It is necessary to a clear idea of the *personnel* of the different navies to understand to what extent coast defence entered into their duties.

France.—Under the arrangements of 1902 the organization of coast defence placed the five naval arsenals of Cherbourg, Brest, Lorient, Rochefort, and Toulon under the command of vice-admirals, styled "Préfets Maritimes." The general defence of the littoral was, however, under the Minister for War. The "Préfet Maritime," as governor of the "place," had command of all the batteries and troops (army) quartered within his district, which extended 6¼ miles (10 kilometres) outside the line of land forts which form the defence of the "place." He also commanded all the floating defences and the semaphore system of the whole of his "arrondissement." French naval officers strongly advocated the defence of the coasts being entirely in the hands of the navy. The War Office were, however, opposed to this step, and the question was still under

TABLE A.—*First-Class Battleships of the Seven Great Maritime Powers in 1902.*

Country.	Launched.	Displacement.	Maximum Speed.
Great Britain.			
Built—		Tons.	Knots.
Irresistible	1899	15,000	18·0
Implacable	1899	15,000	18·0
Formidable	1898	15,000	18·0
Albion	1898	12,950	18·25
Glory	1899	12,950	18·25
Ocean	1898	12,950	18·25
Goliath	1898	12,950	18·25
Canopus	1897	12,950	18·25
Cæsar	1896	14,900	17·5
Illustrious	1896	14,900	17·5
Mars	1896	14,900	17·5
Hannibal	1896	14,900	17·5
Jupiter	1895	14,900	17·5
Majestic	1895	14,900	17·5
Prince George	1895	14,900	17·5
Victorious	1895	14,900	17·5
Renown	1895	12,350	18·6
Magnificent	1894	14,900	17·5
Barfleur	1892	10,500	18·25
Centurion	1892	10,500	18·25
Ramillies	1892	14,150	17·5
Repulse	1892	14,150	17·5
Resolution	1892	14,150	17·5
Revenge	1892	14,150	17·5
Royal Oak	1892	14,150	17·5
Empress of India	1891	14,150	17·5
Hood	1891	14,150	17·5
Royal Sovereign	1891	14,150	17·5
Nile	1888	11,940	16·75
Sans Pareil	1887	10,470	17·25
Trafalgar	1887	11,940	16·75
Anson	1886	10,600	16·9
Benbow	1885	10,600	16·9
Camperdown	1885	10,600	16·8
Howe	1885	10,300	16·8
Rodney	1884	10,300	16·8
Collingwood	1882	9,500	16·5
37			
Building or Preparing to Build—	Laid down.		
Vengeance	1897	12,950	18·25
London	1898	15,000	18·0
Venerable	1899	15,000	18·0
Bulwark	1899	15,000	18·0
Duncan	1899	14,000	19·0
Cornwallis	1899	14,000	19·0
Russell	1899	14,000	19·0
Exmouth	1899	14,000	19·0
Montagu	1899	14,000	19·0
Albemarle	1900	14,000	19·0
Queen	1901	15,000	18·0
Prince of Wales	1901	15,000	18·0
King Edward VII.	1902	16,500	18·5
Dominion	1902	16,500	18·5
Commonwealth	1902	16,500	18·5
15			
Projected— 2 battleships *Programme* 1902–3	..	..	..
2			

Country.	Launched.	Displacement.	Maximum Speed.
France.			
Built—		Tons.	Knots.
Iéna	1898	11,861	18·2
St Louis	1896	11,090	18·1
Gaulois	1896	11,105	18·0
Charlemagne	1895	11,108	18·1
Bouvet	1896	12,007	18·2
Masséna	1895	11,735	17·0
Carnot	1894	11,954	17·8
Charles Martel	1893	11,693	18·1
Jauréguiberry	1893	11,637	17·6
Brennus	1891	11,190	17·5
Magenta	1890	10,680	16·2
Marceau	1887	10,679	16·2
Neptune	1887	10,810	16·0
Hoche	1886	10,823	16·6
Formidable	1885	11,391	16·2
Amiral Baudin	1883	11,442	15·2
Courbet	1882	10,638	15·5
Amiral Duperré	1879	11,032	14·1
Dévastation	1879	10,535	15·2
19			
Building—	Laid down.		
Suffren	1899	12,527	18·0
République	1901	14,630	18·0
Patrie	1901	14,630	18·0
3			
Projected— 4 in number	..	14,630	..
4			
Japan.	Launched.		
Built—			
Hatsuse	1899	15,200	18·0
Asahi	1899	15,200	18·0
Shikishima	1898	14,850	19·0
Fuji	1896	12,450	18·5
Yashima	1896	12,300	19·4
5			
Building—	Laid down.		
Mikasa	1898	15,200	18·0
1			

Country.	Launched.	Displacement.	Maximum Speed.
Russia.			
Built—		Tons.	Knots.
Peresvyet	1898	12,674	19·1
Sevastopol	1895	10,960	16·0
Poltava	1894	10,960	16·3
Petropavlovsk	1894	10,960	16·8
Tri Svyatitelya	1893	12,480	16·8
Georgi Pobyedonosets	1892	10,280	16·5
Navarin	1891	9,476	16·0
Sinop	1887	10,181	17·8
Ekaterina II.	1886	10,181	16·0
Tchesma	1886	10,181	16·0
10			
Building—	Laid down.		
Oslyaba	1895	12,674	18·0
Prince Potemkin	1897	12,600	16·0
Retwisan	1898	12,700	18·0
Pobyeda	1898	12,674	18·0
Tsarevitch	1899	12,900	18·0
Borodino	1899	13,516	18·0
Imperator Alexander III.	1899	13,516	18·0
Orel	1899	13,516	18·0
Kniaz Suvaroff	1900	13,516	18·0
Slava	..	13,516	18·0
10			
United States.	Launched.		
Built—			
Illinois	1898	11,565	17·3
Wisconsin	1898	11,565	17·2
Alabama	1898	11,525	17·3
Kentucky	1898	11,540	16·9
Kearsarge	1898	11,540	16·8
Iowa	1896	11,340	17·0
Indiana	1893	10,288	15·5
Massachusetts	1893	10,288	16·2
Oregon	1893	10,288	16·8
9			
Building—	Laid down.		
Maine	1899	12,300	18·0
Ohio	1899	12,440	18·0
Missouri	1899	12,230	18·0
New Jersey	1901	14,948	19·0
Nebraska	..	14,948	19·0
Georgia	1901	14,948	19·0
Virginia	..	14,948	19·0
Rhode Island	1901	14,948	19·0
8			
Projected— 3 in number	..	..	..
3			

Country.	Launched.	Displacement.	Maximum Speed.
Germany.			
Built—		Tons.	Knots.
Kaiser Barbarossa	1900	10,905	18·0
Kaiser Wilhelm der Grosse	1899	10,905	18·0
Kaiser Wilhelm II.	1897	10,905	18·0
Kaiser Friedrich III.	1896	10,905	18·0
Wörth	1892	9,874	17·0
Brandenburg	1891	9,874	16·5
Kurfürst Friedrich Wilhelm	1891	9,874	17·0
Weissenburg	1891	9,874	17·0
8			
Building—	Laid down.		
Kaiser Karl der Grosse (B)	1898	10,905	18·0
Wittelsbach (C)	1899	11,800	19·0
Wettin (D)	1899	11,800	19·0
Zahringen (E)	1899	11,800	19·0
Mecklenburg	1900	11,800	19·0
Schwaben	1900	11,800	19·0
H.	1901	12,792	18·0
J.	1901	12,792	18·0
8			
Projected—			
2 in number for each year 1902–6	..	..	.
1 in number each year 1907–10	..	..	..
2 in number each year 1911–16	..	..	..
26			
Italy.	Launched.		
Built—			
Ammiraglio di Saint Bon	1897	9,645	18·3
Emanuele Filiberto	1897	9,645	18·0
Sicilia	1891	13,087	19·6
Sardegna	1890	13,640	20·3
Re Umberto	1888	13,673	18·6
Andrea Doria	1885	11,027	17·0
Francesco Morosini	1885	11,145	17·0
Ruggiero di Lauria	1884	10,977	17·0
Lepanto	1883	15,549	18·4
Italia	1880	15,407	18·4
Dandolo	1878	12,071	15·0
Duilo	1876	10,962	15·0
12			
Building—	Laid Down.		
Regina Margherita	1898	13,207	20·0
Benedetto Brin	1898	13,207	20·0
Regina Elena	1901	12,425	21·5 to 22
Victor Emanuele III.	1901	12,425	21·5 to 22
4			

TABLE B.—*First-Class Cruisers of the Seven Great Maritime Powers in 1902.*

Country.		Launched.	Displacement.	Maximum Speed.
Great Britain.				
Built—			Tons.	Knots.
Cressy	A.[1]	1899	12,000	21·0
Amphitrite	P.	1898	11,000	20·75
Ariadne	P.	1898	11,000	20·75
Argonaut	P.	1898	11,000	20·75
Andromeda	P.	1897	11,000	20·5
Europa	P.	1897	11,000	20·5
Niobe	P.	1897	11,000	20·5
Diadem	P.	1896	11,000	20·5
Powerful	P.	1895	14,200	22·1
Terrible	P.	1895	14,200	22·1
Crescent	P.	1892	7,700	19·75
Gibraltar	P.	1892	7,700	19·75
St George	P.	1892	7,700	19·75
Grafton	P.	1892	7,350	20·0
Theseus	P.	1892	7,350	20·0
Endymion	P.	1891	7,350	20·0
Hawke	P.	1891	7,350	20·0
Royal Arthur	P.	1891	7,700	19·75
Edgar	P.	1890	7,350	20·0
Blenheim	P.	1890	9,000	21·1
Blake	P.	1889	9,000	21·1
Aurora	A.	1887	5,600	18·1
Galatea	A.	1887	5,600	18·1
Immortalité	A.	1887	5,600	18·1
Australia	A.	1886	5,600	18·1
Narcissus	A.	1886	5,600	18·1
Orlando	A.	1886	5,600	18·1
Undaunted	A.	1886	5,600	18·1
Warspite	A.	1884	8,400	16·7
Impérieuse	A.	1883	8,400	16·7
A. 10, P. 20 — 30				
Building or Preparing to Build—		Laid down.		
Spartiate	P.	1897	11,000	20·75
Hogue	A.	1898	12,000	21·0
Sutlej	A.	1898	12,000	21·0
Aboukir	A.	1898	12,000	21·0
Bacchante	A.	1899	12,000	21·0
Euryalus	A.	1899	12,000	21·0
King Alfred	A.	1899	14,100	23·0
Drake	A.	1899	14,100	23·0
Good Hope	A.	1899	14,100	23·0
Leviathan	A.	1899	14,100	23·0
Monmouth	A.	1899	9,800	23·0
Bedford	A.	1900	9,800	23·0
Kent	A.	1900	9,800	23·0
Essex	A.	1900	9,800	23·0
Cornwall	A.	1901	9,800	23·0
Suffolk	A.	1901	9,800	23·0
Berwick	A.	1901	9,800	23·0
Donegal	A.	1901	9,800	23·0
Cumberland	A.	1901	9,800	23·0
Lancaster	A.	1901	9,800	23·0
6 in number	A.	1902	10,200	23·0
Programme 1901–2, P. 1, A. 25 — 26				
Projected— 2 in number		..	..	..

Country.		Launched.	Displacement.	Maximum Speed.
France.				
Built—			Tons.	Knots.
Chateaurenault	P.	1898	7,898	24·3
Guichen	P.	1897	8,151	23·5
D'Entrecasteaux	P.	1896	7,995	19·2
Pothuau	P.	1895	5,374	19·2
Brux	A.	1894	4,735	19·0
Chanzy	A.	1894	4,736	19·0
Amiral Charner	A.	1893	4,702	19·0
Latouche Tréville	A	1892	4,681	18·5
Dupuy de Lôme	A.	1890	6,676	19·8
Cécille	P.	1888	5,839	19·8
Tage	P.	1886	7,469	19·2
Vauban	A.	1882	6,110	14·3
— 12				
Building or Preparing to Build—		Laid down.		
Jeanne d'Arc	A.	1896	11,092	23·0
Jurien de la Gravière	P.	1896	5,595	23·0
Dupetit Thouars	A.	1898	9,367	21·0
Gueydon	A.	1898	9,367	21·0
Montcalm	A.	1898	9,367	21·0
Dupleix	A.	1899	7,578	21·0
Desaix	A.	1898	7,578	21·0
Kléber	A.	1898	7,578	21·0
Condé	A.	1899	9,856	21·0
Gloire	A.	1899	9,856	21·0
Sully	A.	1899	9,856	21·0
Marseillaise	A.	1899	9,856	21·0
Amiral Aube	A.	1899	9,856	21·0
Jules Ferry	A.	1900	12,351	22·0
Léon Gambetta	A.	1900	12,351	22·0
Victor Hugo	A.	1901	12,351	22·0
— 16				
Projected— 2 in number	A.	..	12,351	22·0
Japan.		Launched.		
Built—				
Iwate	A.	1900	9,750	21·7
Idzumo	A.	1899	9,750	22·0
Azuma	A.	1899	9,436	21·0
Yakumo	A.	1899	9,850	21·0
Asama	A.	1898	9,700	22·1
Tokiwa	A.	1898	9,700	22·7

Country.		Launched.	Displacement.	Maximum Speed.
Russia.				
Built—			Tons.	Knots.
Pallada	P.	1899	6,630	19·2
Gromovoi	A.	1899	12,364	20·0
Waryag	P.	1899	6,500	23·6
Rossia	A.	1896	12,200	20·2
Rurik	A.	1892	10,933	18·7
Pamiat Azova	A.	1888	6,600	17·0
Admiral Nachimof	A.	1885	8,500	17·0
Dmitri Donskoi	A.	1883	5,796	16·5
Vladimir Monomach	A.	1882	6,000	15·2
Minin	A.	1878	6,000	14·0
Duke of Edinburgh	A.	1875	5,000	15·2
General Apraxin	A.	1873	4,700	14·2
Knyaz Pojarski	A.	1867	5,138	11·0
— 13				
Building or Preparing to Build—		Laid down.		
Diana	P.	1895	6,630	20·0
Aurora	P.	1897	6,630	20·0
Bogatyr	P.	1898	6,570	23·0
Askold	P.	1898	6,000	23·0
Bayan	A.	1899	7,800	21·0
Kagul	P.	1900	6,570	23·0
Otchakoff	P.	1900	6,570	23·0
Oleg	..	..	6,570	23·0
— 8				
Germany.		Launched.		
Built—				
Fürst Bismarck	A.	1897	10,482	19·0
Kaiserin Augusta	P.	1892	5,956	21·5
— 2				
Building or Preparing to Build—		Laid down.		
Prinz Heinrich (A)	A.	1898	8,759	20·75
Prinz Adalbert (B)	A.	1900	8,905	21·0
Ersatz König Wilhelm	A.	1902	8,905	21·0
Kaiser Ersatz	A.	1902	8,905	21·0
— 4				
Projected— 2 in number	A.	..	..	..

Country.		Launched.	Displacement.	Maximum Speed.
United States.				
Built—			Tons.	Knots.
Brooklyn	A.	1895	9,215	21·9
Minneapolis	P.	1893	7,375	23·0
Columbia	P.	1892	7,375	22·8
Olympia	P.	1892	5,870	21·7
New York	A.	1891	8,200	21·0
— 5				
Building or Preparing to Build—		Laid down.		
West Virginia	A.	1901	13,680 (West Virginia to South Dakota)	22·0
Pennsylvania	A.	1901		
California	A.	..		
Maryland	A.	1901		
Colorado	A.	1901		
South Dakota	A.	..		
St Louis	A. (St Louis to Charleston)	1901	9,700	22·0
Milwaukee		..		
Charleston				
— 9				
Projected— 2 in number	A.	..	..	..
Italy.		Launched.		
Built—				
Varese	A.	1899	7,234	20·0
Guiseppe Garibaldi	A.	1899	7,234	20·0
Carlo Alberto	A.	1896	6,396	20·0
Vettor Pisani	A.	1895	6,396	20·0
Marco Polo	A.	1892	4,511	19·0
— 5				
Building—		Laid down.		
Francesco Ferrucio	A.	1898	7,234	20·0
— 1				
Projected— 1 in number	..	..	..	..

[1] A. = "Armoured"; P. = "Protected."

Note.—The numbers given as projected do not include vessels intended to be laid down after the financial year 1902-3.

discussion. When the "Artillerie et Infanterie de la Marine" were transferred to the War Department, under the title of the Colonial Army, by the law of the 7th July 1900, the navy was deprived to a very large extent of the necessary *personnel* for manning coast defences, and this transfer caused a considerable diminution in the cost of the French naval *personnel*, which has to be taken into account in comparing the navy estimates for different years. The transfer necessitated a great change in the responsibility for coast defence from the Ministry of Marine to the War Department. The practice resulting was for the navy to provide the *personnel* for manning only those batteries which had guns trained on the channels and approaches to the harbours or roadsteads of the naval bases.

Russia.—The whole of the coast defence was in the hands of the army in 1902. The navy took no part, except in so far as ships and torpedo-boats may be employed in combination with the military forces.

Italy (1902).—The supreme authority in all matters relating to local sea-coast defences was vested in the respective naval commanders-in-chief of the maritime departments. With the exception of part of the defence of the naval ports, the *personnel* and *matériel* for coast defence were provided by the army.

In the naval ports the navy provided the *personnel* for the submarine defences, and the shore batteries commanding and protecting the mine field, and, in addition, worked all the torpedoes, torpedo batteries, and the electric lights. These absorbed 4527 officers and men. The navy also maintained a small force to work the semaphore stations. The necessary war *matériel* for the above items in the naval ports was provided by the naval estimates.

Germany.—Coast defences were being gradually transferred from the army to the navy at the end of the 19th century. In 1902 the navy garrisoned all land and sea-defence works at Wilhelmshaven, Bremerhaven, Cuxhaven, Heligoland, and Kiel, which were under the command of naval officers.

The submarine defences were entirely in the hands of the navy.

United States.—The navy took no part in the coast-defence system, except that in 1902 Dry Tortugas and Guam were temporarily garrisoned by the navy.

Japan.—The permanent coast fortresses were in the hands of the army in 1902, in so far as that the forts were manned by a military force of fortress artillerymen, and the command of all forts outside the limit of the several naval ports was in the hands of military officers. Where, however, the coast fortresses were situated within the confines of a naval station, the naval commander-in-chief was in supreme command.

All floating and submarine defences were in the hands of the navy. The coast-line of the whole country was divided into five naval divisions, each division having its headquarters at one of the five existing naval ports. The commander-in-chief of a naval station is directly responsible to the emperor in matters of strategy and warfare, but in administrative affairs he is required to abide by the instructions of the Minister of Marine.

When combined naval and military operations were carried out, the duties undertaken by the navy were as follows:—

1. Coast watch-towers and look-out service afloat.
2. Construction and maintenance of booms and other obstructions.
3. Submarine mine defences.
4. Communications and other services afloat.

Great Britain (1902).—The navy had nothing to do with coast defence, but maintained a coastguard of about 4200 men, which assisted the customs against smuggling, and kept up signal stations. Towards the end of the 19th century the practice arose of the War Office referring questions of coast or port defence to the Admiralty for opinion, and a joint committee of defence investigated these questions. A Cabinet Committee of Defence was supposed to harmonize the actions of the War Office and Admiralty, but the correspondents in naval manœuvres called attention to repeated cases of the forts firing on their own side and hampering the navigation of the ships with their searchlights. The naval authorities at the ports took cognizance of the plans of the Royal Engineers for defending the harbours with mines, and approved of these plans. They also possessed the power to veto the laying down of mines if they thought fit. The so-called coast guard ships were really inferior battleships intended to operate as a fleet in home waters. The Secretary of State for War in 1901 stated that he was willing and anxious to hand over the defence of the ports to the navy, while the Admiralty and former First Lords of the Admiralty strenuously opposed the step. This afforded a curious contrast to the reverse state of feeling in France. No clue could be obtained to the opinion of the Cabinet Committee of Defence, which could not be attacked in Parliament, as none of its members drew any salary in respect of work done on the committee. The procedure of the House of Commons at this date enabled a discussion to be raised only by a member moving the reduction of the responsible minister's salary, and in this case none was drawn, so that no estimates for discussion were provided.

TABLE C.

Table showing Increase of the British Navy between 1886 and 1903.

Year.	Total actually expended. (Figures in million £ Sterling).	Voted for New Construction.	Personnel. Numbers voted for the Navy.	Strength of Reserves. Officers.	Firemen.	Firemen and Seamen.
1886–87 [1]	13·27	3·50	61,400	256	256	18,007
1887–88 [1]	12·33	2·82	62,500	287	327	18,672
1888–89	13·00	2·59	62,400	321	439	19,155
1889–90	13·84	3·44	65,400	467	537	19,176
1890–91	14·13	5·43	68,800	673	569	19,207
1891–92	14·15	5·51	71,000	878	572	20,590
1892–93	14·30	4·05	74,100	1101	700	21,700
1893–94	14·05	2·98	76,700	1054	698	21,228
1894–95	17·64	4·78	83,400	1117	1382	22,914
1895–96	19·64	5·88	88,850	1400	2000	21,700
1896–97	22·27	7·33	93,750	1600	2500	24,200
1897–98	22·17	5·05	100,050	1651	2665	24,614
1898–99	24·07	6·73	106,390	1700	3306	26,141
1899–1900	26·00	7·33	110,640	1863	3494	25,456
1900–01	29·52	8·46	114,880	1896	3530	24,659
1901–02	30·88 [2]	9·00	118,625	1890	3714	24,341
1902–03	31·25 [2]	9·06	122,500	1900	3800	26,800

[1] In 1888 the cost of the transport service (at that time about £200,000) was transferred to the army estimates. The vote for naval ordnance, which then amounted to over a million, was transferred from army estimates to navy estimates, so that this has to be allowed for in 1886 and 1887.

[2] Net estimates.

In the case of the reserves, for the years 1892–93, 1895–96, 1896–97, and 1902–1903, we give the numbers voted. For the other years "the Statement of the First Lord of the Admiralty," "the Report of the Committee on the Royal Naval Reserve (1892)," and records at the Admiralty are used.

TABLE D.

The following table of the numbers actually borne on 1st April of the years named in the active service ratings of the British navy, shows the development of the different branches in the period reviewed. The chief feature is the growth of the engine-room branch.

Year.	Executive Branch.	Engine-Room Branch.	Marines.	Other Branches.
1868	31,981	5,391	15,970	11,052
1878	27,911	5,627	13,727	8,508
1888	28,232	8,536	12,847	8,914
1898	44,336	22,289	17,099	11,816
1900	49,222	25,959	18,461	12,865
1902 [1]	54,260	27,000	19,800	14,300

[1] Estimated.

Rate and Cost of Building.

Table E (*a*) compares the rapidity with which different European nations would bring vessels to the stage at which they could be launched at the end of the 19th century. Table E (*b*) shows the comparative cost of typical ships.

TABLE E (*a*).

Nation.	Name.	Class.	Tonnage.	Begun.	Launched.
Great Britain . .	Sutlej	Cruiser, 1st class	12,000	15th August 1898	18th November 1899
,, . .	Cressy	Armoured cruiser	12,000	12th October 1898	4th December 1899
France . . .	Montcalm	,,	9,373	25th January 1898	27th March 1900
,, . . .	Dupleix	,,	7,577	18th January 1899	28th April 1900
,, . . .	Gloire	...	9,824	5th September 1899	27th June 1900
Russia . . .	Pobieda	Battleship	12,700	1st August 1898	24th May 1900
,, . . .	Aurora	Armoured cruiser	6,630	31st October 1896	,,
Germany . . .	Prinz Heinrich	,,	8,880	1st December 1898	23rd March 1900
,, . . .	Kaiser Barbarossa	Battleship	11,081	3rd August 1898	14th April 1900

TABLE E (*b*).

Nation.	Ship.	Tonnage.	Cost.	Cost per Ton.
Great Britain .	Albion	12,950	£803,000	62
,, .	Glory	12,950	844,000	65
,, .	Formidable	15,000	1,023,000	67½
,, .	Cæsar	14,900	865,000	58
Russia . .	Poltava	10,960	1,098,000	100
France . .	Suffren	12,527	1,195,000	95

NUMBER OF WARSHIPS.

Table F shows the number of the warships of the great maritime Powers in 1901.

It should be noted, however, that this table, compiled from the Admiralty return, includes many doubtful vessels. Ten British battleships of a total of 93,655 tons, armed with M.-L. guns, ought undoubtedly to have been struck out. Five of these ships (the *Ajax*, *Agamemnon*, *Téméraire*, *Superb*, and *Alexandra*) were withdrawn from the list in 1901–02, reducing the tonnage of battleships by 46,910. Some British cruisers and coast defence vessels armed with M.-L. guns were also withdrawn during 1901–02.

Note.—In compiling these tables English tons have been used throughout. The tonnage of warships is always given in displacement tons or the actual weight of the ship, but owing to the fact that France, Germany, and Italy used metric tons in their Navy Lists in 1902, while other nations used the English ton, and that reference books repeat the figures simply as tons, there was considerable confusion in comparing the tonnage of warships. Thus while the *Patrie* was given in the French Navy List as 14,865 tons, her tonnage in British measurement would appear as 14,630 tons. The course has therefore been adopted of bringing all to a common measure, this being the only way in which a proper comparison can be obtained.

TABLE F.—*Warships of the World on 15th January 1901.*

	Great Britain.		France.		Russia.		United States.		Germany.		Italy.		Japan.	
	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.	No.	Displacement.
Battleships—		Tons.		Tons.		Tons.		Tons.		Tons.		Tons.		Tons.
Built . . .	50	581,105	28	275,843	15	150,484	8	83,094	19	123,404	15	148,588	6	77,220
Building . . .	16	229,900	5	62,455	10	130,270	10	133,800	10	116,770	6	70,568	1	15,200
		811,005		338,298		280,754		216,894		240,174		219,156		92,400
Armoured cruisers—														
Built . . .	9	56,000	7	37,752	11	83,231	2	17,415	4	35,195	5	31,891	6	50,737
Building . . .	20	226,400	15	148,260	1	7,800	9	109,500	3	26,390	1	7,294	1	9,750
		282,400		186,012		91,031		126,915		61,585		39,185		60,487
Protected cruisers—														
Built . . .	103	499,870	38	128,907	3	12,612	14	61,403	15	58,589	16	41,427	11	51,568
Building . . .	4	24,960	2	13,493	11	60,640	6	21,000	7	18,200	...	...	3	4,400
		524,830		142,400		73,252		82,403		76,789				55,968
Unprotected cruisers—														
Built . . .	11	23,010	7	22,962	3	8,090	6	11,397	20	40,780	...	nil	9	13,802
Building . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Coast-defence vessels (armoured)—														
Built . . .	10	38,900	14	43,331	14	42,873	15	43,934	11	12,001	...	nil	4	10,280
Building . . .	...	...	...	...	1	5,000	4	12,940	...	...	...	...	...	...
Special vessels—														
Built . . .	2	13,020	1	5,994	5	5,280	1	929	3	4,026	...	nil	1	4,120
Building . . .	...	...	...	...	2	5,000	...	...	...	...	...	...	...	...
Torpedo vessels—														
Built . . .	35	27,840	15	8,912	17	14,709	...	nil	2	1,862	14	11,308	1	850
Building . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Torpedo-boat destroyers—														
Built . . .	89	28,314	9	2,700	10	2,890	3	860	12	4,025	3	923	11	3,229
Building . . .	24	8,844	22	6,556	43	10,430	17	6,930	15	5,250	8	2,560	8	2,734
		37,158		9,256		13,320		7,790		9,275		3,483		5,963
Torpedo boats—														
Built . . .	95	7,380	235	16,408	171	9,507	20	2,337	140	11,990	163	8,148	38	3,894
Building . . .	4	720	44	3,343	24	3,730	12	2,040	...	...	...	...	36	3,714
		8,100		19,751		13,237		4,377						7,608
Submarines—														
Built . . .	...	...	4	485	...	...	1	75	...	...	...	...	...	...
Building . . .	5	600	38	3,664	...	...	7	840	...	...	...	...	...	...
Total tonnage—														
Built . . .	404	1,275,439	358	543,294	249	329,676	70	221,444	226	291,872	216	242,285	87	215,700
Building . . .	73	491,424	126	237,771	92	222,870	65	287,050	35	166,610	15	80,422	49	35,798
	477	1,766,863	484	781,065	341	552,546	135	508,494	261	458,482	231	322,707	136	251,498

SUMMARY.

The following is a summary of the above tables showing the position on 15th January 1901 (five of the M.-L. gun battleships having been deducted from the battleships of Great Britain) :—

	Great Britain.	France.	Russia.	Germany.	Italy.	United States.	Japan.
Vessels built—							
Battleships . . .	45	28	15	19	15	8	6
Cruisers, armoured .	9	7	11	4	5	2	6
,, protected .	103	38	3	15	16	14	14
,, unprotected .	11	7	3	20	...	6	9
Coast-defence vessels, armoured . . .	10	14	14	11	...	15	4
Special vessels . .	2	1	5	3	...	1	1
Torpedo vessels . .	35	15	17	2	14	...	1
Torpedo-boat destroyers	89	9	10	12	3	3	11
Torpedo-boats . .	95	235	171	140	143	20	33
Submarine boats . .	...	4	...	...	...	1	...
Vessels building—							
Battleships . . .	16	5	10	10	6	10	1
Cruisers, armoured .	20	15	1	3	1	9	1
,, protected .	4	2	11	7	...	6	3
,, unprotected .	...	...	...	...	...	...	...
Coast-defence vessels, armoured . . .	...	...	1	...	...	4	...
Special vessels . .	...	...	2	...	...	...	...
Torpedo vessels . .	...	...	...	...	...	...	...
Torpedo-boat destroyers	24	14	43	15	8	17	8
Torpedo-boats . .	4	44	24	...	...	12	36
Submarine boats . .	5	38	...	...	...	7	...

The previous year's British Admiralty return for 15th January 1900 as regards armaments was summarized by Mr Schooling :—

Class of Guns.	Number of Guns.		Percentage of France plus Russia's Guns to Great Britain's Guns.	
	Great Britain.	France plus Russia.	Great Britain.	France plus Russia.
Breech-loading guns—				
10 in. to 16·5 in. . .	205	276	100	135
4 in. to 9·5 in. . .	707	588	100	83
Total breech-loading guns	912	864	100	95
Quick-firing guns—				
4 in. to 6·5 in. . . .	1,630	1,215	100	75
12 pounders . . .	1,018	57	100	6
Smaller quick-firing and machine guns . . .	4,806	4,970	100	103
Total quick-firing guns .	7,454	6,242	100	84
Muzzle-loading guns—				
7 in. to 16 in. . . .	340	nil	100	nil
Torpedo tubes . . .	1,534	1,553	100	101
All classes of guns . .	10,240	8,659	100	85

Example.—France plus Russia had 84 quick-firing guns to every 100 quick-firing guns possessed by Great Britain.

AUTHORITIES.—The Navy Estimates; *The Naval Annual;* the *Journals* of the Royal United Service Institution; the *Proceedings* of the Institution of Naval Architects; *Notes on Naval Intelligence,* issued by the United States Naval Intelligence Department, and other works. (BR.; C. W. BE.)

Navigation.—The great development in both size and speed of ships during the last quarter of the 19th century enormously increased the responsibilities of those who command and navigate them, and has led to a careful examination of the existing modes of determining a ship's position at all times by day or night, both when in sight of land and on the open ocean. A comparison between the present text-books on the subject of navigation and those in use in 1875 shows how problems and methods which then were considered chiefly as theoretical exercises have now, from the altered conditions of the navigation of very fast ships, become methods of frequent practice, while corresponding improvements have been made in the instruments, such as compasses, charts, and chronometers, by the aid of which more satisfactory results are now attained. Much has also been done to advance the study of navigation and its numerous allied subjects by the development of the Royal Naval College at Greenwich and the United Service Institution; also by the establishment of shipmasters' societies (of which the well-known society in London is typical), where during the year valuable papers are read and useful discussions take place among those actually carrying out the practice of navigation. It does not appear to be generally known that the advantage of attending courses of study, both practical and theoretical, at the Royal Naval College, is offered to officers of the mercantile marine as well as to those of the royal navy. Arrangements exist by which ten such officers can be received every year and obtain free instruction on almost every subject connected with the nautical profession.

As the reader already has access to the article on this subject which appeared in the earlier volumes of this Encyclopædia (ninth edition), it will be convenient to trace the principal changes which have occurred since then in the chief subjects relating to the art of navigation.

Compass.—The general introduction of compasses with short needles and slow periods of vibration has done very much towards improving the accuracy with which a ship's "dead reckoning" is kept. The original model of these was that patented by Lord Kelvin in 1876, and since adopted in the royal navy as the standard. In this instrument we have a compass specially designed to enable the principles of compensation or correction proposed by Airy in 1837 to be accurately carried out, while its slow period of swing renders it in all circumstances extremely steady. Another conspicuous advantage arising from the use of compasses of this pattern is the readiness with which they admit of correction by the use of the "deflector," a simple instrument devised by Lord Kelvin for the measurement of directive force, the successful application of which to compass correction depends on the fact that, when the directive force is equalized on all points, the error of the compass is neutralized. Accompanying the great improvements in the construction of compasses, there have been great advances in the art of compass adjustment or correction by mechanical means of the errors due to the various kinds of iron or steel in the ship. Some of those errors (such as that caused by horizontal soft iron), which a few years ago were almost insignificant in amount, have, especially in men-of-war, become very large quantities, while the formidable source of error known as "heeling error" has increased, until in some vessels before correction a heel of 5° alters the direction by 20°. It is gratifying to find that the practical application of the principles laid down in the Admiralty *Manual* enables errors of 70° or 80° to be dealt with as readily as those of small amount, while the difficulties attending the heeling error—which, however accurately corrected originally, must be frequently recorrected on any great change of position—have been surmounted by the use of a simple instrument, which in favourable circumstances can be used even at sea. As the whole art of compass adjustment is carried out on the supposition that the compass needle is infinitesimal in length, it is obvious how much more nearly this fundamental condition is satisfied with the modern compass than with those having long needles which were formerly used. Recognizing the great value of a sound knowledge of compass adjustment, the Board of Trade have included this among the compulsory subjects of examination for the rank of master, thus following the example of the royal navy, where all navigating officers have to attend a practical course of study on the subject. While there is no reason to think that the magnetic character of land *above* the water has any disturbing effect on compasses on board ship, modern investigations have shown that in comparatively shallow water (7 to 8 fathoms) there are several parts of the world where land *under* water affects them. The most notable case is Cossack, in North Australia, where the disturbance varied from 56° E. to 26° W. at two positions 180 yards apart, and the area of disturbance extended over nearly three miles of navigable waters. The possibility of this insidious danger adds to the anxiety of the navigator when entering or leaving harbour, especially in circumstances such as occur at night, when he is probably depending entirely on compass bearings.

Log.—While improved and steadier compasses enable modern ships to shape more accurate courses, there is still great room for improvement in the instruments by which speed is measured. The common or hand log has ceased to be regarded as anything but the very roughest of guides, and the patent log in its original form of the record of the revolutions of a small screw towed by the ship does not give satisfactory results at great speeds, nor can anything more favourable be said of those forms where pressure on known areas are employed. The revolutions of the engines, with due allowance made for the condition of the ship's bottom, afford now perhaps the best means of estimating speed. (See Log.)

Charts.—The admirable low-priced charts and sailing directions issued by the Admiralty have now largely superseded those supplied by private publishers (familiarly known as "Blue Backs"), and the issue of the *Nautical Almanac* in its abbreviated and cheaper form has also done much to take the place of those numerous private almanacs and calendars which were necessarily much more liable to error than the original and official sources from which they were derived.

In 1899 the number of charts printed for the Hydrographic Office was 428,890, of which 278,701 were sold to the public for £16,915; and in the same year 15,050 *Nautical Almanacs* were sold. Among the many excellent modern publications of the Hydrographic Office, perhaps the *Ocean Passage Book* is one of the most generally useful, since, when used in combination with the admirable charts of full-powered and auxiliary tracks, it very greatly assists all navigators in planning out a successful voyage. We must here refer to the valuable results arising from the publication of the *Monthly Pilot Charts of the North Atlantic* by the American Government, and more recently by our own Meteorological Department, where observed meteorological results are skilfully combined with forecasts for the ensuing period, suggested tracks for ships are shown, and an epitome of recent navigational and meteorological experiences is given. (See Charts.)

Chronometer.—The marvellous accuracy with which the modern chronometer is constructed is doubtless greatly stimulated by the annual competition at Greenwich, from which the Admiralty purchase for the royal navy. These chronometers are all fitted with secondary compensation balances, and it is therefore unusual in the royal navy to apply any temperature correction to the rate. The perfection obtainable in compensation may be illustrated by the performance of a chronometer at the Royal Observatory in 1886, which at a mean temperature of 50° F. had a *weekly* rate of 1·6 seconds losing; and on being further tested at a mean temperature of 92° F., it only changed its *weekly* rate to 2·9 seconds losing. In the mercantile marine cheaper chronometers without secondary compensation are more commonly used, and temperature corrections applied, calculated from a formula originally proposed by Mr Hartnup, formerly of the Liverpool Observatory. Great success attends this mode of procedure, as illustrated by the following facts. From the discussion of the records of performance of the chronometers of the Pacific Steam Navigation Company during twenty-six voyages from London to Valparaiso and back, by giving equal weight to each of the three chronometers carried by each ship, the mean error of longitude for an average voyage of 101 days was less than three minutes of arc. As a single instance, in the s.s. *Orellana*, on applying temperature rates during a voyage of 63 days, the mean accumulated error of the three chronometers was only 2·3 seconds of time.

Fixing Position.—When a ship is steaming at the rate of 20 knots an hour the navigator remembers that a mile is passed over in three minutes, and that if in sight of land and fixing positions by objects on shore, it is essential to adopt some rapid method; otherwise when laid down on the chart the position shows where the ship *was*, and not where she *is*. This difficulty has led to the more general use of methods of obtaining positions by angles instead of bearings, and laying them down on the chart by the aid of the station pointer. Many advantages accrue from this, as the observer is not restricted in position on board, as is the case when using the compass, and especially if a double sextant (having two index glasses and one horizon glass) is employed two angles can be measured simultaneously, the result on the chart being very rapidly arrived at. An ingenious combination of sextant and station pointer in one has been proposed, and most simply carried out by attaching vertical sights to the legs of a station pointer, which is put on a suitable horizontal stand, and the legs moved until the sights are in line with the objects observed. To assist the navigator in the choice of suitable objects between which to measure the angles, a very useful pamphlet is issued by the Admiralty, from the diagrams in which it can be seen at a glance which combination of objects in sight gives the most favourable result, always remembering as a broad principle that nearer objects are more suitable than distant ones, and that the accuracy of position determined depends on the relative *distances* of the objects as well as on the magnitude of the *angles* between them. The rougher but at certain times very important method of fixing a ship's position when only *one* object can be seen, such as a light at night, is often of great value in modern coast navigation. It is well, however, to remember that in all cases where only *one* object can be seen, the estimate of position is liable to error, owing to any unknown or unallowed-for tide or current during the interval elapsing between the times of the two observations on which, whether using the "four-point" problem or that of "doubling the angle on the bow," the result depends. A simple and useful method, when only one point is in sight, of ascertaining whether with the course maintained a ship will pass at a prudent distance from the point, is to note the reading of the patent log when the object is 26° on the bow, and again when it is 45°; the difference between these readings will be the distance the ship will be from the point at time of nearest approach.

Danger Angles.—To avoid an unnecessarily wide *détour* in rounding points and shoals, extensive use is now made of both horizontal and vertical danger angles; the former is the angle on the arc of a horizontal circle passing through a point at the required distance from the danger, and through two previously selected, easily recognized fixed objects. Should circumstances enable the selection to be made of an angle of about 90°, the ship by continually measuring the angle may be steered on the arc of such a circle with great precision, and may even be safely taken through a channel *between* two dangers. The vertical danger angle enables similar results to be attained by measuring the vertical angle subtended by a known height; but except where the selected object is one whose height is *well* determined, such as a lighthouse, this method is not so trustworthy as the former.

Sounding Machines.—The chronicle of progress in the art of navigation would be very incomplete without reference to the extended use of Lord Kelvin's sounding machines, either in the original form, where the increased pressure at different depths is recorded by discoloration of chemical tubes, or in the later form known as the "depth recorder," where similar results are obtained by the automatic record of the position of a piston forced upwards in a tube by this increased pressure. Very satisfactory results can be obtained at speeds of 15 or 16 knots, enabling that great safeguard of navigation in many places, viz., a *continuous* line of soundings, to be accurately and rapidly obtained. In connexion with this should be mentioned a most ingenious invention known as the "submarine sentry," which on being set for any desired depth and towed overboard remains at that depth whatever the speed of the ship may be. On striking bottom it at once floats to the surface and rings a warning bell. Such an instrument is of obvious value in ships where, owing to the small number of available men, it is difficult to maintain a continuous line of soundings.

Great Circle Sailing.—The practice of great circle sailing has in modern navigation become far more general than formerly; not merely has economy of time and fuel to be considered, but on examining tracks laid down on the excellent pilot charts issued by the Admiralty and Meteorological Office, distinct advantages of winds and currents are often found to attend the pursuit of the great circle track. It is indeed advantageous for the skilful navigator, in planning out a long voyage, always to lay down on a wind and current chart the three possible tracks, viz., the rhumb track, the great circle, and the polar track, and then realize that a course shaped anywhere between the extreme tracks must be attended with some advantage in economy of distance. Great circles are seldom *calculated*, and are most simply originally laid down upon gnomonic charts, where they are represented by straight lines, and then transferred to Mercator charts, or they may very approximately be drawn upon the latter *directly* by the use of Airy's simple method. Azimuth tables or diagrams are sometimes useful in determining great circle courses, since the true bearing of a heavenly body is the great circle course to a position where that body is in the zenith. The latitude of such a position being equal to the declination of the body, and its longitude equal to the hour angle of the body ± the longitude of the observer, the hour angle with which the azimuth is looked out corresponding to the difference of longitude between the observer and that of the position referred to. What is known as the polar track is more difficult to draw accurately. It follows that if on a globe we see that the rhumb track always lying on the *equatorial* side of the great circle is necessarily longer than it, there must be on the *polar* side of that circle another track equal in length to the rhumb track, and equally distant from the great circle at the point of greatest separation. This curve is difficult to draw accurately, but in practice it will be sufficiently correct to mark on the Mercator chart this point of greatest separation on the polar side of the great circle, and draw the curve by hand through it and the extreme points. Cases may arise in practice where, owing to the terminal points of the voyage lying somewhat on the same meridian, the advantage of the great circle may not be very obvious, but the polar track may lead through more favourable winds and currents than the rhumb line, and only traverse the same distance. The excellent idea originally suggested by Maury of establishing steam "lanes" in localities where there is much ocean traffic, so as to minimize the risks of collision between outward- and homeward-bound ships, has been successfully carried out in the North Atlantic. The leading transatlantic steamship companies now agree to follow great circle routes from the Irish coast to points on the Banks of Newfoundland, which vary somewhat in position with the season of the year, but are published in advance. These "lanes" being avoided by sailing vessels, risks of collision are materially lessened.

Sextant.—The establishment of an observatory at Kew, part of whose work is the examination and testing of sextants, has led to great improvement in the construction of these instruments. The determination of "centering" error in a sextant with the means available to an ordinary observer is a long and troublesome operation, and although in an instrument made by a maker of repute such error may be usually neglected in observations at sea, yet for the more accurate work involved in finding errors and rates of chronometers it must be considered and allowed for. By a specially devised instrument this error (including error of graduation) is accurately determined, and for those sextants obtaining A certificates must at no part of the arc exceed 1′, and for those granted B certificates the maximum error must not be greater than 3′. During the five years ending 1899 no fewer than 3443 sextants were tested at this observatory (now incorporated in the National Physical Laboratory). With a view of measuring angles up to 180° sextants have been constructed in which the internal reflection of light from glass prisms has been employed instead of the reflection from mirrors, but great practical difficulties arise in accurately cutting prisms of the desired angle.

Refraction.—The effect of refraction in displacing the apparent sea horizon was partially investigated by the French about a century ago, and the conclusion arrived at was that it mainly depended upon the difference of the surface temperature of the sea and that of the stratum of air resting on it: when the sea surface was the warmer the horizon was apparently *depressed*, and observed altitudes were too great, and *vice versâ*, differences of 3′ to 4′ being found when these temperatures differed 9° F. The subject has now been thoroughly reinvestigated, and the original conclusions confirmed. The errors involved from this uncertainty with regard to the place of the horizon affect the ordinary observations for determinations of latitude (such as meridian and ex-meridian observations) by their full amount; in the determination of hour angles the error introduced will be equal to the error of position of horizon multiplied by the secant of latitude and by the cosecant of azimuth of the body observed. In "lines of position" the error considered will move such lines from or towards the place where the body observed is in the zenith, and will generally cause a position to err mostly in longitude if found by the intersection of two such lines on the *same* side of the meridian, and mostly in *latitude* if the intersecting lines are on *opposite* sides of the meridian. The interesting experiments referred to were carried out in 1899 by the Austrian navy in the Red Sea and at Pola, the requisite observations being made throughout the day with an alt-azimuth instrument from shore stations at elevations of 21, 33, 52, and 138 feet respectively, the sea surface and air temperatures being simultaneously recorded from a steamboat standing off shore. From the experience of over a thousand observations it was found that at an elevation of 33 feet, with a difference of 6°F. in sea and air temperatures, a displacement of $1\frac{1}{2}'$ was observed, which increased to $2\frac{3}{4}'$ when the difference of 12° F. occurred in the temperatures. Such results were only found to be true when a wind of force at least 2 or 3 was blowing; with winds of less force the warm air can apparently remain at a higher level without mixing with the lower cooler air, and abnormal results follow, amounting in one case to a displacement of $9\frac{1}{3}'$. When navigating the Red Sea or localities such as near the edge of the Gulf Stream, where very great differences of sea and air temperatures prevail, due consideration must be made for this source of error, and the practical navigator can also see how greatly this may affect his estimation with regard to currents.

Meridian Altitudes.—In ships of great speed, when steering on courses near north or south the *maximum* altitude of a heavenly body cannot be considered as identical with the *meridian* altitude, for the speed of the ship in these circumstances affects the altitude in the same way as if the ship were stationary, and the declination of the body changed at the same rate as the ship was moving and in the opposite direction. If the declination of the body observed is also rapidly changing, a still greater difference may occur. In the case of the moon, in a ship steaming 20 knots an hour south (true) and in the latitude of the English Channel, the maximum altitude at a certain period of the lunation may exceed the meridian altitude by nearly 4′, and occur eleven minutes after the time of meridian passage. In the case of the sun the corresponding figures would be in similar circumstances $1\frac{1}{4}'$ and six minutes. Meridian altitudes in such circumstances are usually observed when the ship time indicates the instant of meridian passage. The error considered only affects an observation of altitude when it is required at the instant of a heavenly body being on some particular azimuth, as the sun at noon, and has therefore *only* to be considered when observing a *meridian* altitude for latitude.

Star Navigation.—A notable feature of the progress of the art of modern navigation is the greatly increased practice of star navigation, and many of the supposed difficulties of night observations are found to be removed by experience. Determinations of positions at sea by twilight observations, when the brighter stars become visible while the horizon is still well defined, are probably the most accurate means we possess; and the careful navigator, by combining for latitude stars passing north and south of the zenith, and for longitude those near the prime vertical both east and west, can generally depend upon a good result, especially if suitable stars can be found for each pair at about the same altitudes. For these purposes the armillary sphere is extremely useful: this is a small celestial globe on which are depicted the principal stars visible to the naked eye. On elevating the pole to the approximate latitude of the observer, and turning the sphere until the sidereal time is under the fixed meridian, a correct representation of the heavens at the time of observation is obtained; the stars are then easily identified by their bearings and altitudes. This valuable instrument is not merely useful when at twilight, only a few of the brighter stars being visible, the constellations to which they belong are difficult of recognition, but it enables arrangement to be made in advance for such observations as are desired to be taken during the night. By marking in pencil on the globe the positions of the planets in right ascension and declination, the same sphere is also available for their identification. For star observations not made at twilight the invention of some simple and practical form of artificial horizon for use at sea is much to be desired. With the ordinary sea horizon it is well, however, to remember that although indistinct under the star, it may be favourable in the opposite direction, and when the altitude admits of the sextant measuring its *supplement* this may be readily observed. The navigator observing stars on or near the meridian *below* pole has, of course, to remember that the altitude in this case is decreasing, and the direction of movement in azimuth reversed as compared with similar observations made above pole. Here we may note that in the twilight with a *high* star good results for *longitude* can often be obtained by a short equal altitude observed when the star is only a small distance from the meridian on either side, the mean of the chronometer times of observation affording an opportunity of comparing Greenwich and local times of meridian passage, a correction being made for change of position of the ship in the interval.

Observations of the Moon.—The value of observations of the moon by day or night has not met with that recognition by navigators which we should have expected; no doubt in the form of *lunars* moon observations have ceased to be practical problems, though probably no finer training for the eye can be found than practice at sea in measuring lunar distances, and, aided by considerable experience, it is surprising the accuracy with which some modern observers can determine longitude by such means. Apart, however, from observations of the moon of this character, we think that it would be more often used for the ordinary methods of finding latitude and longitude, but for the idea conveyed in most text-books on navigation of the necessity of the somewhat lengthy calculations involved. The rapidity with which at times the right ascension and declination of the moon change necessitates the accurate correction of *them*, but the absence of correction to the other elements taken from the *Nautical Almanac* would not be found in any circumstances, even the least favourable, to involve practical error at sea.

Lines of Position.—All modern navigators recognize the great value of "lines of position" obtained from the various heavenly bodies, forming as they do a system of celestial cross bearings; indeed, before the wider publicity given to this method by Captain Sumner, under the auspices of the United States Government, it was always known as "cross bearings of the sun." In the original mode of application of this valuable method the lines of position drawn at right angles to the bearing of the sun were laid down on the chart from positions obtained either by calculating the longitude by the ordinary chronometer method, using an assumed latitude, or by computing the latitude by the ex-meridian method from an assumed longitude according to the position in azimuth of the heavenly body observed. In the more modern method originally proposed by M. Marc St Hilaire, a comparison is made between the altitude of a heavenly body as actually *observed* and that *calculated* from the supposed position of the ship. For instance, the position of an observer at the instant of observing a (true) altitude of the sun of 40° 10′ must be somewhere on a portion of the circumference of a circle (usually of such size that the portion considered may be represented on a chart by a straight line) having its centre in latitude equal to the sun's declination, and in longitude equal to the Greenwich apparent time at the instant, the radius of such a circle being equal to the sun's zenith distance of 49° 50′. If at the same time the true altitude of the sun is from the *estimated* position of the ship calculated to be 40° 5′, it is evident that the greater observed altitude must be owing to the ship being nearer to the centre of the circle than was supposed, and a line of position drawn through the estimated position at right angles to the bearing of the sun must be transferred parallel to itself through a distance of 5′ towards the direction of the sun's bearing. The second line of position, obtained when the sun's bearing has altered some 25°, is dealt with in a similar way, and the intersection of the two lines so obtained gives the position of the ship at the time of second observation. This mode of procedure enables all observations, whether near or far from the meridian, to be similarly dealt with; in all cases the altitude the heavenly body *should* have is computed and compared with what it actually *has*. The practice of problems such as the foregoing is greatly facilitated by the extended means of finding at any moment the azimuth or true bearing of a heavenly body. When the azimuth was only required for the determination of compass error, the valuable tables from which the computed results could be obtained by inspection were limited to those cases of most practical importance, but from the ingenious and simple graphical form known as Weir's azimuth diagram azimuths of all heavenly bodies, whose declinations extend from 60° N. to 60° S., can be obtained during the whole time they are above the horizon, thus greatly facilitating the laying down lines of position. (W. R. M*.)

Nawabganj, the name of several towns of British India, the most important of which is the administrative headquarters of Bara Banki district in Oudh; station on the Oudh and Rohilkhand Railway, 17 miles east of Lucknow. Population (1891), 14,478; municipal income (1897–98), Rs.18,940. It has a high school, and there is considerable trade in sugar and cotton. It was the scene of a victory by Sir Hope Grant during the Mutiny.

Nawanagar, or JAMNAGAR, a native state of India, in Kathiawar, within the Gujarat division of Bombay, situated on the south of the Gulf of Cutch. Area, 3393 square miles. Population (1881), 316,417; (1891), 379,611. Estimated gross revenue, Rs.30,83,910, of which Rs.2,44,850 was expended on public works in 1897–98; tribute, Rs.1,20,093. The chief, whose title is Jam, is a Jareja Rajput, of the same clan as the rao of Cutch. K. S. Ranjitsinhji, the cricketer, had been adopted by the late Jam, but the adoption was set aside, with British sanction, in favour of a son by a Mahommedan mother. The state was in 1902 under British administration while this son was being educated at the Rajkumar College at Rajkot. A branch railway, constructed mainly at the expense of this state, was opened in 1898 from Rajkot to Nawanagar town (50 miles).

The town of NAWANAGAR is about five miles from the seaport of Bedi. Population (1881), 39,668; (1891), 48,530. Founded by Jam Rawal in 1540, it is handsomely built of stone, and has special manufactures of silk and gold embroidery, and perfumed oils and red powder for ceremonial purposes. Its water-supply is derived from a reservoir covering 600 acres and an aqueduct 8 miles long. It has a high school, with 383 pupils in 1896–97, and three printing-presses, one of which issues an official gazette.

Nazareth, now *en-Násira*, in Palestine, the chief town of a kaza in the sanjak of Acre. The population consists of 3500 Moslems and 6500 Christians. It is a centre of missionary enterprise. The Roman Catholics have a monastery, nunnery, hospice, schools, and orphanages; the Protestants, a hospital, schools, and orphanage; and the Russians, a seminary, hospice, and schools.

Neamtzu, a town in Rumania, on the left bank of the river of the same name, about half-way between Pascani and Piatra. Population (1900), 8578, of whom about half are Jews. In its vicinity are the extensive ruins of the once famous fortress of Neamtzu, constructed in the 13th century by the Teutonic knights of André II., king of Hungary, in order to repel the incursions of the Kouman Tatars. It was subsequently the scene of many bloody fights. It was here that the mother of Stephen the Great shut the doors of the fortress on her son, when a fugitive from the Turks, and compelled him to return and give battle to his adversaries, whom he defeated with enormous loss. An hour's drive to the west of the town is the famous monastery of the same name, founded in the 14th century, containing two churches and many ancient and interesting relics. Prior to the secularization of the monastic lands it was one of the richest and most important of the Rumanian monasteries, and still contains some curious treasures.

Nebraska, a central state of the American Union. The population in 1880 was 452,402, being an increase during the previous decade of no less than 267·8 per cent. In 1890 the population was 1,058,910, the increase for the decade being 134·1 per cent. In 1900 the population was 1,066,300, an increase of only $\frac{9}{10}$ of 1 per cent. Of the 90 counties of the state, 35 showed a decrease in population from 1890 to 1900. Of the 365 incorporated places in the state, 27 had more than 2000 inhabitants in 1900, 7 had more than 5000, and 3 had more than 25,000. These 3 were—Omaha, with a population in 1890 of 140,452 and in 1900 of 102,555; Lincoln, with 55,154 in 1890 and 40,169 in 1900; South Omaha, with 8062 in 1890 and 26,001 in 1900. The decrease in the population of the state probably occurred in the first half of the decade, and was owing to hard times and the reaction from the boom of earlier years. The hard times in their turn occasioned the realignment of political parties and the free silver movement that for a time swept the state. The total land surface is approximately 76,840 square miles; the average number of persons to the square mile being, in 1890, 13·8, and in 1900, 13·9. Of the total population in 1900, 564,592 were males and 501,708 were females; 888,953 were native-born and 177,347 were foreign-born; 1,056,526 were white and 9774 were coloured (including 6269 negroes, 180 Chinese, 3 Japanese, and 3322 Indians). Out of 301,091 adult males 7388 were illiterate (unable to write), of whom 4720 were foreign-born.

Agriculture and Forestry.—Agriculture is the chief industry, and is the foundation of the manufactures and commerce. There is no mining. From 1869 to 1899 there were only 4 crop failures and 3 short crops. In the same period the State Statistical Bureau recorded 18 good crops, 1 fair crop, and 4 great crops. The yearly production of Indian corn runs from 175 millions to 225 millions of bushels. The crop report for 1898 gives corn, 179,599,596 bushels; oats, 48,522,288 bushels; wheat, 39,177,600 bushels. The report for 1899 gives corn, 196,000,285 bushels; oats, 27,335,490 bushels; wheat, 30,545,880 bushels; rye, 3,141,344 bushels; and barley, 2,395,880 bushels. No state has done more for the forestation of its waste and prairie lands. Arbor Day, which has spread through the Union, was instituted by the Nebraska State Board of Agriculture on 4th January 1872, by the adoption of the following resolution, proposed by J. Sterling Morton:—

Resolved that Wednesday, the 10th day of April 1872, be and the same is hereby especially set apart and consecrated for tree-planting in the state of Nebraska, and the State Board of Agriculture hereby name it Arbor Day.

The 10th of April of the same year was set apart by the governor for tree-planting, and more than three millions of trees and cuttings were set out on that date. Since then Arbor Day has been yearly observed by the public schools throughout the commonwealth. It is estimated that more than 20 billions of trees have been planted on these anniversaries. It is not impossible that before the next fifty years have passed lumber will be shipped from the plains of Nebraska to the eastern states.

Manufactures.—In 1860 there were 107 manufacturing establishments in the state; in 1870 there were 670; in 1880, 1403; and in 1890, 3014. The capital invested in 1890 was $37,569,508. The most prominent manufacturing cities are Omaha, South Omaha, Grand Island, Norfolk, and Nebraska City. At South Omaha the packing interests have reached large proportions. The cash value of cattle and hogs sold in 1900 exceeded 40 millions of dollars, while the value of sheep, horses, and mules sold aggregated at least 2 million dollars more. South Omaha is the third largest packing metropolis in the world. At Nebraska City there is a packing-house with a capacity of 2000 swine per day. At the same place is a canning establishment that puts up millions of cans of corn, tomatoes, peas, and fruits of various kinds each year. During the working season (August–November) it employs between 100 and 200 persons. Starch works, also at Nebraska City, employ between 200 and 300 persons, and have a daily average output of 33 tons. The starch is made from Indian corn. At the same place are cereal mills, which employ between 100 and 200 persons, producing daily 30 tons of oatmeal, and converting 4500 bushels of Indian corn into hominy, grits, and meal. Factories at Grand Island and Norfolk consume the beets from about 10,000 acres of land, and ship large quantities of granulated sugar. At O'Neill, in Holt county, is a chicory factory; and the legislature, which passed an Act making the sale of oleomargarine and other substitutes for butter a penal offence in the state, gave a bounty, to be paid out of the treasury, of 1 cent a pound upon chicory which is used only as an adulterant of, or substitute for, coffee. In 1899 Nebraska shipped more than 85 million pounds of flour and 89 millions of other mill products, together with 714,000 head of cattle and 2,477,243 swine, 50,000 head of mules and horses, and 1,700,000 head of sheep.

Railways.—Within the boundaries of the state are more than 6000 miles of railway. The chief lines, with their mileage and cost to 30th June 1890, are as follows:—

Road.	Miles of Road.	Cost.
Burlington and Missouri River (C. B. & Q. system)	2252	$84,547,628
Fremont, Elkhorn, and Missouri Valley (C. & N. W. system) . . .	985	40,256,515
Union Pacific	943	73,903,339
Chicago, St Paul, Minneapolis, and Omaha (C. & N. W. system) . . .	271	10,779,507
Chicago, Rock Island, and Pacific . .	245	9,016,209
The Missouri Pacific Railway . . .	221	10,823,399

Finances.—The census of 1890 valued the real and personal property at $1,275,685,514. The state has no bonded debt. The rate of taxation for all purposes is from $6\frac{1}{2}$ to $7\frac{1}{2}$ mills; through this levy is obtained a revenue of $1,208,984. There are 400 state banks, with a capital of between 13 and 14 millions of dollars, and 113 national banks, whose aggregate capital amounts, in round numbers, to 10 millions of dollars.

Charity.—The charitable and penal institutions are as follows:—The Asylum for Insane, at Lincoln; the Home for the Friendless, at Lincoln; the State Penitentiary, at Lincoln; the Industrial Home, at Milford; the Soldiers' and Sailors' Home, at Milford; the Girls' Industrial School, at Geneva; the Boys' Industrial Home, at Kearney; the Soldiers' and Sailors' Home, at Grand Island; the Asylum for Chronic Insane, at Hastings; the Asylum for Insane, at Norfolk; the School for Deaf, at Omaha; the School for Feeble-Minded Youth, at Beatrice; the School for Blind, at Nebraska City.

Education.—The rate of illiteracy (1890) was $2\frac{3}{10}$ per cent., the lowest in the Union. The common schools are supported by a general tax, which cannot be less than one-half mill on the entire valuation of the real and personal property. Added to this is the interest on the permanent school fund, derived from the sale of school lands granted by Congress under the Enabling Act of 19th April 1864, which gave the school fund 5 per cent. of the net proceeds derived from the sale of all government lands within the state. This permanent educational fund yields, for semi-annual *per caput* distribution, between $300,000 and $400,000. The number of pupils of school age is over 400,000; the number of teachers, approximately, 10,000; the number of school-houses, 7000. The value of these school-houses and grounds, together with books, apparatus, and fixtures, amounts to more than 8 millions of dollars. The State Normal School at Peru has 500 students and 21 instructors. The university at Lincoln has 2200 students, 110 instructors, and its annual disbursements amount to $248,000.

Politics.—The people have been realigned as to political organizations since 1890. Before that time the Democratic party advocated free trade or a tariff for revenue only, and the Republican party a protective tariff. In 1892, under the leadership of William Jennings Bryan, the Democratic party divided upon the money question, and subsequently amalgamated with the Populist party in the advocacy of the free coinage of silver with gold at the ratio of 16 to 1, forming a party which consisted of Silver Republicans, Democrats, and Populists. The Populists were largely in the majority among the directors of the combination. The Republican party maintained the necessity of the gold standard. In the national election of 1896 the Fusionists (Silver Democrats, Silver Republicans and Populists) polled 115,880 votes, and in 1900, 114,013. The Republicans polled 102,304 in 1896, and 121,835 in 1900. Since 1898 the Populists have named two-thirds or more of the candidates for county and state offices, while Silver Republicans and Democrats acting with them have divided the remainder.

The statement that Bellevue was the first capital of Nebraska is an error: Bellevue was never the capital of either the territory or state. The first capital of the territory was Omaha, and it remained the seat of government until 1867, when by act of the legislature the capital was located at Lincoln, where it remains.

(J. S. M*.)

Nebraska City, a city of Nebraska, U.S.A., capital of Otoe county, on the west bank of the Missouri river, and the Burlington and Missouri River and the Missouri Pacific railways, at an altitude of 961 feet. The city is regularly laid out, is well sewered and lighted, and has a good water supply. It is the site of the state school for the blind. It is in a rich farming region, has considerable manufactures of a varied character, and some commerce in farm products by rail and river. Population (1880), 4183; (1890), 11,494; (1900), 7380, of whom 882 were foreign-born and 142 negroes.

Neckar, a river of Germany, rising between the Black Forest and the Swabian Alb, near Schwenningen, in Würtemberg, at an altitude of 2287 feet. It flows north past Rottweil as far as Horb, thence past Rottenburg, Tübingen, and Nürtingen in a north-easterly direction, then in a generally northerly direction as far as Eberbach, passing on the way Esslingen, Canstatt, and Heilbronn; from Eberbach it pursues a winding west course past Heidelberg, and enters the Rhine (from the right) at Mannheim (295 feet alt.). Its length is 247 miles, and its drainage area 4790 square miles. Its more important tributaries are the Enz (left), and Fils, Rems, Kocher, and Jagst (right). It is navigable for small steamboats up to Heilbronn, for boats up to Canstatt, and for rafts from Rottweil. It is the principal waterway of Würtemberg, and greatly used for floating down timber. From Rottenburg downwards its banks are almost everywhere planted with vineyards. Up to Frankfort it has been deepened and the channel otherwise improved. A committee, chiefly promoted by the Würtemberg government and the Stuttgart Chamber of Commerce, reported in 1901 that it was both desirable and practicable to dredge the river and canalize it, from Esslingen down to Mannheim, and that the cost would probably fall between 2 and $2\frac{1}{2}$ millions sterling.

Neemuch, or Nimach, a town of Central India, with British military cantonment, within the native state of Gwalior, on the border of Rajputana, with a station on the Rajputana Railway, 170 miles north of Mhow. Population (1881), 18,230; (1891), 21,600. Number of police, 69 men; expenditure on public works (1897–98), Rs.3052.

Neenah, a city of Winnebago county, Wisconsin, U.S.A., on the Fox river, at the foot of Winnebago Lake, in the eastern part of the state, at an altitude of 754 feet. The Chicago and North-Western, the Chicago, Milwaukee, and St Paul, and the Wisconsin Central railways intersect at this point. The city has good water-power, and manufactures of lumber, flour, and paper. It has some reputation as a summer resort. It was founded in 1836 as a military post. Population (1880), 4202; (1890), 5083; (1895), 5781; (1900), 5954, of whom 1559 were foreign-born.

Negapatam, a seaport town of British India, in the Tanjore district of Madras, forming one municipality with Nagore, a port 3 miles north at the mouth of the Vettar river. It is the terminus of a branch of the South Indian Railway, which has been extended to Nagore. Population (1881), 53,855; (1891), 59,221; (1901), 56,455; municipal income (1897–98), Rs.75,000. There is a large population of Labbays, Mahommedans of mixed Arab descent, who are keen traders. Jesuit and Wesleyan missions are carried on. In 1897–98 the total sea-borne trade of the district was valued at Rs.1,94,29,666. The chief export is rice to Ceylon. The number of vessels that entered and cleared for foreign trade was 453, with an aggregate burthen of 191,000 tons. The Wesleyan Mission College was closed in 1895. The two aided high schools (Wesleyan and Catholic) had 411 pupils in 1896–97. There are four printing-presses, issuing an English and two vernacular newspapers, besides two large reading-rooms and literary associations.

Negaunee, a city of Marquette county, Michigan, U.S.A., in the Marquette Iron Range, on the Upper Peninsula, 12 miles west of Marquette, and on the Chicago and North-Western, and the Duluth, South Shore, and Atlantic railways, at an altitude of 1564 feet. The city overlies enormous deposits of hæmatite iron ore, and the industries consist in mining and shipping this ore. Population (1880), 3931; (1890), 6078; (1900), 6935, of whom 3270 were foreign-born.

Negligence, in law, is a ground of civil liability, and in criminal law it is an element in several offences, the most conspicuous of which is manslaughter by negligence. In order to establish civil liability on the ground of negligence, three things must be proved,—a duty to take care, the absence of due care, and actual damage caused directly by the absence of due care. Mere carelessness gives no right of action unless the person injured can show that there was a legal duty to take care. The duty may be to the public in general, on the ground that any person who does anything which may involve risk to the public is bound to take due care to avoid the risk. For instance, in the words of Lord Blackburn, "those who go personally or bring property where they know that they or it may come into collision with the persons or property of others have by law a duty cast upon them to use reasonable care and skill to avoid such a collision." Where a special duty to an individual is alleged, the duty must rest on a contract or undertaking or some similar specific ground. Thus, where a surveyor has carelessly given incorrect progress certificates, and a mortgagee who has had no contractual relation with the surveyor has advanced money on the faith of the certificate, the surveyor is not liable to the mortgagee in an action of negligence, because he owed no duty to the mortgagee to be careful. When a duty to take care is established, the degree of care required is now determined by a well-ascertained standard. This standard is the amount of care which would be exercised in the circumstances by an "average reasonable man." This objective standard excludes consideration of the capacity or state of mind of the particular individual. It also gets rid of the old distinctions between "gross," "ordinary," and "slight" negligence, though no doubt the degree of care required varies with the circumstances of the case. The application of such a standard is a task for which a jury is a very appropriate tribunal. In fact the decision of the question whether there has been a want of due care is left almost unreservedly to the jury. There is this amount of control, that if the judge is of opinion that the evidence, if believed, cannot possibly be regarded as showing want of due care, or in technical language that there is "no evidence of negligence," it is his duty to withdraw the case from the jury and give judgment for the defendant. Unless the judge decides that there is no duty to take care, or that there is no evidence of want of care, the question of negligence or no negligence is wholly for the jury.

Ordinarily a man is responsible only for his own negligence and for that of his servants and agents acting within the scope of their authority. For the acts or defaults of the servants of an independent contractor he is not liable. But in certain cases a stricter obligation is imposed on him by law. The occupier of premises is under a duty to all persons who go there on business which concerns him to see that the premises are in a reasonably safe condition so far as reasonable care and skill can make them so. Thus he cannot release himself by employing an independent contractor to maintain or repair the premises. The effect of this doctrine is that the occupier may be liable if it can be shown that the independent contractor or his servant has been guilty of a want of due care. A similar obligation has been enforced in the case of a wreck stranded in a navigable river, and the owner was held liable for damage caused by the carelessness of the servant of an independent contractor who had undertaken to light the wreck. So too any person who undertakes a work likely to cause danger if due care is not taken is liable for damage caused by the carelessness of the servant of an independent contractor, so long as the carelessness is not casual or collateral to the servant's employment.

In an action of negligence a familiar defence is "contributory negligence." This is a rather misleading expression. It is not a sufficient defence to show that the plaintiff was negligent, and that his negligence contributed to the harm complained of. The plaintiff's negligence will not disentitle him to recover unless it is such that without it the misfortune would not have happened, nor if the defendant might by the exercise of reasonable care on his part have avoided the consequences of the plaintiff's negligence. The shortest and plainest way of expressing this rule is, that the plaintiff's negligence is no defence unless it was the proximate or decisive cause of the injury. There was an attempt in recent times to extend this doctrine so as to make the contributory negligence of a third person a defence, in cases where the plaintiff, though not negligent himself, was travelling in a vehicle or vessel managed by the negligent third person, or was otherwise under his control. In such circumstances it was said that the plaintiff was "identified" with the third person. The court went so far in one case as to "identify" a child with its grandmother. But the case of *The Bernina*, decided in 1888, exploded this supposed doctrine, and made it clear that the defence of contributory negligence holds good only when the defendant contends and proves that the plaintiff was injured by his own carelessness. (A. Ll. D.)

Negro.—In recent years the domain of the true African negro, with whom alone we are here concerned (*Ency. Brit.* vol. xvii. p. 316), has been considerably enlarged by the explorations of Dybowski, Crampel, and Clozel about the Congo–Chad water-parting; of Junker and the Belgian officials about the Congo–Nile water-parting; of Lugard, Jackson, Gregory, and others in British East Africa and Uganda; of Baumann and Emin Pasha in German East Africa. The main result is that the ethnical divide between the full-blood Sudanese negro and the Negroid Bantu populations has to be shifted more to the south than had hitherto been supposed. Owing to numerous overlappings and interminglings in some districts it is still often difficult to lay down the frontiers between the two domains with any approach to accuracy. But, speaking generally, the parting line may now be traced across the continent along the fifth parallel from the Rio del Rey in the extreme west to about 20° E., where it roughly coincides with the elevated plateau, which here separates the waters flowing north to Lake Chad and south to the Congo. Farther on it dips considerably to the south-east along the southern borders of the Niam-Niam and Monbuttu (Mangbattu) territories to the Semliki valley between Lakes Albert and Albert Edward, near the equator. From this point the ethnic boundary follows a somewhat irregular course, first north by the east side of Albert Nyanza to and up the Somerset Nile as far as Mruli, and then round the east side of Usoga and Lake Victoria to Kavirondo Bay, where it turns nearly east to and down the Tana river almost to the Indian Ocean. From the Atlantic to Lake Victoria the line thus drawn seems to represent the actual relations with some accuracy; but in Kavirondo it enters a debateable region, where much further research will be needed correctly to determine the respective limits of the various Hamitic negro and Bantu peoples—*Masai*, *Turkana*, *Galla*, *Wakikuyu*, *Shuli*, and others—whose territories here converge from the north, east, and south. Meanwhile, this extension of the Sudanese negro domain has brought within its borders a considerable number of fresh groups, some only discovered in recent years, others hitherto supposed to belong to different ethnical connexions. In Western Sudan also, and especially in the region within the Niger bend, the explorations of the late Col. Ellis and of Col. Binger have not only brought to light many new groups, but have also cleared up some obscure points connected with the inter-relations of the already known peoples. A much wider extension must now be given to the great *Mandingan* family, as well as to that of Upper Guinea, which still lacks a satisfactory collective name, but the various sections of which—*Tshi*, *Ewe*, *Yoruba*, and others—are shown by Ellis to be fundamentally connected in speech, physique, religion, and social usage.

As a consequence of all these discoveries the tentative classification of the Sudanese negro peoples (vol. xvii. p. 319) requires so many readjustments that it will be more convenient to substitute a fresh table harmonizing better with the present state of African ethnology. Here are included the Fulahs, Hausas, and the other historical Negroid nations:—

Wolof Group—Wolofs proper; Jolofs; Serers; between the lower Senegal river and Cape Verde.
Felup Group—Aiamat; Yola; Kabil; Jugut; Fogni; Kaimut; Vaca; Banjiar; Fuluu; Bayot; Casamanza and Cacheo estuaries.
Toucouleur (*Taeuror*)—Kaarta district and Senegal river.
Mandingan (*Mandé*) *Family*—Mandé proper; Bambara; Sarakolé; Kassonké; Jallonké; Suzy; Susu; Vei; Mano; Toma; Landoro; Kabunga; Tene; widespread throughout Senegambia and the Upper Niger basin.
Sonrhay (*Songhay*)—Middle Niger between Lake Debo and Sokoto confluence.
Temné Group—Temné (Timneh) proper; Kissi; Sherbro; Gallina; Kono; Bullom; Solima; Sierra Leone.
Fulah Group—Futa-Jallo; Futa-Toro; Jel; Baa; So; Mabube; Laube; Beri; Senegambia, and sporadically throughout West and Central Sudan.
Liberian Groups—Deh; Gurra; Kru ("Kroo Boys"); Kondo; Pessa; Gollo; Bassa; Kabo; Grebo; Tebo; Webo; Nyambo; Grain Coast.
Upper Guinea Family—Oshin; Agni; Tshi (Ashanti, Fanti, Wassawa, Adansi); Ga (Accra, Krobo, Agotine); Ewe (Awuna, Agbosimi, Togo, Dahoman, Krepe, Fra, Appi); Yoruba (Jebu, Egba, Oworo, Ondo, Ife, Oyo); Ivory, Gold, and Slave Coasts.
Niger-Benue Groups—Benin; Ibo; Nupe; Iju (Akasa); Nempé; Okrika; Qua; Efik; Andoni; Ebe; Kambari; Wuruku; Tangala; Kali; Bele; Akpa; Mitchi; Doma; Niger delta, Oil Rivers, Lower Benue, and Niger.
Adamawa Groups—Batta; Fala; Marga; Holma; Bula; Kilba; Woka; Fani; Longoela, Upper Benue, thence east to Logon.
Niger Bend Groups—Mossi; Gurma; Gonja; Tombo; Gurunga; Sienuf (Sieneret); within the Niger Bend.
Hausa—From the Niger to Bornu; chief nation in Central Sudan.
Lake Chad Groups—Kanembu; Kanuri; Yedina; Kuri; Baghirmi; Logon; Mandara; Mosgu; Gamergu; Kerrikerri; Sara; Babir; Chad Basin (Kanem, Bornu, Baghirmi, Logon, and surrounding districts).
Wadai Groups—Maba; Birkit; Massalit; Korunga; Kondongo; Mubi; Marta; Wadai and East Dar-Fur.
Nuba-Fur Family—Fur; Kunjara; Nuba and Nile Nubians; Kargo; Kulfan; Kolaji; Tumali; Tegele; Dar-Fur, Kordofan, Nubia.
Nilitic Groups—Shuli; Labore; Kirim; Janghey; Falanj; Luri; Madi; Bari; Nuer; Shilluk; Dinka; Mundu; Abaka; Abakaya; Bongo; Rol; Mittu; Krej; Fertit; White Nile; Sobat; northern slopes of Nile-Congo divide.
Welle Groups—Niam-Niam (A-Zandeh); Mangbattu (Mombuttu); Kalaka; A-Baugba; A-Madi; A-Kahle; A-Babua; A-Barambo; Embata; Mangballe; A-Banjia; Mabenge; Nsakkara; A-Ngaddu; Welle river from its source to Mbomu confluence.
Lacustrine Groups—Shefalu; Wa-Kavirondo; Magaya; Wiehwezi; Drugu; Drudu; Wa-Konjo; Wambuba; Wa-Wamba; Wa-Lenga; Wa-Yerra; Wa-Tigawa; Unyoro, Kavirondoland: Victoria Nile; Semliki river; Mpororo and Batumi districts.

See Dr W. Junker. *Travels in Africa*. English ed., 3 vols., 1875–86.—M. Clozel. *Tour du Monde*, 1896, p. 1 *sq*.—M. Dybowski. *Le Naturaliste*. January 1894.—Capt. Binger. *Du Niger au Golfe de Guinée*, 2 vols., 1892.—H. Gannett. *North America*, vol. ii., 1898.—Dr O. Baumann. *Jour. Roy. Geo. Soc.*, 1896–97.—Dr J. W. Gregory. *The Great Rift-Valley*, 1896.—Col. A. B. Ellis. *The Tshi-speaking Peoples* (1887); *The Ewe-speaking Peoples* (1890); *The Yoruba-speaking Peoples* (1894).

(A. H. K.)

Negroes in United States of America.

The first negro slaves in America were brought by the Spaniards to San Domingo, in the island of Hayti, in 1565. There has been much controversy as to the year when the first negroes were landed on the continent of North America; and the number brought in the first shipment has been given as fourteen by some authorities, and as twenty by others. Williams [1] says that fourteen negroes were landed in the colony of Virginia in the month of August 1619 from a Dutch man-of-war, claiming to sail under a commission from the prince of Orange. The negroes were exchanged for provisions, and were forced upon the colony. At that period white servitude was common; women were sold for wives, being sometimes kidnapped in England and sent to the colony. Slavery grew slowly at first. In 1624 there were only twenty-two negroes in the colony of Virginia. In 1648 the white population of the colony was about 15,000, with 300 slaves. Slavery existed from 1619 to 1662 without sanction of law. In 1662 a law was enacted in Virginia that the issue of slave mothers should follow their condition (*Partus sequitur ventrem*). In 1705 a law was passed, by approval of Queen Anne, declaring slaves to be real estate. There is no trustworthy record of slavery in New York under the Dutch between 1609 and 1664, but it undoubtedly existed. When New Netherland became an English colony in 1664, slavery received official recognition. Slaves were introduced into Massachusetts from Barbados in 1637. In 1676 there were 200 slaves in Massachusetts. At the beginning of the Revolution in 1775, there were 501,102 slaves in the American colonies. The last cargo of slaves brought to the United States consisted of thirty full-blooded Dahomeyans landed from the ship *Clothilde* in 1859. Efforts for emancipation were begun as early as 1780 by the Quakers. One of the first organized attempts at "abolition agitation" was that of Benjamin Lundy, begun in 1821. The colony of Liberia, in Africa, was founded by the American Colonization Society as a place of residence for free negroes. The first shipload of emigrants, consisting of 86 negroes, went to the colony in February 1820. In 1861, at the beginning of the Civil War, there were about 4,441,000 negroes in the United States, of whom 11 per cent. were free.

History.

Table A shows the white and coloured population of the United States by decades since 1790. Previous to 1860, Indians and Chinese were included in the census report as "coloured."

[1] *History of the Negro Race in America from 1619 to 1880*, George W. Williams. New York: G. P. Putnam's Sons. The author of this work is himself a negro.

TABLE A.

Year.	White.	Coloured.	Proportion of White.	Proportion of Coloured.
1790	3,172,006	757,208	81·12	18·88
1800	4,306,446	1,002,037	81·13	18·87
1810	5,862,073	1,377,808	80·98	19·02
1820	7,862,166	1,771,656	81·62	18·38
1830	10,537,378	2,328,642	81·90	18·10
1840	14,195,805	2,873,648	83·17	16·83
1850	19,553,068	3,638,808	84·32	15·68
1860	27,001,491	4,441,830	85·88	14·12
1870	33,678,362	4,880,009	87·35	12·65
1880	43,574,990	6,580,793	86·88	13·12
1890	55,152,210	7,470,040	88·07	11·93
1900	66,990,802	8,840,789	88·35	11·65

Table B shows the changes in proportion of coloured to white population in the Southern states.

TABLE B.

	1830.	1860.	1890.	1900.
Maryland	34·88	24·91	20·69	19·79
District of Columbia	30·81	19·07	32·80	31·12
Virginia	42·69	34·39	38·37	35·64
North Carolina	35·93	36·42	34·67	33·07
South Carolina	55·63	58·59	59·85	58·37
Georgia	42·57	44·05	46·74	46·68
Florida	47·06	44·63	42·46	43·69
Kentucky	24·73	20·44	14·42	13·26
Tennessee	21·43	25·50	24·37	23·77
Alabama	38·48	45·40	44·84	45·24
Mississippi	48·44	55·28	57·58	58·60
Louisiana	58·54	49·49	49·99	47·14
Texas	...	30·27	21·84	20·36
Arkansas	15·52	25·55	27·40	27·94

From 1860 to 1900 the negro population of the entire country increased 100 per cent., and the whites about 150 per cent., the whites receiving 14,000,000 by immigration, and the negroes practically none. The natural increase of the two races was about equal. Between 1880 and 1900 the whites increased (excluding immigration) nearly 33 per cent., and the negroes nearly 34 per cent. From 1850 to 1900 a perceptible change in the distribution of the negro population was apparent. In 1850 the proportion of negroes in the Southern states was 94·2 per cent. ; in 1900 it had fallen to 89·9. In the upper Southern states, viz., Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Kentucky, Tennessee, and Missouri, there was a loss of 17 per cent.—from 54·4 to 37·4—and in the lower Southern states an increase of 12·7 per cent.—from 39·8 to 52·5. Alabama alone held its proportion unchanged. From the upper Southern group of states there were two different movements, one to the southward, the other to the north and west. Virginia has afforded the largest migration to the north and west, while South Carolina, North Carolina, Tennessee, and Virginia, in the order given, have contributed most to the lower Southern group of states. There has been a marked increase of the urban negro population, especially in the larger cities of the North and the states bordering on the North (Table C).

TABLE C.—*Negro Population in Twelve Cities having the largest Negro Population.*

	1870.	1880.	1890.	1900.
Washington, D.C.	38,726	52,135	75,572	86,702
Baltimore, Md.	39,558	53,716	67,104	79,258
New Orleans, La.	50,456	57,617	64,491	77,714
Philadelphia, Pa.	22,147	31,699	39,371	62,613
New York, N.Y.	13,072	19,663	33,994	60,666
Memphis, Tenn.	15,471	14,896	28,706	49,910
Louisville, Ky.	14,956	20,905	28,651	39,139
Atlanta, Ga.	9,929	16,330	28,098	35,912
St Louis, Mo.	22,088	22,256	26,865	35,516
Richmond, Va.	23,110	27,832	32,330	32,230
Charleston, S.C.	26,173	27,276	30,970	31,522
Chicago, Ill.	3,691	6,480	14,271	30,150

In the decade 1890–1900 several of the Southern cities made little gain. On the other hand, the four Northern cities, New York, Chicago, Philadelphia, and Pittsburg, show an aggregate increase of 80,973. Four other cities, Washington, Baltimore, New Orleans, and Memphis, show an aggregate increase for the same period of 68,711, but this is much below that of the four Northern cities named.

The relative proportion of the races in the Southern states shows little change, notwithstanding the movements indicated. In the low swampy regions of the Atlantic coast, and in the alluvial regions of the Mississippi valley, 17 per cent. of the total negro population are found, whereas only 4 per cent. of the total population of the country live there. Seventy per cent. of the negroes live below an altitude of 500 feet. The total population of the country live under a mean average temperature of 53° ; the average temperature under which the negro lives is 61°.

Occupation and ownership.

The negro is mainly occupied in agriculture or personal service. Between 1865 and 1890 there was little progress in manufacture, transportation, and trade, but in the last decade of the 19th century there was definite and encouraging progress in those directions. In 1890 the total number of farms in the United States was 4,767,179. Of these the negroes occupied 549,642, or 11·5 per cent. The number of homes, as distinguished from farms, was 7,922,973, and of these the negroes occupied 861,137, or 10·9 per cent. At the same date the proportion of negroes to the total population was 12·2 per cent. Of the farms occupied by negroes in 1890, 120,738, or 22 per cent., were owned by the occupants. The corresponding proportion for whites was 71·7 per cent. In 1890 negroes owned 19 per cent. of the homes occupied by them, whereas the whites owned 39·4 per cent. of their homes. The property owned by the negroes was acquired in the twenty-five years following their freedom. The progress in acquiring farms and homes in the decade from 1890 to 1900 was marked. The report of the State Comptroller of Georgia showed that in 1901 the assessed value (half actual) of negro property in the state was $15,629,811, while negroes owned 1,141,135 acres of land, valued at $4,656,042.

A study of the negro in business, made in 1899 by Professor W. E. B. Du Bois, estimated the capital then invested in negro business enterprises to be $8,784,637. Seventy-nine per cent. of this was in sums of less than $2500. The same study reported 3 monthly magazines, 3 daily papers, 11 school journals, and 136 weekly papers, owned, edited, and published by negroes.

The absolute poverty of the negro after his freedom was responsible for the one-room cabin. Slavery had made family life uncertain or impossible, and this had led to inconstancy, and to a lack of appreciation of the importance of virtue. In these respects there has been a marked improvement. The two-room cabin, making possible separation of the sexes, the ownership of lands, and the general impulse incited in the people for bettering their position, have brought a higher standard of life and morals. The most encouraging result of opportunity and development is the growing differentiation of classes among negroes, even in small communities, and the fact, now clearly defined, that the industrious and property-holding class of the negro population represents the general tendency of the race. "In slavery days marriage or cohabitation was entered upon very early, and the first generation of freemen did the same. The second generation is postponing marriage to better its condition" (Du Bois). In 1890 there were 9 native white prisoners in gaol to every 10,000 of the white population, and 33 negroes to every 10,000 of the negro population ; but as negroes are committed for petty offences in much greater proportion than the whites, the comparison is unfair. It is undoubtedly true, however, that the proportion of negro criminals is in excess of the whites.

Lynching.

Lynching, or the practice of punishment for crimes or offences by unauthorized persons without a legal trial, has been practised against the negro to an alarming extent. A grouping of the lynchings of negroes for five years, with the alleged causes, gives the figures shown in Table D.

TABLE D.

Year.	Murder.	Rape.	Other Causes.	Total.
1896	24	31	31	86
1897	55	22	46	123
1898	47	16	39	102
1899	23	11	56	90
1900	30	16	57	103
Total	179	96	229	504

The lynching may occur from any cause, and any crime by a negro is considered in some communities as an inter-racial crime. The punishment is due to race antipathy and the desire to protect the white race. The rape of the negro by the white, when it occurs, is condoned, and is seldom punished. Throughout the four years of the Civil War, when the negroes were left in charge of the homes of the whites, there is no record of a single murder that could be called an outrage on the part of the negro. The health of the negro race suffered by the free license that followed the restraint in slavery. The introduction of civilized vices into the uncivilized negroes induced excesses, and the lack of self-control brought crime and disease in its path. The birth-rate among the negroes is high, but the death-rate, especially in the cities, is far in excess of that of the whites. This is due to improper food, clothing, excesses, and ignorance of the care of infants.

By Federal constitutional amendment the negro was given the right of franchise. In the former slave states, where the negro predominates, five states—Mississippi, South Carolina, North Carolina, Louisiana, and Alabama—have adopted educational and property qualifications in their constitutions, which practically disfranchise the majority of the negroes. The Constitutional Convention of Virginia (1902) adopted the same qualification. The attitude of the white population varies in proportion to the number of negroes. Where there is no fear of negro domination, as in the North and West, the relationship is simple. But in some Southern states where the negro largely predominates (in some counties in the ratio of 12 to 1), the relations between the negro and the white are very complex. The universal sentiment of the Southern white is that the negro shall neither dominate politically nor shall he have social recognition. He is encouraged, however, to secure a reasonable education, and is respected in proportion to his good citizenship. More trades are open to him in the South than elsewhere, and his labour in agriculture, personal service, and the more laborious trades is appreciated.

Legal disfranchisement.

Statistics of the progress of the negro in education are not complete, but all indicate a wonderfully rapid progress in the elements of education. During slavery it was generally held throughout the South to be a crime to teach negroes to read and write. Schools existed, however, to some extent, for the free negroes, and the U.S. censuses of 1850 and 1860 reported a considerable number of adult "Free Coloured People" in the Southern states who could read and write, 25,490 in 1850, and 29,864 in 1860. The records for literacy and illiteracy among the negroes over ten years of age in eleven of the Southern states since freedom are given in Table E.

Education.

TABLE E.

Year.	Total Negro Population.	Total Number over 10.	Literate Numbers over 10.	Illiterate Numbers over 10.	Percentage of Literates.	Percentage of Illiterates.
1870	3,939,032[1]	2,728,748	295,800	2,432,948	10·8	89·2
1880[2]	5,360,298	3,609,203	837,855	2,771,348	23·2	76·8
1890	6,118,592	4,264,271	1,622,163	2,642,108	38·6	61·4
1900	7,185,617	5,051,828	2,563,090	2,488,738	50·7	49·3

Table F shows the literacy of negro males of voting age (twenty-one years and over) in the United States.

TABLE F.

	Total.	Literate.	Illiterate.	Percentage of Literates.	Percentage of Illiterates.
1870	1,032,475	170,232	862,243	16·5	83·5
1880	1,487,344	465,193	1,022,151[3]	31·3	68·7
1890	1,740,455	714,799	1,025,656[4]	41·1	58·9
1900	2,065,989	1,088,940	977,049	52·7	47·3

Table G shows the variation in different localities.

TABLE G.—*Negro Males of Voting Age in Twelve Cities (1900).*

	Total.	Literate.	Illiterate.	Per Cent. of Illiterate.
Chicago, Ill.	12,414	11,732	682	5·5
New York, N.Y.	18,651	17,365	1286	6·9
Philadelphia, Pa.	20,095	17,905	2190	10·9
St Louis, Mo.	11,727	9,351	2370	20·2
Washington, D.C.	23,072	17,048	6024	26·1
Baltimore, Md.	21,806	16,021	5785	26·5
Savannah, Ga.	7,932	5,497	2435	30·7
Louisville, Ky.	12,416	8,070	4346	35·0
Richmond, Va.	8,472	5,471	3001	35·4
New Orleans, La.	19,809	12,684	7125	36·0
Memphis, Tenn.	14,251	8,867	5384	37·7
Atlanta, Ga.	7,944	4,915	3029	39·4

[1] Estimated from proportions of 1890.
[2] Includes Chinese and Indians.
[3] Includes Chinese, Japanese, and Indians.
[4] Illiterates twenty years of age and over.

With this table may be compared another of twelve counties, in Southern states, having a large proportion of illiterate negroes.

TABLE H.—*Negro Males of Voting Age in Twelve Rural Counties (1900).*

	Total.	Literate.	Illiterate.	Per Cent. of Illiteracy.
Buckingham, Va.	1545	461	1084	70·8
Wilkes, Ga.	2896	848	2048	70·7
Calhoun, Ga.	1393	401	992	71·2
Macon, Ga.	1899	529	1370	72·1
Greene, Ala.	4342	1264	3078	70·9
Marengo, Ala.	6140	1751	4389	71·4
Lowndes, Ala.	6455	1788	4667	72·3
East Feliciana, La.	2831	770	2061	72·8
Concordia, La.	3119	690	2429	77·9
St Landry, La.	5101	1038	4063	79·7
St Martin, La.	1695	329	1366	80·6
Lafayette, La.	1739	250	1489	85·6

In New York, Chicago, and Philadelphia few of the negro males of voting age are unable to read and write; in St Louis, Baltimore, and Washington the number increases; in the more southerly cities it becomes upward of a third; and in many of the rural districts the literacy is little greater than under slavery. In some two hundred counties upward of 60 per cent. of the negro males of voting age are recorded as illiterate. The large number that have gone from the South into Northern cities during recent years are evidently of the educated classes who have had the benefit of the schools. Their training seems to have given them an inclination to other pursuits than those which would have made them of greatest use to the more needy people of their own race.

The general disposition of the negro is to educate his children, even at great personal sacrifice. Records of public school expenditure and attendance in the sixteen former slave states and the District of Columbia since 1870 give the following figures:—

TABLE I.

School Year.	Estimated Expenditure for each Race.		Estimated School Population, *i.e.*, Children 5 to 18.		Expenditure per caput.	
	White.	Coloured.	White.	Coloured.	White.	Coloured.
1870–1871	$9,605,158	$780,306	3,236,630	1,578,170	$2·97	$0·49
1880–1881	11,312,573	2,344,241	4,096,800	2,145,990	2·76	1·09
1890–1891	21,245,685	5,444,625	5,230,115	2,551,511	4·06	2·13
1899–1900	28,297,857	7,296,214	6,103,390	2,991,100	4·64	2·44

The total expenditure for the public schools in these states during this time has been $615,074,209, of which $499,119,910 was for white children, and $115,954,299 was for coloured children.

The U.S. Commissioner of Education reported that for the school year 1900–01 there were 180 institutions for the education of the negro in the United States, other than the public schools. 145 of these, reporting to the Commission, gave the following figures:—

Number of students		37,696
Elementary	22,043	
Secondary	13,267	
College grades	2,386	

Of this number 15,683 were receiving industrial training. The aggregate income of the 145 schools was $1,182,365. Of this amount there came from public funds, $212,950; from tuition, $148,506; from productive funds, $142,932; and from private donations, $677,977.

In addition to generous private benefactions, largely from the North, there have been expended for negro education a portion of the income of the Peabody fund, the income of the Slater fund, and large sums contributed through the American Missionary Association and other societies maintained by different churches.

The training given at Hampton Institute, Hampton, Virginia, at the Tuskegee Normal and Industrial Institute, Tuskegee, Alabama, and at similar institutions, has had a marked influence on the education of the negro race. The aim of such schools is to give agricultural or industrial training, together with a practical academic course. The importance of teaching the negro the value of work and how to work is paramount. The need of fitting him for his necessary environment is a responsibility which is gradually being recognized by the whole people.

For a very complete bibliography of the negro, see Appendix "C," p. 419, of *The Philadelphia Negro*, published for the University of Pennsylvania, 1899, Philadelphia, Penn., U.S.A., edited by Prof. W. E. Du Bois. (W. H. B.)

Negro, Rio. See AMAZON.

Nehávend, a small but very fertile and productive province of Persia, situated south-west of Hamadan, west of Maláyir, and north-west of Burújird. It has a population of about 15,000, and pays taxes amounting to about £9000 per annum. The capital is the ancient city of Nehávend, where Yezdigird, the last monarch of the Sassanian dynasty, was finally defeated by the Arabs. It has a population of about 5000, including 700 to 800 Jews; there are fine gardens, and an old citadel on a hill, It is situated at an elevation of 5540 feet, 27 miles from Doletábád (Maláyir), and 25 miles from Burújird.

Neisse, two rivers of Germany, both left-hand tributaries of the Oder. 1. The Glatz Neisse rises on the Schneeberg, at an altitude of 1400 feet, flows north past Glatz, turns east and pierces the Eulengebirge in the Wartha pass, then continues east as far as the town of Neisse, and after that flows north-north-east until it joins (altitude, 453 feet) the Oder between Oppeln and Brieg. It is only used for floating down timber, owing to its torrential character. It abounds in fish. Its total length is 121 miles. 2. The Lausitz or Görlitz Neisse rises near Reichenberg in Bohemia, on the south side of the Riesengebirge, at an altitude of 1130 feet, flows north past Reichenberg, Görlitz, Forst, and Guben, and enters the Oder above Fürstenberg (altitude, 105 feet). Its length is 140 miles, of which less than 10 miles are navigable.

Neisse, a town of Prussia, province of Silesia, 32 miles by rail south-west of Oppeln, on the Neisse. It has a (Renaissance) exchequer (1604; restored in 1890), with frescoes and sculptures on the façade; also a fountain (1686), a museum of antiquities, a military school, an industrial school, a sanatorium (St Rochus); and in the quarter of Friedrichstadt monuments to the poet Eichendorff (who died here in 1857), to the war of 1866, and the war of 1870–71. Population (1885), 21,837; (1900), 24,271.

Nellore, a town and district of India, in the Madras presidency. The town is on the right bank of the Penner river; a station on the East Coast Railway, 109 miles north of Madras city. Population (1881), 27,505; (1891), 29,336; municipal income (1897–98), Rs.44,300. There are United Free Church, American Baptist, and Catholic missions; two high schools, with 558 pupils in 1896–97; five printing-presses, issuing three vernacular periodicals, and four reading-rooms and literary associations.

The district of NELLORE has an area of 8765 square miles; population (1881), 1,220,236; (1891), 1,463,736; (1901), 1,497,796, showing an increase of 20 per cent. after the famine of 1876–77, and of 2·3 per cent. between 1891 and 1901; average density, 171 persons per square mile. The land revenue and rates in 1897–98 were Rs.30,80,873, the incidence of assessment being R.1 : 12 : 5 per acre; cultivated area, 1,094,682 acres, of which 301,932 were irrigated, including 130,762 from Government canals; number of police, 1212; boys at school (1896–97), 24,874, being 22·5 per cent. of the male population of school-going age; registered death-rate (1897), 19·5 per thousand. The principal crops are millet, rice, other food grains, indigo, and oil-seeds. The breed of cattle is celebrated. There are altogether 1223 indigo vats, employing 17,450 hands, with an out-turn valued at Rs.7,65,000 a year; and 32 saltpetre refineries. There are two important irrigation works, the Penner and Sangam systems. On the former the capital expenditure has been Rs.18,99,000. In 1897–98 the irrigated area was 70,464 acres, yielding a profit of 4 per cent. On the latter (not quite finished) the capital outlay has been Rs.38,56,000. In 1897–98 the irrigated area was 76,217 acres, yielding a surplus of Rs.16,234. The East Coast Railway, running through the length of the district, was opened throughout for traffic in 1899. The section of line from Nellore city to Gudur (24 miles), formerly on the metre gauge of the South Indian Railway, has been converted to the standard gauge. Previously the chief means of communication with Madras was by the Buckingham canal. The sea-borne trade is insignificant.

Nelson, a municipal borough (1890) in the Clitheroe parliamentary division of Lancashire, England, 3 miles north of Burnley by rail. Cotton is manufactured. There are a free library, with a largely attended technical school in the same building, and a handsome market hall. Recreation grounds have been opened. Population (1881), 10,381; (1891), 22,754; (1901), 32,816.

Nelson, chief town of the silver-mining localities of West Kootenay, British Columbia. It was one of the earliest mining "camps" in Kootenay, but was incorporated only in 1897. It is situated on the south shore of a branch of Kootenay Lake, and has rail connexion with Rossland, Robson, the terminus of the Arrow Lake steamers, and with the railways of Washington state. It has banks, churches, and schools, as well as large smelting plant for ores. Population, about 6000.

Nelson, a river of Keewatin, Canada, discharging the waters of Lake Winnipeg into Hudson Bay. It drains an area of 360,000 square miles, and, including its great tributary the Saskatchewan, is 1450 miles long. It is unnavigable except for canoes, and has a total fall between the lake and sea of 710 feet. The Saskatchewan rises in the Rocky Mountains in 52° 07′ N. and 117° 06′ W., and flows in a general easterly direction to Lake Winnipeg. It has many large tributaries, including the Clearwater, Brazeau, Battle, Carrot, and the South Saskatchewan, with its affluents, Red Deer, Bow and Belly rivers, and is navigable for shallow-draught steamers from Edmonton to the Grand Rapids at its *débouchement* into Lake Winnipeg, a distance of 820 miles. Other considerable streams discharging into Lake Winnipeg are Berens, Poplar, Winnipeg, Red, with its western branch, the Assiniboine and Dauphin rivers.

Nelsonville, a village of Athens county, Ohio, U.S.A., on the Hocking Valley Railway, in the south-east part of the state. It is in a coal-mining region, and is largely engaged in shipping coal. Population (1890), 4558; (1900), 5421, of whom 328 were foreign-born and 204 negroes.

Nematoda.—Since the date (1884) of the article in the earlier volumes (ninth edition) of this Encyclopædia innumerable details have been added to our knowledge of the minute anatomy and life-history of the Nematoda, but the present article will be mainly confined to the more important additions to our knowledge of the pathological and economic thread-worms. A word or two, however, must be said about certain organs recently brought into prominence—the so-called phagocytic organs. These consist of enormous cells with nuclei so large as to be in some cases just visible to the naked eye. These cells are disposed in pairs, though the members of each pair are not always at the same level. The number of cells is not large (some 2 to 8), and as a rule they lie along the lateral lines. In some species (*Ascaris decipiens*) the giant cell is replaced by an irregular mass of protoplasm containing a number of small nuclei. Such a plasmodium bears, on its periphery, groups of rounded projections of protoplasm termed end-organs. Similarly the giant cells are produced at their periphery into a number of branching processes which bear similar end-organs on their surface and in some cases terminate in them. These end-organs are the active agents in taking up foreign granules, or bacteria, which may have found their way into the fluid of the body-cavity. From the shape and position of the phagocytic organs it is obvious that they form admirable strainers through which the fluid of the body-cavity filters (Figs. 1, 2). (See N. Nassonov, *Arch. Mikr. Anat.*, 1900; *Arch. parasit.*, 1898. Rabot, *Lab. Warsaw*, 1898; *Zool. Anz.*, 1898. L. Jägerskiold, *Centrbl. Bakter.*, 1898. J. Spengel, *Zool. Anz.*, 1897. H. Ehlers, *Arch. Naturg.*, 1899. O. Hamann, *Die Nemathelminthen*, 1895.)

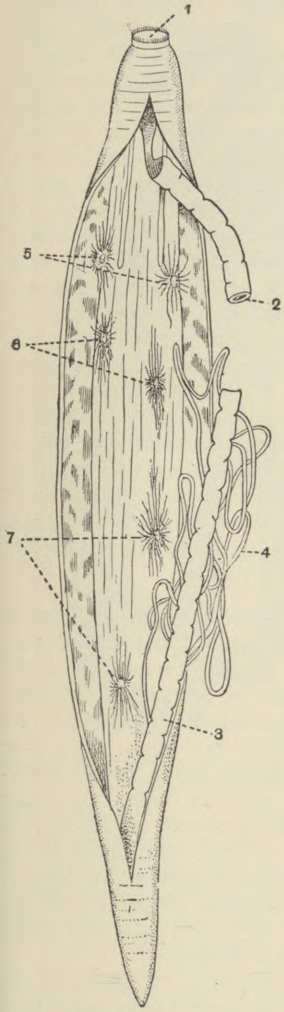

Fig. 1.—*Sclerostomum armatum*, ♀, × about 3½, opened to show the phagocytic organs. 1, Mouth; 2, anterior end of alimentary canal; 3, posterior end of alimentary canal; 4, ovary; 5, 6, and 7, anterior middle and posterior pairs of phagocytic organs. (*From Nassonov.*)

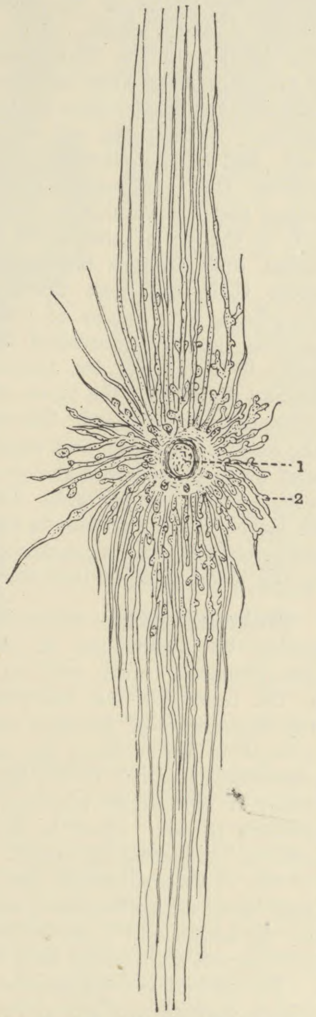

Fig. 2.—One of the phagocytic organs of *Sc. armatum*, highly magnified. 1, Nucleus of giant-cell; 2, one of the processes and end-organs of the same. (*From Nassonov.*)

Agriculturists are paying increased attention to the nematodes that destroy their crops. A good example of a fairly typical case is afforded by *Heterodera schachtii*, which attacks the beetroot and causes great loss to the Continental sugar manufacturers. The young larvæ, nourished by the yolk which remains over from the egg and by the remains of the mother which they have taken into their alimentary canal, make their way through the earth, and ultimately coming across the root of a beet, begin to bore into it. This they do by means of a spine which can be protruded from the mouth. Once within the root, they absorb the cell sap of the parenchyma and begin to swell until their body projects from the surface of the root in the form of a tubercle (Fig. 3). The reproductive organs do not begin to appear until the larva has twice cast its skin. After this a marked sexual dimorphism sets in. The female, hitherto indistinguishable from the male, continues to swell until she attains the outlines of a lemon. Doing this she bursts the epidermis of the rootlet, and her body projects into the surrounding earth. The male has a different life-history (Fig. 4). After the second larval moult, he passes through a passive stage comparable to the pupa-stadium of an insect, and during this stage, which occurs inside the root, the reproductive organs are perfected. The male next casts his cuticle, and by means of his spine bores through the tissues of the root and escapes into the earth. Here he seeks a female, pairs, and soon afterwards dies. The eggs of the female give rise to embryos within the body of the mother; her other organs undergo a retrogressive change and serve as food for the young, until the body-wall only of the mother remains as a brown capsule. From this the young escape and make their way through the earth to new roots. The whole life-history extends over a period of some 4–5 weeks (Fig. 4), so that some 6–7 generations are born during the warmer months. The number of descendants which arise from a single pair during one summer are enormous. If we assume that each female produces 300 embryos, and that half of these are females, the number of descendants would be, after six generations, some 22,781 milliards (A. Strubell, *Bibl. Zool.*, 1888–89). Other species which have been recorded in the United Kingdom are *Tylenchus devastatrix* (Kuhn), on oats, rye, and clover roots; *T. tritici*, causing the ear-cockle of wheat; *Cephalobus rigidus* (Schn.),

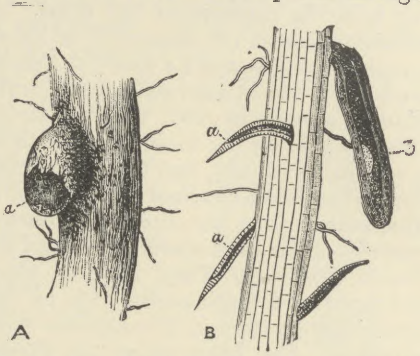

Fig. 3.—A. *a*, Female *Heterodera schachtii* Schmidt, breaking through the epidermis of a root; the head is still embedded in the parenchyma of the root. B. *a*, larvæ boring their way into a root; *b*, larva of the immobile kind surrounded by the old skin, living as an ectoparasite on the outside of the root. (*From Strubell.*)

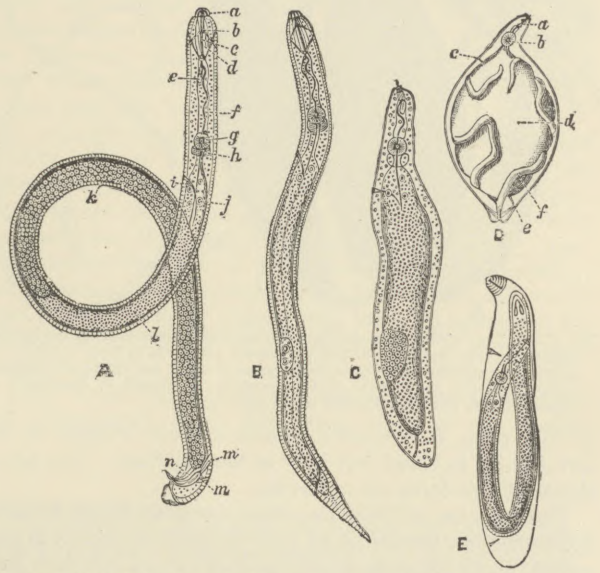

Fig. 4.—A, Male *Heterodera schachtii*, greatly magnified: *a*, head lappets; *b*, mouth cavity; *c*, spine; *d*, muscle of spine; *e*, gland; *f*, œsophagus; *g*, bulb; *h*, nerve-ring; *i*, excretory pore; *j*, œsophagus; *k*, testis; *l*, intestine; *m*, muscles moving spicule; *n*, spicule. B, First motile larva. C, Second immovable parasitic larva casting its skin. D, A female with one half of the body-wall taken away to show the coiling generative organs: *a*, boring apparatus; *b*, œsophageal bulb; *c*, excretory pore; *d*, alimentary canal; *e*, anus; *f*, ovary. E, A male shortly before casting its larval skin.

on oats; *Heterodera radicicola* (Greef) Mull, on the roots of tomatoes, cucumbers, potatoes, turnips, peach-trees, vines, and lettuce and many other plants.

Among recent advances having medical import in our knowledge of the Nematodes, the chief are those dealing with the parasites of the blood. *Filaria sanguinis hominis nocturna* (*F. bancrofti*) is known to live in the lymphatic glands, and its embryos, passing by the thoracic duct, reach the blood-vessels and circulate in the blood. Manson showed, in 1881, that the larvæ were not at all times present in the blood, but that their appearance had a certain periodicity, and that the larvæ of *F. sanguinis hominis nocturna* swarmed in the blood at night-time and disappeared from the circulation during the day. Ten years later Manson discovered a second species whose larvæ live in the blood. They, however, show no periodicity, and are found continuously both by day and by night; hence they are termed *F. sanguinis hominis perstans* (*F. perstans*). The adult stages are thought to be certain Nematodes found in the sub-peritoneal connective tissue.

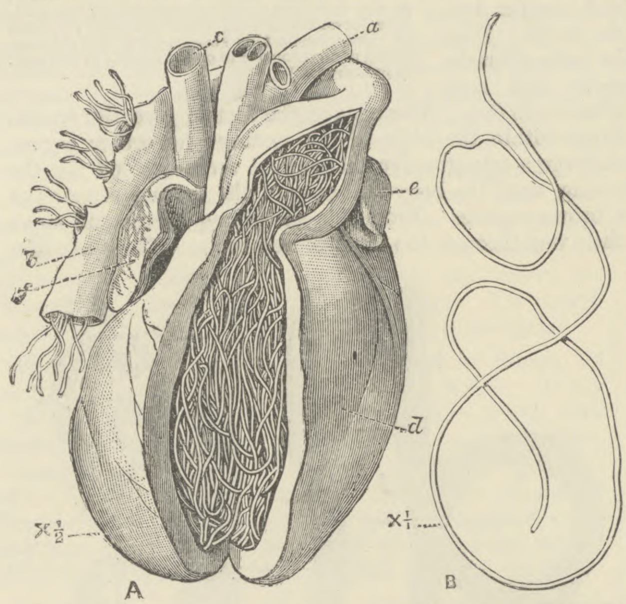

Fig. 5.—A, View of the heart of a dog infested with *Filaria immitis* Leidy; the right ventricle and base of the pulmonary artery have been opened: *a*, aorta; *b*, pulmonary artery; *c*, vena cava; *d*, right ventricle; *e*, appendix of left auricle; *f*, appendix of right auricle. B, Female *F. immitis*, × 1, removed from the heart to show its length.

A third form, *F. sanguinis hominis diurna*, is found in the larval stage in blood, but only in the day-time. The adult stages of this form are unknown.

The presence of these parasites seems at times to have little effect on the host, and men in whose system it is calculated there are some 40–50 million larvæ have shown no signs of disease. In other cases very serious disorders of the lymphatic system are brought about, of which the most marked is perhaps Elephantiasis. Manson and Bancroft suggested that the second host of the parasite is the mosquito or gnat, and for a long time it was thought that they were conveyed to man by the mosquito dying after laying her eggs in water, the larval nematodes escaping from her body and being swallowed by man. It is now held that the parasite enters the blood of man through the piercing mouth-parts at the time of biting. When first sucked up by the insect from an infected man it passes into its stomach, and thence makes its way into the thoracic muscles, and there for some time it grows. Next the larvæ make their way into the connective tissue in the pro-thorax, and ultimately bore a channel into the base of the piercing apparatus and come to rest between the hypopharynx and the labium. Usually two are found in this position lying side by side; it would be interesting to know if these are male and female. From their position in the proboscis the larvæ can easily enter the blood of man the next time the mosquito bites. (Low, *Brit. Med. Journ.*, June 1900; James, *ibid.*, Sept. 1900.) Shortly after Low had published his results, Grassi and Noè issued a paper dealing with the larvæ of *F. immitis*, which is spread by means of the mosquito *Anopheles* (*Centrbl. Bakter.* I. Abth. xxviii., 1900). The larvæ of this parasite develop in the Malpighian tubules of the insect; at a certain stage they cast their cuticle and make their way into the space—part of the hæmocœl—found in the labium. During the act of biting the labium is bent back, and as the piercing stylets enter the skin of the sufferer this bending becomes more and more acute. Grassi and Noè think that if the cavity of the labium be full of the larval nematodes this bending will burst the tissue, and through the rent the larvæ will escape and make their way into the body of the host. Besides *Anopheles*, two species of *Culex*, *C. penicillaris* and *C. pipiens*, are also accused of transmitting the larvæ. A paper by Noè (*Atti Acc. Lincei*, ix., 1900) seems to prove beyond doubt that the larvæ of *F. immitis* are transmitted in the manner indicated. The adult worm is chiefly found in the heart of the dog, and usually in the right side, which may be so packed with the worms as seriously to interfere with the circulation (Fig. 5). The females produce thousands of larvæ, which circulate in the blood, and show a certain periodicity in their appearance, being much more numerous in the blood at night than during the day. (A. E. S.)

Nemertina.—Since the publication of Hubrecht's article on Nemertines in the earlier volumes of this Encyclopædia (ninth edition), the most important event in the history of our knowledge of the group has been the appearance of Bürger's magnificent monograph.[1] As a result of his revision, the author has drawn up a new classification, given below, has added much to our knowledge of the minute histology, and has cleared up many obscure points. There is little to correct in Hubrecht's article, but something to add. In particular, the structure of the excretory system has been elucidated by Bürger, and many naturalists have contributed to our knowledge of the habits and distribution of Nemertines, and many new genera and species have been described.

The curious neuro-glandular pits (Fig. 1), absent in the Mesonemertine and one or two aberrant species, have been shown to possess large glandular cells at their base which secrete a mucus. The development of these organs, which in the Protonemertine are but grooves in the epidermis, not far removed from the similar cephalic slits of many Turbellaria, reaches its height in *Drepanophorus*. Here the pits split into two, one part ending in a sac lined with sensory epithelium, and embedded in nervous tissue, the other projecting backwards as a long, glandular, blind canal. The exit of these organs takes many shapes, of value in systematic work. Their function is still little understood. Two lateral, shallow pits occur on the side of the body about the level of the hinder end of the proboscis in some species of the genus *Carinella*, which are termed side-organs. These are capable of being everted, and are probably sensory in function (Fig. 3, 17).

The vascular system is entirely closed, and its main vessels were described and figured in Hubrecht's article. It contains a colourless fluid, with flat, oval, nucleated corpuscles, as a rule colourless, but in some cases tinged with yellow or red hæmoglobin. Its presence is one of the most distinctive features which separate the Nemertines

[1] "Die Nemertinen," *Fauna und Flora des Golfes von Neapel*, Bd. xix., 1895.

from the Platyhelminthes. In origin the vascular system is due to a fusion of spaces which arise in the mesoblast of the larva. The blood is probably circulated by the general contraction of the whole animal, since it is very doubtful if there are any intrinsic muscles in the vessel-walls. Its function is less that of respiration than of conveying the digested food-products all over the body and the excretory products to the nephridia, and doubtless it serves at times to assist in the extension and retraction of parts of the body. The vessels in the more highly-developed genera seem to be partly lacunæ and partly true vessels with definite walls.

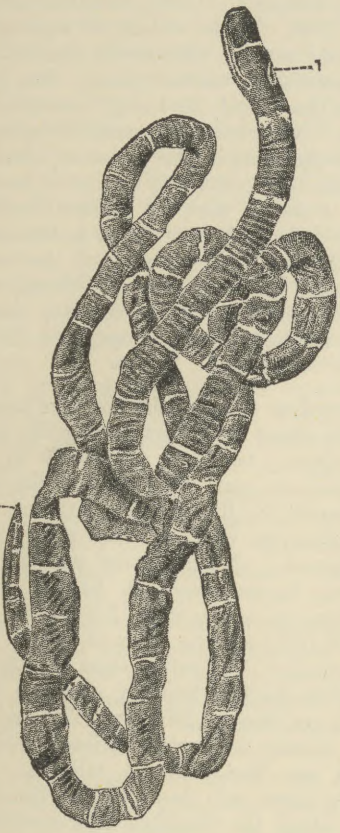

Fig. 1.—*Lineus geniculatus.* × ⅔. (*From Bürger.*) 1, Lateral slits on head; 2, anus.

Closely associated with the lateral blood-vessels are the single pair of nephridia. Each consists of a more or less coiled, ciliated, longitudinal canal, which on its external surface gives origin to one or more transverse canals, which pass to the exterior and open a little way behind the mouth on the sides of the body. On its inner surface the longitudinal canal is adpressed to the lateral blood-vessel, and gives off a number of small, blind cæca or tags, each of which ends in a small clump of cells. These tags indent the blood-vessel. From their inner ends, projecting into the lumen of the tag, hangs a bunch of cilia, which forms the flickering "flame" so well known in the excretory apparatus of the Platyhelminthes and larval Annelids (Fig. 2). There is no communication between the nephridia of one side and the other, but in *Eupolia* there are ducts opening into the alimentary canal as well as to the exterior, a condition of things which recalls what obtains in certain Oligochætes. As a rule these organs only extend a short way along the anterior end of the body, a concentration which we may associate with the development of a vascular system to bring the products of excretion to a fixed spot. In *Stichostemma*, however, Montgomery[1] has described a series of nephridia lying all along the body, and each with a varying number of external pores. The excretory system is epiblastic in its origin.

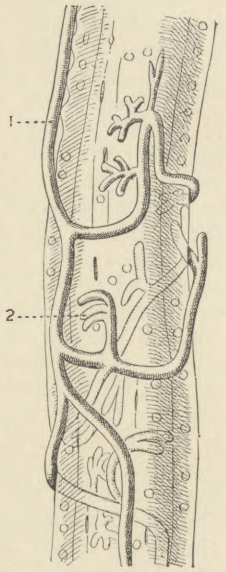

Fig. 2.—Part of the excretory system lying on the lateral vessel of *Drepanophorus spectabilis.* (Magnified about 750.) 1, The longitudinal excretory canal; 2, one of the tags containing the flame-cells.

In the Metanemertini there is a curious diverticulum of the intestine which stretches forward in the median line, ventral to the so-called stomach. It is at times sacculated, but its chief interest is that, as Lebedinsky[2] has shown, the tip of the cæcum in embryonic life opens to the exterior as the blastopore. This subsequently closes up, and the newly-formed œsophagus and stomach open in the intestine above and behind it. It is a curious feature in Nemertines that the alimentary canal seldom contains traces of food, and yet as a class they are voracious. The food must be digested, absorbed, and excreted with great rapidity. There is some evidence that in this group the ectoderm of the œsophagus is chiefly concerned with digestion, whereas the endoderm of the intestine is limited to the absorption of the soluble products.

The armed character of the proboscis of the Metanemertini is dwelt upon by Hubrecht. The median calcareous stylet is supported by usually two, but in *Amphiporus* by as many as twelve lateral stylets secreted in sacs, which Bürger regards as the vacuoles of certain enormous cells. In many forms the epidermis of the proboscis is provided with nematocysts, which differ from those of the Cœlenterata only in that they are found several in one cell. Others secrete rhabdites, recalling similar structures in the Turbellaria. The cavity into which the proboscis is retracted, the rhynchocœlum, is formed by a split which appears in the mesoblast surrounding the epiblastic pit, which is the forerunner of the proboscis. It does not seem to be cœlomic in origin or relations (Fig. 3).

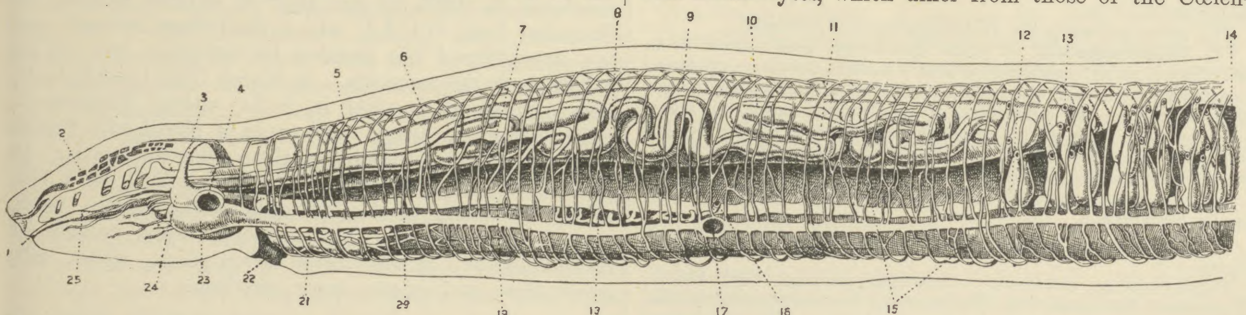

Fig. 3.—Anterior end of a *Carinella*, partly diagrammatic. Magnified. (*From Bürger.*) 1, Opening of proboscis; 2, cephalic glands running to frontal organ; 3, dorsal commissure of brain; 4, cerebral organ; 5, upper dorsal nerve; 6, under dorsal nerve; 7, rhynchocœlic blood-vessel; 8, fore-gut; 9, rhynchocœl; 10, nerve to proboscis; 11, proboscis; 12, genital sac; 13, genital pore; 14, mid-gut; 15, circular nerves; 16, pore of excretory system; 17, lateral organ; 18, excretory canal; 19, lateral vessel; 20, lateral nerve; 21, œsophageal nerve; 22, mouth; 23, ventral ganglion of brain; 24, dorsal ganglion of brain; 25, rhynchodæum.

The reproductive system is of the simplest, strongly contrasting with the complicated arrangements in the Platyhelminthes. A series of sacs lined with an epithelium, the proliferation of which gives rise to the ova or spermatozoa, alternate between the cæca of the intestine.

[1] *Zool. Jahrb. Anat.* x., 1897, p. 265.
[2] *Arch. Mikr. Anat.* xlix., 1897, p. 503.

When mature, each sac pushes out a process to the exterior, and this forms the genital duct. The line of the genital openings is usually dorsal to the lateral nerve. The whole sac, with its epithelial wall and its contained genital cells, arises ultimately from some of the parenchymatous cells of the body. The walls and contents in some forms arise simultaneously; in others the walls are first formed, and their lining then proliferates. It has been pointed out that the cavity of the sacs corresponds in many particulars with the cœlom of higher animals, and in Lebedinsky's observations on the development there is some support to the view that a cœlom exists. Montgomery has also described certain spaces which may be cœlomic lying between the alimentary canal and the inner longitudinal layer of muscles in the Heteronemertini.

The position of the Nemertines in the animal kingdom is now looked upon as more isolated than was formerly thought, and recent writers have been inclined to treat them as a separate phylum. Whether this view be adopted or not, and whether the Turbellaria be regarded as nearly related or only remotely connected, there can be little doubt that the Nemertines resemble the Turbellaria more nearly than they do any other group of animals. Bürger even goes so far as to homologize the proboscis with the Turbellarian pharynx, and he sums up their relationship to the Annelids by the statement that to a certain extent the Nemertines represent Turbellaria, which in the course of time have copied certain features of an Annelid character. The possible relationship to the ancestral forms which must have preceded the Chordata put forward by Hubrecht[1] has met with little recent support, and is not accepted by some of the later writers on the subject.

Bürger classifies Nemertines into four Orders:—

I. **Protonemertini**, in which there are two layers of dermal muscles, external circular and internal longitudinal; the nervous system lies external to the circular muscles; the mouth lies behind the level of the brain; the proboscis has no stylet; there is no cæcum to the intestine. Families, CARINELLIDÆ, HUBRECHTIIDÆ.

II. **Mesonemertini**, in which the nervous system has passed into the dermal muscles, and lies amongst them; other characters as in Protonemertini. Family, CEPHALOTHRICIDÆ.

III. **Metanemertini**, in which the nervous system lies inside the dermal muscles in the parenchyma; the mouth lies in front of the level of the brain; the proboscis as a rule bears stylets; the intestine nearly always has a cæcum. Families, EUNEMERTIDÆ, OTOTYPHLONEMERTIDÆ, PROSORHOCHMIDÆ, AMPHIPORIDÆ, TETRASTEMMATIDÆ, NECTONEMERTIDÆ, PELAGONEMERTIDÆ, MALACOBDELLIDÆ.

This order represents the Hoplonemertini of Hubrecht.

IV. **Heteronemertini**, in which the dermal musculature is in three layers, an external longitudinal, a middle circular, an internal longitudinal; the nervous system lies between the first and second of these layers; the outer layer of longitudinal muscles is a new development; there is no intestinal cæcum; no stylets on the proboscis, and the mouth is behind the level of the brain. Families, EUPOLIIDÆ, LINEIDÆ.

This order represents the Schizonemertini of Hubrecht and the family Eupolidæ.

The following families and genera are represented on the British coasts:—[2]

CARINELLIDÆ, *Carinella*; CEPHALOTHRICIDÆ, *Cephalothrix*, *Carinoma*; EUNEMERTIDÆ, *Eunemertes*; OTOTYPHLONEMERTIDÆ, *Ototyphlonemertes*; AMPHIPORIDÆ, *Amphiporus*, *Drepanophorus*; TETRASTEMMIDÆ, *Tetrastemma*, *Prosorochmus*; MALACOBDELLIDÆ, *Malacobdella*; EUPOLIIDÆ, *Eupolia*, *Valencinia*, *Oxypolia*; LINEIDÆ, *Lineus*, *Euborlasia*, *Micrura*, *Cerebratulus*, *Micrella*.

(A. E. S.)

[1] "*Challenger*" *Reports*, xix. 1887.

[2] Riches, J., *Mar. Biol. Assoc.*, N.S. iii. 1893–95, p. 1; and Punnett, *Liverpool Mar. Biol. Committee Memoirs*, vii. 1901.

Nemours, town, arrondissement of Fontainebleau, department of Seine-et-Marne, France, 18 miles in direct line south of Melun, on the railway from Paris to Lyons, and the Loing canal. The church, of which the older parts date from the 13th century, has a handsome wooden spire, and there is a castle of the 13th century. A statue of the mathematician Bézout (d. 1783), a native of the town, was erected in 1885. In the vicinity is a group of fine sandstone rocks, and sand is extensively quarried for the supply of glass factories at various places. The total traffic of the port on the Canal de Loing amounted in 1900 to 174,561 tons. Nemours is supposed to derive its name from the woods (*nemora*) in the midst of which it formerly stood. In the 10th century it was an important lordship, in the 13th it passed into the possession of the kings of Navarre, and in 1425 it was united to the crown of France. From 1528 to 1659 it belonged to the counts of Savoy; it then passed to the house of Orléans, to a branch of which it still gives titular dignity, though possession was lost at the Revolution. Population (1881), 4156; (1901), 4861.

Nepal, an independent state on the northern frontier of India, extending for about 500 miles among the lower ranges of the Himalaya; bounded westwards by the British district of Kumaon, and eastwards by the state of Sikkim. The capital is Khatmandu, situated in a valley of the same name, on the Baghmati river, about 4000 feet above the sea. No accurate statistics are available. The area is estimated at 54,000 square miles; the population at more than 2,000,000; the revenue at Rs.1,50,00,000; and the army at 50,000 men, in a fair state of efficiency. The ruling class of Gurkhas or Gurkhalis, to which the raja belongs, claim to be of Rajput descent, and are devout Hindus. The majority of the inhabitants belong to various tribes of Indo-Chinese origin, and are Buddhists in religion. The present ruling family dates only from 1768. Since the war of 1814–16, in which the Gurkhas after a stubborn resistance were driven from the conquests they had made in the plains of India and the adjoining hill states, the relations of Nepal with the British have been friendly. A Resident is stationed at Khatmandu, but no interference is exercised with the internal administration. The present maharaja, Prithir Bir Bikram, was born in 1875, and succeeded in 1881. But by custom of old standing, he is a *roi fainéant*, all power being vested in the minister. For many years the minister was Jang Bahadur, G.C.B., who established his position by murdering his rivals in 1846, and died in 1877. His son and successor was in his turn murdered in 1885 by the head of a rival faction, Bir Shamsher Jang, G.C.S.I., who is the present minister, and has strengthened his position by marrying two of his daughters to the maharaja. In March 1892 Lord Roberts, then commander-in-chief in India, visited Khatmandu, and reviewed the army. The trade of Nepal with British India is registered at several stations along the frontier. In 1900–01 the total exports were valued at Rs.1,84,78,548, chiefly consisting of rice, oil-seeds, cattle, tobacco, hides, ghee, and timber. The imports were valued at Rs.1,62,26,456, chiefly cotton piece-goods, silver, salt, spices, brass and copper, sugar, and iron.

Nervi, a town and winter resort of the province of Genoa, Liguria, Italy, on the coast, 6 miles east-south-east of Genoa, on the railway to Spezia. It is frequented because of its mild climate and sheltered situation. It produces lemons, oranges, figs, &c., and manufactures macaroni. There is a small harbour. Population, about 3000.

Nesfield, William Eden, British architect, (1835–1888), one of the leaders of the Gothic revival, was born 2nd April 1835. His father, Major Nesfield, a well-known landscape gardener in his day, laid out Regent's Park and St James's Park, and remodelled Kew. Educated at Eton, Nesfield was articled first to Mr Burn, a classicist, and then to his uncle, Mr Anthony Salvin, who took the Gothic side in the "battle of the styles," and had an enthusiastic adherent in his nephew. Having had some practical training, Nesfield travelled for study in France, Italy, and Greece, afterwards publishing a volume, *Sketches from France and Italy* (London, 1862), which by its striking and accurate delineation became one of the text-books of the Gothic revival. In 1859 Nesfield settled down in London. His first important commission was a new wing to Combe Abbey for Lord Craven. In 1862 began a nominal partnership with Norman Shaw, the artistic fruits of which have sometimes been exaggerated; they shared rooms in Argyle Street for some years, but never collaborated in any design. It was in Argyle Street that the principal work of Nesfield's life was conceived—Combe Abbey, Cloverly Hall, and Kinmel Park. Here he showed a mastery of planning and construction, a conscientious regard for detail, an eye for the picturesque, an unfailing regard for quiet dignity, a refusal to strain after effects, which together make his achievements landmarks in the history of his art. His cottages and lodges are more especially characteristic. He built the lodge in Regent's Park (1864) and that in Kew Gardens (1866). Combe Abbey and Cloverly are somewhat "early French" in style, but as Nesfield developed he adopted a purely English manner, and presented his newer ideas in Loughton Hall and Kinmel Park. The gate lodge at Kinmel Park, Abergele, is entirely "English Renaissance"; Cloverly Hall (1864), planned when he was twenty-nine, with its great hall, fine approaches to the staircase, and the staircase itself, is already half English, and Eastlake in his *History of Gothic Revival* praises it on that very ground. "The whole nature of the design, refined and skilful as it is, may be described as the reverse of pretentious. Its graces are of a most unobtrusive kind. The work is homely rather than grandiose, and though it bears evidence of well-directed study, it certainly derives its chief charm from its unmistakably national character." To this period, or a little later, belong some notable farm buildings at Shipley Hall near Derby, and at Croxteth Park near Liverpool. The full development of the revived classic taste in Nesfield came with his addition to Kinmel Park—red brick, stone dressings, grey-green slated roofs—which elevated that originally unpretentious 18th-century building into a small Renaissance palace. The interior is rich in panelling, in plaster work, and in chimney-pieces, the hall fireplace being especially notable. For contrast in style, harmonious as they are in artistic expression, Cloverly and Kinmel are the typical examples of the artist's style. Other works are Farnham Royal House near Slough, Lea Wood, Loughton Hall, and Westcombe Park. His more notable urban works are the bank at Saffron Walden (1873), and the Rose and Crown Hotel; they stand next door to each other and exhibit another contrast, the former being mediæval and the latter what is called "Queen Anne." Though he built no new important church, Nesfield rebuilt the Early Decorated St Mary's, Farnham Royal, near Slough, mainly on the old lines. He restored King's Walden church, Herts (1868), and Radwinter church, Essex, the latter also an enlargement (1871), and Cora church near Whitchurch, Salop. The Grammar School at Newport, Essex, is his, as also is the Boys' School, Romsey, Hants; but no great public building came from him. Nesfield's career was a comparatively short one. He had retired from practice some years before his death at Brighton in 1888. He left behind him a valuable series of sketches and measured drawings, most of which are now in the Library of the Royal Institute of British Architects. (J. M. BY.)

Nestorians.—The Nestorians or East Syrians (*Surayi*) of Turkey and Persia inhabit a district bounded by Lake Urmia, or Urumia, on the east, stretching westwards into Kurdistan, to Mosul on the south, and nearly as far as Van on the north. They are divided into the Persian Nestorians of the plain of Azerbaijan, and the Turkish Nestorians, inhabiting chiefly the sanjak of Hakkiari in the vilayet of Van, who are subdivided into the *Rayat* or subject, and the *Ashiret* or tribal, the latter being semi-independent in their mountain fastnesses. Forming at once a church and a nation, they own allegiance to their hereditary patriarch, Mar Shimun, Catholicos of the East, who resides at Qudshanis, a village about 7000 feet above the sea-level, near the Kurdish town of Julamerk. They are the representatives of the "Church of the East," planted by St Adai, according to tradition one of the Seventy (St Luke x. 1), and St Mari, his disciple, and until the Council of Ephesus (431) in connexion with the patriarchate of Antioch. Separated from the unity of the Catholic Church, the Church of the East assumed large proportions outside the Eastern Empire, and by the 12th century had spread over the whole of Central Asia. Finally ruined by Tamerlane, it shrank to its present dimensions, and in 1552 a disputed succession to the patriarchate caused an internal schism. One-third of the whole body, inhabiting the plain of Mosul, seceded, and with the anti-patriarch, since called the *Patriarch of Babylon*, submitted to Rome in 1778. These "Uniat-Chaldeans" retain their Syriac services and rites in a somewhat modified form. It is only of late years, under the influence of the different missions, that education, ruined by centuries of persecution, has revived amongst the Nestorians; and even now the mountaineers, cut off from the outer world, are as a rule destitute of learning, and greatly resemble their neighbours, the wild and uncivilized Kurds. They are, however, extraordinarily tenacious of their ancient customs, and, almost totally isolated from the rest of Christendom since the 5th century, they afford an interesting study to the ecclesiastical student. Their churches are rude buildings, dimly lighted and destitute of pictures or images, save that of the Cross, which is treated with the deepest veneration. The *qanki*, or sanctuary, is divided from the nave by a solid wall, pierced by a single doorway; it contains the altar, or *madhb'kha* (literally, *the sacrificing place*), and may be entered only by persons in holy orders who are fasting. Here is celebrated the Eucharist (*Qurbana*, or the *offering*; cf. "Corban"), by the priest (*qasha*), attended by his deacon (*shamasha*). Vestments are worn only at the ministration of the sacraments; incense is used invariably at the Eucharist, and frequently at other services. There are three liturgies—of the Holy Apostles, of Theodore, and of Nestorius. The first is quite free from Nestorian taint, dates from some remote period, perhaps prior to 431, and is certainly the most ancient of those now in use in Christendom; the other two, though early, are undoubtedly of later date. The Nestorian canon of Scripture seems never to have been fully determined, nor is the sacramental system rigidly defined. Nestorian writers, however, generally reckon the mysteries as seven, *i.e.*, Priesthood, Oil of Unction, the Offering of the Body and Blood of Christ, Absolution, the Holy Leaven, the Signation of the life-giving Cross. The "Holy Leaven" is reputed to be a part of the original bread of the first Eucharist, brought by Adai and Mari and maintained ever since in the Church; it is used in the confection of the Eucharistic wafers, which are rather thicker than those used in the Western Church. Communion is given in both kinds, as throughout the East; likewise, confirmation is administered directly after baptism. Sacramental confession is enjoined, but has recently become obsolete; prayers for the departed and invocation of saints form part of the services. The primitive restriction on the marriage of priests and deacons was removed by a synod of Seleucia in 499; the bishops, however, are always celibates, and are chosen from episcopal families. The service-books were wholly in MS. until the press of the archbishop of Canterbury's mission at Urmia issued the *Takhsa* (containing the liturgies, baptismal office, &c.) and several other liturgical texts.

The Nestorian Heresy.—The Nestorians commemorate Nestorius as a saint, and invoke the aid of the heresiarch and his companions. They reject the Third Œcumenical Council, and though showing the greatest devotion to the Blessed Virgin, deny her the title of *Theotokos*, *i.e.*, the mother or bearer of God. The heresy of Nestorius consisted, not in *denying* either the divinity or the humanity of Christ, but in so *dividing* the natures as to destroy His "ego" or identity. In other words, Nestorius would not confess a personal union of the Godhead and the Manhood, but only an association between the Eternal Word and the Man born of Mary. He rightly shrank from making the Godhead to originate in Mary, or to be passable on the Cross; but he went farther, and denied that the divine person of Christ could be born or could suffer, *secundum humanitatem;* it was a mere man and not "the everlasting Son of the Father" who did "not abhor the Virgin's womb"; it was but one of the sons of Adam, energized by God the Word, who "overcame the sharpness of death." Nestorius being condemned at the Council of Ephesus in 431, the Church of the East threw in her lot with the excommunicated patriarch. The question remains, How far do the modern Nestorians embrace the teaching of Nestorius? That they are in *formal* heresy there can be, from the foregoing, no doubt, and it would be rash to state, with some writers, that they are free from *actual* heresy. Their theological teaching is misty and perplexing; their earliest writings contain no error, and the hymns of their great St Ephrem, still sung in their services, are positively antagonistic to Nestorianism; their theology dating from the schism is not so satisfactory. They attribute two *Kiani*, two *Qnumi*, and one *Parsopa* in Christ. *Kiani* appears to answer to *Nature*, but the difference between *Qnuma* and *Parsopa*, both apparently meaning *Person*, is not clear to Western scholars. Those who wish to follow this intricate subject may consult Assemanni, a learned but somewhat prejudiced writer, *Bibl. Orient. de Syris Nestorianis*, and various dissertations in the *Quarterly Papers* of the archbishop of Canterbury's Assyrian mission (S.P.C.K.). To say that the modern Nestorians are not definitely and firmly orthodox is perhaps fairer than to charge them with being distinctly heretical.

Missions amongst the Nestorians.—The peculiar circumstances, both ecclesiastical and temporal, of the Nestorians have attracted much attention in Western Christendom, and various missionary enterprises amongst them have resulted.

1. *The Roman Catholic Missions.*—In Turkey these consist of the Dominican mission, established at Mosul during the 18th century, and in Persia of the French Lazarist mission, which sprang out of some schools established by a French layman and scientific traveller, M. Eugène Boré, in 1838. At M. Boré's entreaty the Propaganda sent the first Lazarist father to Persia in 1840. The chief stations of the Lazarists are at Khosrova and Urmia. At the latter place there is an orphanage under the superintendence of the Sisters of St Vincent de Paul. The work of these missions is to extend and consolidate that Catholicized and partly Latinized offshoot of the Nestorians known as the *Uniat-Chaldean Church* (see *ante*).

2. The *American Presbyterian Mission*, established in Persia in 1834–35 by the Rev. Justin Perkins and Dr Grant, comprises large buildings near Urmia, a college, and a hospital. The influence of this mission does not extend much beyond the Turkish frontier, but it is strong in the Persian plains. The original aim was to influence the old Nestorian Church rather than to set up a new religious body, but the wide difference between Presbyterians and an Oriental Church rendered the attempt abortive, and the result of the labours of the Americans has been the establishment since 1862 of a Syrian Protestant community in Persia, with some adherents in Turkey.

3. *The Archbishop of Canterbury's Mission to the Assyrian Christians.*—This Anglican mission was promoted by Archbishop Tait, and finally established by Archbishop Benson in 1886. Its aim is thus officially defined: "To aid an existing Church, . . . not to Anglicanize, . . . not to change any doctrines held by them which are not contrary to that faith which the Holy Spirit, speaking through the Œcumenical Councils of the Undivided Church of Christ, has taught us as necessary to be believed by all Christians, but . . . to strengthen an ancient Church, at the earnest request of the Catholicos, and with the knowledge and blessing of the Catholic patriarch of Antioch, one of the four patriarchs of the Holy Orthodox Eastern Church, and occupant of the Apostolic See from which the Church of the East revolted at the time of Nestorius." This mission has its headquarters at Urmia, with a college for candidates for holy orders and a printing-press. Two mission-priests reside in Turkey, one at Qudshanis with Mar Shimun, the Nestorian Catholicos and Patriarch. The Anglican Church in America co-operates with the mission.

4. *The Russian Mission.*—One of the Nestorian bishops joined the Russian Orthodox Church in 1898, and returned the same year with a small band of missionaries sent by the Holy Synod of Russia. This mission enrolled a very large number of adherents drawn from the old Church, the Protestant Nestorians, and the Uniat-Chaldeans, but it can hardly be said to have commenced any active work, although the Anglican mission withdrew from competition by closing its schools in the dioceses occupied by the Russians.

AUTHORITIES.—ASSEMANNI. *Bibl. Orient. de Syris Nestorianis.* —MACLEAN and BROWNE. *The Catholicos of the East and his People.* S.P.C.K., London, 1892.—BADGER. *Nestorians and their Rituals.* Masters, London, 1852.—*The Liturgy of the Holy Apostles Adai and Mari, &c.* S.P.C.K., London, 1893. (This and other liturgical works are printed in the original Syriac at Urmia, Persia, and published by the Archbishop of Canterbury's Assyrian Mission.)—PIOLET. *Les Missions catholiques au XIX^me siècle.* Paris (vol. i. published in 1900).—See also article on "Persia" in *The Encyclopædia of Missions.* Funk and Wagnalls, New York, 1891; and the *Quarterly Papers* and *Annual Reports* of the Archbishop of Canterbury's Assyrian Mission, Church House, Dean's Yard, Westminster.

(J. A. L. R.)

Netherlands. See HOLLAND.

Nettleship, Henry (1839–1893), English classical scholar, was born on 5th May 1839 at Kettering, being the eldest of a distinguished group of brothers. His career at Oxford was a brilliant one, and he had the good fortune to attract the notice of Conington, who invited his co-operation in his edition of Virgil. After Conington's death in 1869 Nettleship saw the whole work through the press. In 1861 he was elected fellow of Lincoln, and for seven years he held a lectureship there. After visiting Berlin, where he attended the lectures of Moritz Haupt, he went to Harrow as assistant master, his recent marriage having compelled him to resign his fellowship at Lincoln. In 1873 he returned to Oxford, and was elected to a fellowship at Corpus, and in 1878 he was appointed to the professorship of Latin formerly held by Conington. Nettleship had been from the first attracted to the study of Virgil, and a good deal of his time was devoted to his favourite poet. In 1875 he had undertaken to compile a new Latin lexicon for the Clarendon Press, but the work proved more than he could accomplish, and in 1887 he published some of the results of twelve years' labour in a volume entitled *Contributions to Latin Lexicography*, a genuine piece of original work. In conjunction with Dr Sandys, Nettleship revised and edited a new edition of Seyffert's *Dictionary of Classical Antiquities*, and he contributed to a volume entitled *Essays on the Endowment of Research* an article on "The Present Relation between Classical Research and Classical Education in England," in which he pointed out the great value of the professorial lecture in Germany, which gave the student the very latest results of the lecturer's studies. In his views on the research question he was a follower of Mark Pattison, whose essays he edited in 1889 for the Clarendon Press. In *Lectures and Essays on Subjects connected with Latin Literature and Scholarship*, Nettleship revised and republished some of his previous publications. Yet the best of his work was never published, for he reserved this for his lectures, in which he often dealt with some little-known subject, *e.g.*, the study of Latin grammar by the Romans themselves, or the literary criticism of antiquity. He had the rare gift of making each subject live in his exposition, and of inspiring his hearers with his own enthusiasm. He died at Oxford on 10th July 1893.

Nettleship, Richard Lewis (1846–1892), Oxford tutor and lecturer on philosophy, brother of the foregoing, was born 17th December 1846, and was educated at Uppingham under Thring, and subsequently at Balliol, of which college he was a scholar. He had a distinguished university career, winning the Hertford and the Ireland. Nor was he indifferent to athletics, rowing in his college Torpid and Eight. He became a fellow and tutor of his college, and remained in that position until his death on 25th August 1892 from an Alpine accident. His chief work was the editing and preparing for publication of Professor T. H. Green's writings, with a memoir of the author, his friend and master. He left an unfinished work on Plato, part of which was published after his death, together with his lectures on logic and some essays. The tendency of his thought is idealistic and Hegelian. His literary style was clear and agreeable; but though he had considerable influence, rather of a suggestive than of a positive character, on his generation at Oxford, a certain indecisiveness and nebulousness of view marred his actual teaching, and prevented his making any permanent mark in philosophy.

Netze, a river of Prussia, rising in Poland, south-east of Inowrazlaw. It pursues by winding loops a north-westerly direction as far as Nakel (latitude of Bromberg), where it becomes navigable, and where it is connected by the Bromberg canal (17 miles long) with the Vistula. Down to this point its fall, in a distance of 68 miles, has only been about 100 feet. At Nakel it turns westwards, and after a time west-south-westwards, and finally enters the Warthe a little above Landsberg. From Nakel to the confluence, a farther distance of 143 miles, the fall is again about 100 feet. Its lower valley is very fertile. The area of its basin is 5400 square miles.

Neu-Brandenburg, in Platt-Deutsch, Niegen-Bramborg, a town of Germany, in the grand-duchy of Mecklenburg-Strelitz, on the Tollen lake, 58 miles west by north of Stettin by rail. It possesses a bronze statue of Fritz Reuter (1893); monuments to Bismarck (1895) and the war of 1870–71 (1895); a small museum of antiquities and an art collection; and the grand-ducal country-seat of Belvedere. Population (1885), 9134; (1900), 10,560.

Neuchâtel, one of the Swiss cantons, and ranking last in the Confederation save Geneva. Its total area is 311·8 square miles. Of this, 220·9 square miles are reckoned as "productive," forests occupying 86·8 square miles, vineyards 4½ square miles, and arable and pasture land 129½ square miles. Of the "unproductive" 90·9 square miles, no less than 36½ square miles are covered by the waters of that part of the Lake of Neuchâtel that lies within the canton, and 4 square miles by those of the cantonal share of the Lake of Bienne. The asphalte mines in the Val de Travers belong to the state of Neuchâtel, but are worked by an English company. The lace industry is now extinct. Watchmaking is mainly carried on at La Chaux de Fonds and Le Locle. The population (mostly Protestant) of the canton in 1880 was 102,744, while in 1900 it was 126,600. In 1900 the rate of density was 406 inhabitants to each square mile. The Roman Catholics numbered 11,651 in 1880, and 17,778 in 1900; Jews 689 in 1880, and 1032 in 1900. The language of the canton is practically French, though in 1900 there were 17,638 (in 1880, 24,489) German-speaking and 3687 (in 1880, 1346) Italian-speaking persons.

The present cantonal constitution dates from 1858. The legislature is elected (in the proportion of one member per 1000 inhabitants, or fraction over 500), and holds office for three years, while by a law of 1891 the principles of proportional representation obtain in these elections. The five members of the executive are named by the legislature for three years. Three thousand citizens have the right since 1879 of "facultative referendum" as to all legislative projects, and since 1848 of "initiative" as to the revision of the cantonal constitution, and (since 1882) also as to all legislative projects. There are no fewer than three "established and state endowed churches"—the National Evangelical, Roman Catholic, and Old Catholic, while the pastors of the Free Evangelical and Jewish churches are so far recognized as such by the state that they are not required to fulfil their term of military service, like ordinary laymen. The canton is divided into six administrative districts. In 1897 the state revenue was 3,746,417 francs (a rise of over 59¾ per cent. since 1885), and the state expenditure 3,490,171 francs (a rise of 48½ per cent. since 1885), but in 1898 there was a deficit of 93,876 francs. The public debt in 1897 amounted to 16,632,646 francs.

Neuchâtel, the capital of the Swiss canton of the same name, at a height 1434 feet above the sea. Adjoining the castle is the collegiate church of Notre Dame, dating from the 12th and 13th centuries; now a Protestant meeting-house. On the new quay is the Musée des Beaux Arts, in which are the archæological museum, a good collection of modern Swiss pictures, and also various historical curiosities and relics. The Collège Latin contains the natural history collections and the public library. There is an Académie at Neuchâtel (to be raised to the rank of a university), which was attended in the winter of 1898–99 by 102 matriculated students. There is a watchmaking school at Neuchâtel. Population (1880), 15,370; (1900), 21,064. The majority of the inhabitants are Protestants and French-speaking. The railway line to Pontarlier passes through the Val de Travers, and *not* by Yverdon, while in 1900 a new direct line to Bern *viâ* Kerzers (in French, Chiètres) was opened. Two miles south-west of Neuchâtel is Serrières, with M. Suchard's great chocolate manufactory.

Bourgeois. *Neuchâtel et la Politique Prussienne en Franche Comté* (1702–13). Paris, 1887.—Boyve. *Annales Historiques du Comté de N. et de Valangin.* 6 vols. Bern and Neuchâtel, 1855.—Matile. *Monuments de l'Hist. de N.* 3 vols. Neuchâtel, 1844–48; *Musée Neuchâtelois* (published by the Cant. Hist. Soc.) from 1864.

Neufahrwasser. See Danzig.

Neuhaus (Czech, *Hradec Jindřichův*, which signifies "Henry's Castle"), the chief town of a government district in Bohemia, Austria, near the eastern border of the province, at the foot of the Moravian heights. The Gothic parish church and the château of Count Czernin both date from the 13th century. The latter contains valuable archives and a collection of pictures. The industries comprise the manufacture of cloth and woollen goods, paper, dyeing, corn-milling, distilling, and brewing. Population (1890), 8502; (1900), 9316, including garrison of 1066 men, chiefly Czech and Catholic.

Neuilly-sur-Seine, a town in the arrondissement of St Denis, department of Seine, France, 3½ miles west of the centre of Paris, of which it is a suburb, between the fortifications and the Seine. The fine bridge, designed in the 18th century by Perronnet, is noteworthy as the first level bridge constructed in France. The castle of St James, built about 1775 by Claude Baudard, Baron St James, is now occupied as a lunatic asylum. Amongst modern buildings are the large church of St Peter, a Protestant church, and a synagogue. The Galignani Institution, founded by the brothers Galignani for aged booksellers, printers, and others, has accommodation for 100 residents. A steam pump at Neuilly supplies daily to Paris 176,000 cubic feet of water. Population (1881), 23,805; (1901), 36,437.

Neunkirchen, or, more correctly, NEUENKIRCHEN AM STEINFELD, a market-place in Lower Austria, on the Southern Railway, about 8 miles south of Wiener-Neustadt. An important centre of the metal and textile industries. Population (1890), 8795; (1900), 10,831.

Neuquen, a territory in the west centre of the Argentine Republic, bounded on the N. by Mendoza; on the S. by the territory of Rio Negro, from which it is separated by the Rio Limay; on the E. by Pampa; and on the W. by Chile. Official area at the census of 1895, 42,345 square miles; population, 14,517; capital, Chosmalal. The territory is divided into five departments. In 1895 there were 888 farms in the province, with 6778 acres planted in cereals, 1,022,844 head of cattle, 57,015 horses, and 357,429 sheep.

Neuropathology. See PATHOLOGY.

Neu-Ruppin, a town of Prussia, on Lake Ruppin, 37 miles north-north-west of Berlin by rail. The educational establishments include a gymnasium, a normal training college, and a higher grade girls' school. Population (1890), 14,584; (1900), 17,132.

Neusalz, a town of Prussia, province of Silesia, on the Oder, 20 miles by rail north-west of Glogau. It has numerous iron-works, enamelling works, manufacture of flax, papier-mâché, millstones, &c., and tanning. Population (1885), 7716; (1900), 12,586.

Neusandec, or NEU-SANDETZ, the chief town of a district in western Galicia, Austria. Population (1890), 12,722; (1900), 15,724 (estimated at 97 per cent. Polish, 3 per cent. German; 64 per cent. Roman Catholic, 2 per cent. Greek Catholic, 32 per cent. Jewish, and 2 per cent. Protestant). There are large workshops belonging to the Austrian State Railway. A part of the petroleum district lies to the north-west of the town. Population of the adjoining ALTSANDEC (Polish, *Stary Sácz*), 4537 in 1900. It has an important annual fair and a trade in cattle, wine, furs, honey, yarn, and linen.

Neusatz. See UJVIDÉK.

Neutitschein (Czech, *Nový Jičin*), the chief town of a government district in Moravia, Austria. Population (1890), 11,562; (1900), 11,891, chiefly German and Catholic. It has manufactures of agricultural implements and machinery, and is connected by local railways with several of the surrounding districts and with the Northern Railway.

Neutrality.—Neutrality is the most progressive branch of modern International Law. It is also that branch of International Law in which the practice of self-restraint takes the place of the direct sanctions of domestic law most effectively. The rapid changes it is undergoing are in fact bringing the state-system of the modern world nearer to the realization of the dream of many great writers and thinkers, of a community of nations just as much governed by legal methods as any community of civilized men. While the right of war was simply the right of the stronger, there was no room for neutral rights, for, without going back to the time of the ancients, the so-called rights of war and conquest are nothing but survivals of the right of brute strength. No nation or community down to comparatively recent times was treated as having a right to what it could not keep. It is the growth of a law of neutrality, through the modern possibility of concerted action among neutral states, which is bringing about improvement, and, though the signs of our times are not always reassuring, we have taken a long stride forward since Molloy in his *De Jure maritimo et navali* (1680) wrote: "As a neuter neither purchases friends nor frees himself from enemies, so commonly he proves a prey to the victor; hence it is held more advantage to hazard in a conquest with a companion than to remain in a state wherein he is in all probability of being ruined by the one or the other."

It was the great commercial communities, the Hansa in the north and Venice and the Mediterranean maritime republics in the south, which were first able to insist on some sort of regulation of the usages of war for their own protection. With the growth of intercourse among nations a further advance was made, by treaty stipulations entered into in time of peace, to provide rules for their guidance in the event of war, but it is only in our own time that the idea of a substantive neutral right has obtained recognition. To our own time belongs the final acceptance of the principle that the neutral flag protects enemy's goods except contraband, the conception of neutralization of territory, the abolition of fictitious blockades, the practice of declarations of neutrality, the detachment from the high sea and neutralization of the zone called territorial waters, and the Areopagus of nations called the European Concert, in which the right of neutrals is asserted as a brake upon the operation of the still venerated right of conquest. The rights of neutrals have received their most recent affirmation in several of the decisions of the Peace Conference.

International trade and intercourse have become so intricate that war can no longer be waged without causing the most serious loss to neutral nations, which moreover suffer from it without any of the possible contingent benefits it may procure for the immediate parties. So much is it so, that most great Powers have found it necessary for their self-protection to enter into defensive alliances with others, the direct object of which is the preservation of European peace by the threat of making war so gigantic a venture that no State will again embark on it "with a light heart." The next step will probably be alliances between States which, by their nature or by their having reached the limit of their expansion, have nothing further to gain by war with each other, for the purpose of securing perpetual peace as between themselves.

Different attempts have been made to define neutrality, but the word defines itself, so far as a succinct definition serves any purpose. The subject covers too wide and varied an area of matter to be condensed into a short statement of any kind. Neutrality entails right and duties on both the belligerent and the neutral sides. Theoretically, neutrality, to be complete, would require the neutral to abstain from everything which could even remotely be of assistance to either belligerent. To this obligation would theoretically correspond that the belligerent should carry on the war without doing anything which could even remotely disturb or interfere with the neutral State or the free activity of its citizens. Neither the one nor the other is found to be practicable. It is not even easy for the belligerent to observe absolutely the duty of doing no direct injury to

Definition and scope.

neutral territory. A battle may be fought to the very edge of the neutral frontier, and shells may explode in any neutral town within the firing range of modern artillery. The present respect paid by belligerents to territorial waters is a palliative in the case of a seaboard frontier; but even the three-miles limit acknowledged by most countries would permit belligerent vessels with the present range of artillery to fire landwards far into neutral territory. Compensation, it is true, would be due for any damage done, but this does not alter the fact that acts of war can produce direct consequences on neutral territory which have the character of carrying war into a neutral State. The neutral State, moreover, is obliged to incur heavy expenditure to protect its frontier from being traversed by either belligerent, and thus avoid itself being exposed to claims for compensation for an act which it would otherwise be powerless to prevent. In the case of a maritime war, the neutral State is also bound to exercise strict supervision to prevent its ports from being used by either belligerent for the purpose of increasing his military strength. In short, war cannot be carried on without heavy expense and inconvenience to neighbouring neutral States. The inconvenience to the intercourse of neutral citizens is still greater. Their ships are liable to be taken out of their course, and their cargoes to be discharged to the bottom of the hold in search of articles which are contraband according to circumstances over which they have no control, and they may be confiscated without recourse by judges appointed by one of the interested parties. Even their whole trade with specific ports of the one belligerent may be stopped by the ships of the other belligerent without indemnity. On the other hand, a great deal of vital assistance can be given by neutral citizens to the one or the other belligerent in money, or by supplies of arms, ammunition, food, and other commodities, which it is not at present the duty of neutral States to interfere with.

The respective rights and duties of belligerent neutrals in current practice may be subdivided as follows:—

(1) Belligerent duty to respect neutral territory and neutral territorial waters.

(2) Neutral right of official representation, and mediation; of intercourse of neutral citizens with citizens of either belligerent; of convoy, &c.

(3) Belligerent right of blockade, angary, visit and search, capture and confiscation of contraband of war.

(4) Neutral duties: (*absolute*) of abstention from any direct corporate assistance to either belligerent, of enforcement of respect by both belligerents for neutral territory; (*relative*) of prevention of any recruiting for either belligerent, or arming or equipping of vessels for their service; and (*contingent*) of allowing commercial access to the one or other belligerent without distinction, and of granting impartially to one or the other belligerent any rights, advantages, or privileges, which, according to the usages recognized among nations, are not considered as an intervention in the struggle.

This subdivision, we believe, covers the whole ground of neutrality. We shall follow it in this article.

Duty to respect neutral territory.

Belligerent Duty.—It is now universally recognized among European States that a belligerent army must make no use of its strength in the field to carry its operations into neutral territory or into neutral waters. Belligerent forces entering neutral territory are by the practice of nations bound to surrender their arms to the neutral State, and remain *hors de combat* till the close of the war. (See also International Convention, The Hague, 29th July 1899, Art. 57.)

Through territorial waters belligerent vessels are allowed to pass freely as in time of peace. Nor does the usage of nations forbid a belligerent vessel from entering a neutral port. Motives of humanity have sanctioned this distinction between territorial and maritime warfare. The Admiralty Instructions (1893) set out the rights of belligerents as Great Britain views them as follows: "Subject to any limit which the neutral authorities may place upon the number of belligerent cruisers to be admitted into any one of their ports at the same time, the captain, by the comity of nations, may enter a neutral port with his ship for the purpose of taking shelter from the enemy or from the weather, or of obtaining provisions or repairs that may be pressingly necessary (I. section 592).

Access to and duty to respect territorial waters and ports.

He is bound to submit to any regulations which the local authorities may make respecting the place of anchorage, the limitation of the length of stay in the port, the interval to elapse after a hostile cruiser has left the port before his ship may leave in pursuit, &c. (I. section 593). He must abstain from any acts of hostility towards the subjects, cruisers, vessels, or other property of the enemy which he may find in the neutral port (section 594). He must also abstain from increasing the number of his guns, from procuring military stores, and from augmenting his crew even by the enrolment of British subjects" (section 595).

Nor may the commander of a British warship take a capture into a neutral port against the will of the local authorities (Holland, *Manual of Naval Prize Law*, 1888, section 299).

Right of legation.

Neutral Rights.—Neutral Powers have the right to remain, as far as possible, unaffected by the war operations, and therefore continue their diplomatic relations with the belligerent States. The immunities and exterritoriality of their diplomatic agents attach to them as in time of peace, subject only to necessity of war, which may entitle a belligerent to place restrictions on this intercourse. Thus, during the Franco-German war, on the surrounding of Paris, foreign diplomatists in the besieged city were refused by the German authorities all possibility of corresponding with their Governments, except by letters left open for their inspection. Neutral legations may also undertake the representation of private interests of subjects of the one belligerent on the territory of the other. Thus in the Franco-German war of 1871 the Germans in France were placed under the protection of the United States legation, and the French in Germany under that of the British legation; in the war of 1898 between the United States and Spain, American interests in Spain were committed to the care of the British legation, and those of Spaniards in the United States to that of the Austro-Hungarian legation. By legations are understood both diplomatic and consular authorities. The protection granted is in the nature of mere mediation. It confers no rights on the belligerent subjects in question, nor does it give the neutral legation any right to protect a belligerent subject or his property against any ordinary rights of war.

Right of offering good offices and mediation.

Good offices, properly speaking, are a mild form of mediation or tentative mediation, *i.e.*, mediation before it has been accepted by the parties. Article 3 of the Hague Convention of 29th July 1899, however, provides that "Powers, strangers to the dispute, have *the right* to offer good offices or mediation, even during the course of hostilities," and that "the exercise of this right can never be regarded by one or other of the parties in conflict as an unfriendly act" (see Peace Conference). The Hague Convention puts an end to the doubt whether a neutral Power can mediate without involving itself in some way with the one or the other side in the dispute. Mediation had already been provided for in several existing treaties, such as the Treaty of Paris (30th March 1856), which provides that "if any dissension should arise between the Sublime Porte and one or more of the other signatory Powers and threaten the maintenance of their good relations, the Sublime Porte and each of these Powers before resorting to force shall give an opportunity to the other contracting parties in order to prevent such extreme measures" (article 8); the Treaty of Yedo between the United States and Japan (29th July 1858) stipulating that in the case of difference between Japan or any other State, "the President of the United States, at the request of the Japanese Government, will act as a friendly mediator in such matters of difference as may arise between the Government of Japan and any other European Power" (article 2); and the General Act of Berlin relating to West Africa (1885), which provides that "in the case of a serious dissension having arisen on the subject of, or within the territories" in question, between the signatory Powers, they undertake, before taking up arms, to have recourse to the mediation of one or more of the friendly Powers (article 12).

In the Venezuela-Guiana boundary question, the mediation of the United States Government was declined by Great Britain, but its good offices were accepted. In the difficulty which arose between Germany and Spain in connexion with the hoisting of the German flag on one of the Caroline Islands, Spain did not consider arbitration consistent with the sovereign power she claimed to exercise over the island in question, but she accepted the mediation of the Pope, and the matter was settled by protocols, signed at Rome (17th December 1885). These incidents show the uses of variety and graduation in the methods of diplomacy.

Rights of neutral subjects on belligerent soil.

Neutral subjects have the right to carry on trade and intercourse with belligerent subjects in so far as they do not interfere with the operations or necessities of war, and it is no violation of the neutral character that this trade or intercourse is of benefit to either side. This is subject always to the belligerent right to capture and confiscate contraband of war (see below). On the other hand, the property of subjects and citizens of neutral States follows the fortune of the belligerent State within whose territorial jurisdiction it is situated. It is liable to the same charges as that of native subjects and citizens, and in case of military contributions neutral subjects on belligerent soil can claim no protection or exemption (see below, *Angary*). They have also the same rights to all indemnities for loss as are granted to native subjects and citizens.

The rights of neutral public ships and mail steamers.

The position of neutral public ships and the relative assimilation to them of mail steamers has been the subject of some controversy. A public ship is a ship having an official character. It includes not only warships, but also any ships affected to any specific and *exclusive* government purpose. Public ships in this sense are invested with an extra-territorial character, and the State to which they belong is directly responsible for their acts. They are therefore not liable to visit and search for contraband of war, and are exempt from territorial jurisdiction even in belligerent waters. As regards vessels which are engaged partly in private traffic and partly on public service, such as mail steamers and government packets, the position is necessarily different. Under the Japanese Prize Law, adopted in view of the Chino-Japanese campaign, any vessel carrying contraband of war, whose destination is hostile, may be detained, without exception being made for mail steamers. The United States proclamation of April 1898 in connexion with the Spanish war stated that mail steamers would only be stopped in case of grave suspicion of their carrying contraband or of their violating a blockade. This is obviously not an exemption; in practice no belligerent State would stop a mail steamer without grave suspicion.

On the arrest of the German mail steamers *Bundesrath* and *General* during the South African war, the German Government represented to the British Government that "it was highly desirable" that steamers flying the German mail-flag should not be stopped, and the British Government thereupon issued orders not to stop them on suspicion only (*Parliamentary Papers*, Africa, No. 1, 1900). This is a precedent of the greatest importance. It would practically assimilate mail steamers to public ships. Yet the mere circumstance of carrying the mails does not manifestly *per se* change the character of the ship. Both this subject and the position of packets under State ownership, which may carry on trade and may consequently transport contraband, require deliberate adjustment by treaty.[1] In fact, it is one of the most pressing questions of neutrality. The tendency seems to be towards exemption, but in this case there should be official certification that the ships in question carry nothing in the nature of contraband.

Convoy.

Connected with the position of public ships is the question of the right of convoy. Neutral merchant ships travelling under the escort of a warship or warships of their own flag are held by some authorities to be exempt from visit and search. The Japanese Prize Law, which is largely based on English practice, following on this point the recommendations of the Institute of International Law (see *Règlement des prises maritimes*, Annuaire 1888, p. 221), provides that "when the commander of a neutral convoy declares that there is no contraband of war on board the vessels under convoy, and that all the papers are in order in these vessels, the vessels shall not be visited" (article 23).[2] It is believed that Great Britain is, at the present moment (1902), the only Power which does not in one form or another recognize the principle of the protective character of convoy. The United States, in treaties with Mexico, Venezuela (20th January 1836), Peru (6th September 1870), Salvador (6th December 1870), and Italy (26th February 1871), have agreed to accept the commander's declaration as provided in the Japanese Prize Law. Wharton quotes in his *International Law Digest* a passage from a despatch of Mr Secretary Forsyth (18th May 1837) in which he states that "it is an ordinary duty of the naval force of a neutral during either civil or foreign wars to convoy merchant vessels of the nation to which it

[1] The convention between Great Britain and France respecting postal communications (30th August 1890) provides that "in the case of war between the two nations the packets of the two administrations shall continue their navigation, without impediment or molestation, until a notification is made on the part of either of the two Governments of the discontinuance of postal communications, in which case they shall be permitted to return freely to their respective ports" (article 9). The position of either as neutral is not dealt with.

[2] At the outset of the Chino-Japanese war, Vice-Admiral Sir E. R. Fremantle sent a note to the Japanese admiral requesting him to "give orders to the ships under his command not to board, visit, or interfere in any way with British merchant vessels, observing that the British admiral had directed all British ships under his orders to afford protection to such merchant vessels, and not to allow them to be molested in any way." Professor Takahashi, in his *International Law of the Chino-Japanese War*, relates that the Japanese admiral replied that "as the matters demanded by the British admiral belonged to the sphere of international diplomacy, and consequently were outside his official responsibility, they should be communicated directly to the Japanese Department of Foreign Affairs." "The idea of the British admiral," observes Professor Takahashi, "seemed to be not only to claim a right of convoy, which has never been recognized by British prize courts, but also to extend it over all waters of the Far East, where British warships were not actually engaging in convoy. Soon afterwards the matter was settled without any difficulty. On 11th August the Under-Secretary of the Japanese Foreign Office received a letter from the British Minister in Tôkyô stating that there must be some misunderstanding, and that the British Government would never try to interfere with belligerent right."

belongs to the ports of the belligerents. This, however, should not be done in contravention of belligerent rights as defined by the law of nations or by treaty." The Spanish Naval Instructions (24th April 1898) in the war with the United States granted unconditional exemption to convoyed neutral ships (article 11).

A neutral merchant ship, travelling under *enemy's* convoy, places itself, with the assistance of the belligerent force, beyond the application of the belligerent right of visit and search, and thus commits a breach of neutrality.

Blockade.

Belligerent Rights.—Since the declaration of Paris providing that blockades (see article under this heading in ninth edition for general information on the subject) "in order to be binding must be effective, that is to say, must be maintained by a force sufficient really to prevent access to the enemy's coast," the tendency has been to give a precise form to all the obligations of the blockading belligerent. Thus it is now generally agreed that notification to the neutral should be sufficiently detailed to enable neutral vessels to estimate, with practical accuracy, the extent of their risks. French writers consider a general diplomatic notification, though desirable, as insufficient, and hold an individual notification to each neutral ship which presents itself at the line of blockade as requisite. This theory was applied by France in the Franco-German war, and earlier by the Northern States in the American Civil War. The new Japanese Prize Law (1894) does not attempt to prescribe any such notification to each ship, but sets out that notice of blockade to each ship is either actual or constructive. "Actual" it describes as being when the master is shown to have had knowledge of the blockade, in whatever way he may have acquired such knowledge, whether by direct warning from a Japanese warship or from any other source; "constructive," when a notification of its existence has been made to the proper authorities of the State to which the vessel belongs, and sufficient time has elapsed for such authorities to communicate the notification to the subjects of that nation, whether or not they have in fact communicated it. No blockade, however, was attempted by the Japanese Government, and the application of the rules was not put to the test.

In the Spanish war the United States' proclamation of the investment of Cuba stated that an efficient force would be posted, so as to prevent the entrance and exit of vessels from the blockaded ports, and that any neutral vessel approaching or attempting to leave any of them, "without notice or knowledge" of the establishment of the blockade, would be duly warned by the commander of the blockading forces, who would endorse on her register the fact and date of such warning, and where such endorsement was made. The words "without notice or knowledge" were explained fully in the instructions to blockading vessels (20th June 1898). "Neutral vessels," said these instructions, "are entitled to notification of a blockade before they can be made prize for its attempted violation." "The character of this notification is not material. It may be actual, as by a vessel of the blockading force, or constructive, as by a proclamation of the Government maintaining the blockade, or by common notoriety. If a neutral vessel can be shown to have notice of the blockade in any way, she is good prize and should be sent in for adjudication; but should the formal notice not have been given, the rule of constructive knowledge arising from notoriety should be construed in a manner liberal to the neutral." Thus the United States Government abandoned the system of individual notification inserted in the proclamation of 19th April 1861, which was only found practicable in the case of vessels which had presumably sailed without notification. In such cases it was provided by the more recent instructions that they should be boarded by an officer, who should enter the notice in the ship's log, such entry to include the name of the blockading vessel giving notice, the extent of the blockade, and the date and place, verified by his official signature. The vessel was then to be set free, with a warning that, should she again attempt to enter the same or any other blockaded port, she would be good prize.

Angary.

Angary, or *Droit d'Angarie*, is a contingent belligerent right, arising out of necessity of war, to dispose over, use, and destroy, if need be, property belonging to neutral States.[1] During the Franco-German war imminent necessity was pleaded by the German Government, as the justification of using force to seize and sink six British coal-ships in the Seine to prevent French gunboats from running up the river and interfering with the tactics of the German army operating on its banks. The captains of the vessels refused to enter into any agreement with the commanding German general, and the vessels were then sunk by being fired upon. The British Government raised no objection to the exercise of the right, and confined itself to demanding compensation for the owners, which the German Government declared itself ready to pay. Count Bismarck evidently felt the use which might be made against Germany as a neutral Power, of such an extreme measure, and took care in the correspondence with the British Government to emphasize the pressing character of the danger, which could not be otherwise parried.

A case given in the text-books as another one of angary during the same war was the temporary seizure and conversion to war purposes of Swiss and Austrian rolling-stock in Alsace, without any apparent military necessity. Ordinary private neutral property on belligerent soil, it must be remembered, follows the fate of private property generally. The only distinction between the right of angary and the right of assimilating private neutral property to private property generally on belligerent soil which seems based on reason is that, whereas private property of neutrals generally which has remained on belligerent soil is sedentary, or, so to speak, domiciled there, neutral vessels are mere visitors with a distinct external domicile. The writer thinks the assimilation of neutral railway carriages to neutral vessels in this respect not unreasonable.[2]

Contraband.

A neutral State in its corporate capacity, we have seen, must abstain from acts which can be of assistance to either belligerent, and it is bound to exercise reasonable diligence to prevent its territory being used as a base for belligerent operations. The duties of a neutral State as a State go no farther. Commercial acts of its citizens, even the export of arms and munitions of war to a belligerent country, do not, in the present state of international usage, so long as both belligerents are free to profit by such acts alike, involve liability on the part of the neutral State. But relief from the obligation of repressing breaches of neutrality by contraband traffic of subjects has its counterpart in the right granted to belligerent warships of visit and search of neutral merchant vessels, and in the possible condemnation, according to circumstances, of the ship and confiscation of goods held to be contraband.

Contraband is of two kinds—*absolute* contraband, such as arms of all kinds, machinery for manufacturing arms, ammunition, and any materials which are of direct application in naval or military armaments; and *conditional*

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[1] Angaria (from ἄγγαρος, a messenger), a post station. The French word *hangar* or shed is probably of the same origin.

[2] Treaties between the Zollverein and Spain (30th March 1868) and between Germany and Portugal (2nd March 1872) contain special provisions for the fixing of indemnities in case of any forced utilization by either State of private property of the citizens of the other.

contraband, consisting of articles which *are fit* for, but not necessarily of direct, application to hostile uses. The British Admiralty *Manual of Prize Law* (1888), following this distinction, enumerates as *absolutely contraband:* arms of all kinds and machinery for manufacturing arms; ammunition and materials for ammunition, including lead, sulphate of potash, muriate of potash, chlorate of potash, and nitrate of soda; gunpowder and its materials, saltpetre and brimstone; also guncotton; military equipments and clothing; military stores, naval stores, such as masts, spars, rudders, and ship-timber, hemp and cordage, sail-cloth, pitch and tar, copper fit for sheathing vessels, marine engines and the component parts thereof, including screw propellers, paddle wheels, cylinders, cranks, shafts, boilers, tubes for boilers, boiler plates and fire-bars, marine cement and the material used in the manufacture thereof, blue lias and Portland cements; iron in any of the following forms—anchors, rivet iron, angle iron, round bars of iron of from $\frac{3}{4}$ to $\frac{5}{8}$ of an inch diameter, rivets, strips of iron, sheets, plate iron exceeding $\frac{1}{4}$ of an inch, and Low Moor and Bowling plates;—and as *conditionally contraband:* provisions and liquors fit for the consumption of army or navy, money, telegraphic materials, such as wire, porous cups, platina, sulphuric acid, materials for the construction of a railway, such as iron bars, sleepers, and so forth, coal, hay, horses, rosin, tallow, timber.[1]

Coal. The classing of coal as conditional contraband has given rise to much controversy. Great Britain has consistently held it to be so. During the war of 1870 the French and German warships were only allowed to take at English ports enough to return to a French or German port respectively. In 1885, during the Franco-Chinese campaign, after protest by the Chinese Government, Great Britain applied the same rule at Hong Kong and Singapore. During the Spanish-American war neither belligerent seems to have treated coal as contraband. In the case of the coal ships which were prevented from landing their cargoes at Cuba, the prevention seems to have been connected with the blockade only. At the West African conference of 1884 Russia declared that she would "categorically refuse her consent to any articles in any treaty, convention, or instrument whatever which would imply" the recognition of coal as contraband of war (*Parliamentary Papers*, Africa, No. 4, 1885). Coal, however, is so essential to the prosecution of war that it is impossible to avoid classing it as conditional contraband, so long as such contraband is recognized. The alternative, of course, would be to allow both belligerents freely to supply themselves at neutral ports, and neutral vessels freely to supply belligerent coaling stations.

Food-stuffs. During the Franco-Chinese campaign of 1885 and the South African war, there was controversy as to the legality of treating food-stuffs as conditional contraband. During the former the subject-matter was rice, and the circumstances were exceptional. The hostilities being at the outset reprisals, and not actual war, France at first exercised no right of search over British merchant ships. Great Britain, on her side, for the same reason did not object to French war vessels coaling, victualling, and repairing at British ports. On China protesting against this indulgence to France, Great Britain, as above stated, put in force her practice of treating coal as contraband, and thereupon France exercised her corresponding belligerent right of searching British vessels. The closing of British coaling stations to French warships was a serious inconvenience to France, and she proclaimed "that in the circumstances in which war was being carried on" the cargoes of rice which were being shipped to the northern Chinese ports were contraband. By depriving the Chinese Government of part of the annual tribute sent from the southern provinces in the form of rice she hoped to bring pressure on the Peking Government. This was a manifest stretching of the sense of conditional contraband. Besides, no distinction was made as to destination. The British Government protested, but no cases were brought into the French prize courts, and the legality of the measure has never been judicially examined.

The controversy during the South African war was confined to theory. In practice no stoppage of food-stuffs seems to have taken place, though the fact that the whole able-bodied population of the enemy States formed the fighting force opposed to Great Britain made it clear that the free import of food supplies from abroad helped the farmer-soldiers to carry on warfare without the immediate care of raising food crops.

The two cases cited show the great difficulty of fixing the character of conditional contraband in a way to prevent arbitrary seizures.

Continuous voyages. Trade between neutrals has a *primâ facie* right to go on, in spite of war, without molestation. But if the ultimate destination of goods, though shipped first to a neutral port, is enemy's territory, then, according to the "doctrine of continuous voyages," the goods may be treated as if they had been shipped to the enemy's territory direct. This doctrine, though Anglo-Saxon in its origin and development, has been put in force by an Italian court in the case of the *Doelwijk*, a Dutch vessel which was adjudged good prize on the ground that, although bound for Jibouti, a French colonial port, it was laden with a provision of arms of a model which had gone out of use, and which could only be intended for use by the Abyssinians, with whom Italy was at war. The subject has been fully discussed by the Institute of International Law, by whom the following rule has been adopted: "Destination to the enemy is presumed where the shipment is to one of the enemy's ports, or to a neutral port, if it is unquestionably proved by the facts that the neutral port was only a stage (*étape*) towards the enemy as the final destination of a single commercial operation."[2]

The question of the legality of the doctrine was raised by Chancellor von Bülow during the South African war in connexion with the stopping of German ships bound for Delagoa Bay, a neutral port. He contended that such

[1] The Japanese Prize Law (21st August 1894) makes the following distinction: (1) Arms of all kinds, brimstone, dynamite, nitrate of potash, and all goods fit for the purpose of war exclusively: the above-mentioned goods are contraband when they are on board a vessel which either has a hostile destination or calls at any port of the enemy. (2) Provisions and liquors, money, telegraphic materials, such as wire, platinum, sulphuric acid and zinc, porous cups, materials for the construction of a railway, as iron bars, sleepers, &c., coal, timber, and so forth: the above-mentioned goods are contraband goods when the destination of the vessel is either the enemy's fleet at sea or a hostile port, used exclusively or mainly for naval or military equipment. When it is clearly known that, though goods detailed in the above sections 1 and 2 are found on board a vessel, they are merely for her own use, they cannot be deemed contraband goods.

[2] The only person in that eminent assemblage who raised an objection to the principle of the doctrine was the distinguished French writer on maritime law, M. Desjardins, who declined to acknowledge that any theory of continuous voyages was, or could be, consistently with the existing law of neutrality, juridically known to International Law. He admitted, at the same time, that penalties of contraband would be incurred if the shipping to a neutral port were effected merely in order "to deceive the belligerent as to the real destination of the cargo." This was the French ruling in the *Frau Houwina* case (26th May 1855). He proposed to restrict the operation of the doctrine to this condition, but was opposed by three Italian Professors of International Law, Professors Fusinato, Catellani, and Buzzati, on the ground that it would exclude, as it obviously would do, the contingency of goods shipped to a neutral port, not for the purpose of defrauding the belligerent, but for that of being ultimately delivered to a belligerent not in possession of a seaport. The article as quoted in the text was also supported by the greatest German authority on International Maritime Law, Director Perels of the German Admiralty.

vessels were quite, and at all times, outside belligerent jurisdiction, and that only the authorities of the neutral port were entitled to stop contraband on its way to a belligerent force. He did not, however, press the point, and only reserved the right of raising it at a future date.[1]

The procedure employed to ascertain whether a neutral vessel carries contraband or not is called *Visit and Search*, a belligerent right universally recognized and justified by the considerations that merchant ships of the enemy might evade capture by hoisting a neutral flag, if the belligerent had not the right of ascertaining the real character of the ship, and that private neutral vessels might carry contraband goods and generally help the enemy, if the belligerent had not the right of examining their cargo. All neutral private vessels in time of war are liable to visit by belligerent warships on the high seas and in the territorial waters of the belligerents, but not in the territorial waters of neutral States. Neutral public ships are not liable to visit (see above as to neutral public ships, mail ships, and convoy). Visit and search must be effected at every stage with "as much consideration as possible" (Herr von Bülow, in Reichstag, 19th January 1900). The visiting officer first examines the ship's papers. If satisfied that the vessel is not liable to detention, he immediately quits her. If not so satisfied, he proceeds to search her. If in the course of the search he is satisfied that the vessel is not liable to detention, the search is immediately discontinued. The visiting officer has the right to inspect any lockers, stores, or boxes, and in case of refusal to open them he is justified in using such coercive measure as the case warrants. If after the visit and search the commander has reason to entertain suspicion, he gives the master an opportunity of explanation, and if the explanation is unsatisfactory he detains the vessel. If the seizure turns out after all not to have been justified, the ship and cargo are immediately released, and compensation is due for the loss through the detention. In the case of the stoppage and search of German vessels during the South African war, the German Government proposed the appointment of arbitrators to decide upon the claims for compensation, but this was an innovation to which the British Government did not assent.

Visit and search.

The consequences of carrying contraband are capture, trial by a belligerent prize court, and possible confiscation of the ship and cargo, or of the cargo alone or of a part of the cargo, according to the facts of the case. All are agreed as to articles which are absolute contraband being liable to capture. As regards conditional contraband, British law,[2] in so far, at least, as concerns "naval and victualling stores," is less severe, the Lords of the Admiralty being entitled to purchase such stores without condemnation in a prize court. In practice such purchases are made at the market value of the goods, with an additional 10 per cent. for loss of profit. This proceeding is known in International Law as the right of pre-emption. It is not, however, as yet officially recognized on the continent of Europe, though the need of some palliative for confiscation, in certain cases, is felt, and some continental jurists, moved by the same desire to distinguish unmistakable from so to speak constructive contraband, and protect trade against the vexation of uncertainty, have tried to argue conditional contraband away altogether.

Capture, pre-emption, prize.

The tendency, however, among the majority of continental authorities is seen in the rule drawn up in 1895, after several years of discussion, by the Institute of International Law, a body composed exclusively of international jurists of acknowledged status. The majority which adopted it represents authoritative opinion in Germany, Denmark, Italy, Holland, and France, showing that the old antagonism between the British and continental views on conditional contraband has ceased to exist. To prevent confusion the Institute declares conditional *contraband* abolished, and then adds that "nevertheless, the belligerent has, at his option and on condition of paying an equitable indemnity, *a right of sequestration or preemption* as to articles (*objets*) which, on their way to a port of the enemy, may serve equally for use in war or in peace." The proposed rule goes beyond the directions of the British Prize Act, and it could only come into operation under a verbal alteration of the Declaration of Paris, under which "contraband" alone is excepted from the protection of the neutral flag, a fact which seems to have escaped the notice of the Institute.

British prize law is at present governed by the Prize Act of 1864. The Prize Manual for the guidance of British naval commanders was re-edited by Professor T. E. Holland, and reissued 1888. Both require alteration to bring them into harmony with changes which have resulted from inroads of legislation even since so recent a date as 1888. A Consolidation Prize Bill, drafted, we believe, by Professor Holland, and dealing with the legislative changes which have become necessary, had by 1902 passed through the House of Lords, and was awaiting its turn in the House of Commons. The British Prize Instructions were, at the time of writing this article, also undergoing revision by a committee, appointed by the Government for this purpose, but whose work of course can only be completed after the adoption of the new Act.

Absolute Duties of Neutrals.—For abstention from direct corporate assistance, see INTERNATIONAL LAW, *Ency. Brit.* vol. xii. p. 195 *et seq.*

The duty of neutral States to enforce respect for their territory has become a very serious one. A belligerent cannot be allowed to cross the neutral frontier or carry on war operations in neutral waters, without the same right being granted to the other belligerent. Pursuit of one force by the other would amount to waging war on the neutral territory. It is agreed among nations that the avoidance of such a contingency is in the interest of them all. During the Franco-German war both France and Germany, as belligerents, and Belgium and England, as neutrals, rigorously observed their duties and enforced their rights, and no difficulty occurred. It is, nevertheless, conceivable that, under pressure of military necessity, or on account of an overwhelming interest, a powerful belligerent State would cross the territory of a weak neutral State and leave the consequences to diplomacy. The South African war was exceptional, in that the Portuguese Government exposed itself to no international difficulty through allowing a belligerent, whose final victory was certain, and of necessity entailed total suppression of the conquered belligerent, to cross its colonial territory. At the same time it is an unfortunate precedent of taking advantage of the practical powerlessness of neighbouring neutral States to commit a violation of the law of nations, respect for which it is a primary duty of every self-respecting State to encourage.[3]

Enforcement of respect for neutral territory.

If, by inadvertence or otherwise, belligerent soldiers pass the frontier, they have to be turned back. If they claim the *droit d'asile*, they are arrested, disarmed, and kept in such a manner as to render it impossible for them to take any further part in the

Refugees.

[1] *Parl. Papers*, Africa, No. 1 (1900), pp. 14, 25.
[2] The Naval Prize Act, 1864, sect. 38.

[3] The right of way claimed and acceded to under the Anglo-Portuguese Treaty of 11th June 1891 was a mere right of transit for merchandise, and could not in any way be construed as diminishing the neutral obligation to a belligerent who was no party to the treaty.

hostilities. In the case of territorial waters, as has already been pointed out, the neutral State is not in the same position as on land, all ships without distinction having a right of innocent passage through them. Belligerent ships also have the right to enter neutral ports, but the neutral authority is bound to take precautions to prevent any favour being shown to the one party or the other.[1]

Relative Duties of Neutrals.—Relative duties embrace those duties which citizens are bound to observe and for which States incur a relative responsibility. It was the non-observance of these relative duties that led to difficulties between Great Britain and the United States at the close of the American Civil War and which brought the two countries themselves to the verge of conflict. The Treaty of Washington (8th May 1871) referring these difficulties to arbitration defined the scope of the duties in question for all future purposes between the two peoples (see below, "Proclamations of Neutrality," and International Law, 9th ed.). Under this treaty the parties bind themselves to use "due diligence," where they have "reasonable ground" to believe that any acts have a belligerent character, in "preventing" them. They are bound to prevent—

Foreign enlistment, &c.

(1) Fitting out, arming, or equipping any vessel;

(2) The departure from their jurisdiction of any vessel, having been specially adapted in whole or in part within such jurisdiction to warlike uses;

(3) The making use by a belligerent of their ports or waters as a base of naval operations against the other;

(4) The making use thereof for the purpose of the renewal or augmenting of military supplies or arms;

(5) The making use thereof for the recruitment of men. (See International Law, 9th ed.)

The contracting States undertook to bring the rules they adopted on this subject to the knowledge of other maritime Powers, and to invite them to adopt them also, but thus far, it seems, nothing has been done to get them accepted among other States. Provision had already been made to enable the Government to carry them out in the *Foreign Enlistment Act* (9th August 1870). This Act, which repealed the previous one of 1819 on the same subject, is minute in its provisions to prevent enlisting or recruiting men, or the building or the equipping of vessels, for the military service "of a foreign State at war with a friendly State." Other States, except the United States (which have adopted a similar Act), have not followed the example of Great Britain, but leave it to the Central Government to deal with the cases, when they may arise, as matters of public safety.[2]

There is evident reluctance among foreign States to commit themselves to the obligation of exercising "due diligence." It is clear that the duty of a State to forbear from committing any act which may be of assistance to either belligerent can never be formulated as an absolute one in regard to the acts of private persons, merely within the neutral jurisdiction. In recent times it has certainly become possible for States to exercise a more effective control than formerly over these acts; but at the present moment, though a much greater latitude is left to neutral subjects and citizens than is consistent with the idea of strict neutrality, there is no movement to alter the usages to the disadvantage of neutral interests. That the Geneva Arbitral Tribunal found in favour of the United States in the *Alabama* case in no way implies that International Law has as yet undergone any change. The tribunal was bound by the antecedent fixation of the Washington rules, and laid down no new principle. On the other hand, the magnitude of the Geneva award is not likely to promote change in the direction of increasing neutral duties, except as part of a general regulation of neutral and belligerent rights.

Proclamations of neutrality.

To some extent the difficulty of determining the extent of relative neutral duty is overcome by the issue of proclamations of neutrality; but neutrality and its rights and duties are in no respect dependent on their being proclaimed by the neutral Power. Germany issues no proclamation; at least the German empire has issued none in connexion with the different wars which have taken place since 1870. The Austro-Hungarian Government during the same period only in the case of the war of 1870 itself, and in 1877, issued proclamations, and these probably had objects outside the ordinary purposes of proclamations of neutrality, and its usual practice is the same as that of Germany. France usually issues a short general proclamation, and

[1] The rules laid down on this subject by the British authorities during the Spanish-American war were as follows:—

Rule 1. During the continuance of the present state of war all ships of war of either belligerent are prohibited from making use of any port or roadstead in the United Kingdom, the Isle of Man, or the Channel Islands, or of any of Her Majesty's colonies or foreign possessions or dependencies, or of any waters subject to the territorial jurisdiction of the British crown, as a station or place of resort for any warlike purpose, or for the purpose of obtaining any facilities for warlike equipment; and no ship of war of either belligerent shall hereafter be permitted to leave such port, roadstead, or waters from which any vessel of the other belligerent (whether the same shall be a ship of war or a merchant ship) shall have previously departed until after the expiration of at least twenty-four hours from the departure of such last-mentioned vessel beyond the territorial jurisdiction of Her Majesty.

Rule 2. If there is now in any such port, roadstead, or waters subject to the territorial jurisdiction of the British crown any ship of war of either belligerent, such ship shall leave such port, roadstead, or waters within such time, not less than twenty-four hours, as shall be reasonable, having regard to all the circumstances and the condition of such ship as to repairs, provisions, or things necessary for the subsistence of her crew; and if after the date hereof any ship of war of either belligerent shall enter any such port, roadstead, or waters subject to the territorial jurisdiction of the British crown, such ship shall depart and put to sea within twenty-four hours after her entrance into any such port, roadstead, or waters, except in case of stress of weather, or of her requiring provisions or things necessary for the subsistence of her crew, or repairs; in either of such cases the authorities of the port, or the nearest port (as the case may be), shall require her to put to sea as soon as possible after the expiration of such period of twenty-four hours, without permitting her to take in any supplies beyond what may be necessary for her immediate use; and no such vessel which may have been allowed to remain within British waters for the purpose of repair shall continue in any such port, roadstead, or waters for a longer period than twenty-four hours after her necessary repairs shall have been completed. Provided, nevertheless, that in all cases in which there shall be any vessels (whether ships of war or merchant ships) of both the said belligerent parties in the same port, roadstead, or waters within the territorial jurisdiction of Her Majesty, there shall be an interval of not less than twenty-four hours between the departure therefrom of any such vessel (whether a ship of war or merchant ship) of the one belligerent and the subsequent departure therefrom of any ship of war of the other belligerent; and the time hereby limited for the departure of such ships of war respectively shall always, in case of necessity, be extended so far as may be requisite for giving effect to this proviso, but no further or otherwise.

Rule 3. No ship of war of either belligerent shall hereafter be permitted, while in any such port, roadstead, or waters subject to the territorial jurisdiction of Her Majesty, to take in any supplies, except provisions and such other things as may be requisite for the subsistence of her crew, and except so much coal only as may be sufficient to carry such vessel to the nearest port of her own country or to some nearer destination; and no coal shall again be supplied to any such ship of war in the same or any other port, roadstead, or waters subject to the territorial jurisdiction of Her Majesty, without special permission, until after the expiration of three months from the time when such coal may have been last supplied to her within British waters as aforesaid.

Rule 4. Armed ships of either belligerent are interdicted from carrying prizes made by them into the ports, harbours, roadsteads, or waters of the United Kingdom, the Isle of Man, the Channel Islands, or any of Her Majesty's colonies or possessions abroad.

[2] The French Penal Code, however, contains the following clauses covering the Government's powers in this respect:—

Art. 84. Whoever shall by hostile acts, not approved by the Government, expose the State to a declaration of war, shall be punished by banishment, and should war follow, by deportation.

Art. 85. Whoever shall, by acts not approved by the Government, expose Frenchmen to the risk of reprisals, shall be punished by banishment.

Great Britain a more detailed one, which must be as old as the "ancient custom" of its being publicly read from the steps of the Royal Exchange by the sergeant-at-arms and common crier of the City of London.[1] The British proclamation practically recites the Foreign Enlistment Act, 1870 (an Act to regulate the conduct of His Majesty's subjects during the existence of hostilities between foreign States with which His Majesty is at peace), admonishes all persons entitled to British protection to observe and respect the exercise of those belligerent rights which "We and Our Royal Predecessors have always claimed to exercise," and warns them that any such persons "breaking, or endeavouring to break, any blockade lawfully and actually established" by either belligerent, "or carrying officers, soldiers, despatches, arms, ammunition, military stores, or materials, or article or articles, considered and deemed to be contraband of war, according to the law or modern usages of nations, for the use or service" of either belligerent, "rightfully incur, and are justly liable to, hostile capture and to the penalties denounced by the law of nations in that behalf." During the South African war no proclamation of neutrality was issued by any country.

Proclamations of neutrality may be made to serve the twofold purpose of warning the belligerent of the length to which the neutral Government considers neutral duty to extend, and neutral subjects of the exceptional measures to which a foreign war exposes them. They may also be used to give effect to any modification of neutral right or duty which the neutral State may consider warranted by special or altered circumstances.

Sale of arms and ammunition by neutrals.

No purely mercantile transactions are considered a violation of neutrality. Six years before the American Civil War, President Pierce, in his message to the Thirty-fourth Congress, first session, made the following statement:—"The laws of the United States do not forbid their citizens to sell to either of the belligerent Powers articles of contraband of war, or to take munitions of war or soldiers on board their private ships for transportation; and although in so doing the individual exposes his person or property to some of the hazards of war, his acts do not involve a breach of the national neutrality, nor of themselves implicate the Government." This is as true a statement of international practice to-day as then.

During the Franco-German war there was correspondence between the Prussian diplomatic representatives in London and at Washington and the British and United States foreign secretaries concerning shipments of arms and ammunition to the French armies, in which the Prussian Government contended that it was incompatible with strict neutrality that French agents should be permitted to buy up in the neutral country, under the eyes and with the cognizance of the neutral Government, "many thousands of breech-loaders, revolvers, and pistols, with the requisite ammunition, in order to arm therewith the French people, and make the formation of fresh army corps possible after the regular armies of France had been defeated and surrounded." Nothing, however, was done to prevent the departure of these supplies. Both the British and United States Governments claimed entire liberty for the traffic in question.

Raising of loans on neutral territory.

In the case of loans publicly issued or raised on neutral territory the position is a little different, inasmuch as the neutral State is necessarily cognizant of the fact. No restriction, however, is imposed by international usage, and provided the same rights are granted to both belligerents, either or both can raise money *ad libitum* in neutral countries. Thus neutral States did not prevent the issue on their territory of the Russian war loan of 1876–77. Nor in the recent war between China and Japan was any opposition made by Japan to the raising of the Chinese loan in London.

[1] *The Times*, 28th April 1898.

Proposed Neutrality Reforms.—It has been seen in the course of this article that the rules relating to neutrality need to be made more clearly ascertainable. At the Hague Peace Conference a suggestion was agreed to, without discussion, that a further State conference should be held for the purpose of dealing specially with neutrality. Later, Count von Bülow, the German chancellor, in connexion with German neutrality during the South African war, referred to this proposal. "Attempts at a settlement," he said, "have so far invariably failed, owing to the obstacles created by the divergent views of the different Powers. An endeavour was even made to include this question in the deliberations of the Peace Conference at The Hague. The sole result was that the Conference gave expression to the wish that an attempt should be made, by means of subsequent international conferences, on the one hand to deal with the rights and duties of neutrals, and, on the other, with the question of private property at sea. The German empire would not withhold its concurrence and support, if a prospect were to arise of defining more distinctly than heretofore, in conjunction with other Powers, the lines for an international settlement of the disputed points of maritime law." Both the Institute of International Law and the International Law Association have appointed committees for the examination of the whole subject of neutrality. In fact, there is a distinct movement among the maritime States of the world in favour of revising belligerent rights and neutral duties.

War at the present day cannot be conducted without involving vital interests of neutral states. Germany in the course of the South African war showed great irritation at the stoppage of certain of her merchant vessels, and Great Britain had to consent to a modification of belligerent right under International Law—a modification which, be it said, is a perfectly justifiable one, viz., to restrict the right of search for contraband of war to a specified area. We may be sure that, in future wars, powerful neutral States will show, in similar cases, quite as much irritation as did Germany.[2]

How far States would go in accepting responsibility it is difficult to forecast. It has been said that a State is responsible for acts of infringement of neutrality by those within its jurisdiction, though it may not possess a machinery to repress them. Several States, as a fact, have no enactments specifically to punish infringements of neutrality, and others, like France, deal only with violations of the laws of neutrality as productive of public damage or difficulties. On the other hand, it is not unreasonable to contend that neglect of a State to enforce the laws it possesses entails responsibility for the consequences, and the absence of reciprocity would not be a complete answer to a claim by a State whose laws were less stringent. (T. BA.)

Neuville, Alphonse Marie de (1836–1885), French painter, was born, the son of wealthy parents, at Saint-Omer, France, on 31st May 1836. From school he went to college, where he took his degree of *bachelier ès lettres.* His taste led him to serve in the navy, and in spite of the opposition of his family he entered the naval school at Lorient. It was here, in 1856, that his artistic instincts first declared themselves. He returned to Saint-

[2] Nothing shows more the power of neutral opinion than the fact that the United States and Spain during the war of 1898, though they had refused to be parties to the Declaration of Paris, found themselves obliged to act in accordance with its provisions.

Omer, where his father announced his intention of starting the youth in a public office, but de Neuville obtained his permission to become a painter. After being refused and discouraged by several painters of repute, he was admitted to work in Picot's studio. He did not, however, remain there long, and he was painting by himself when he produced his first picture, "The Fifth Battalion of Chasseurs at the Gervais Battery (Malakoff)." This work won the good opinion of Delacroix. In 1860 de Neuville painted an "Episode of the taking of Naples by Garibaldi" for the Artists' Club in the Rue de Provence, and sent to the Salon in 1861 "The Light Horse Guards in the Trenches of the Mamelon Vert." He also made successful illustrations for *Le Tour du Monde* and for Guizot's *History of France.* At the same time he painted a number of remarkable pictures: "The Attack in the Streets of Magenta by Zouaves and the Light Horse" (1864), "A Zouave Sentinel" (1865), "The Battle of San Lorenzo" (1867), and "Dismounted Cavalry crossing the Tchernaia" (1869). In these he showed peculiar insight into military life, but his full power was not reached till after the war of 1870, in which he had fought with courage. He then aimed at depicting in his works the episodes of that war, and began by representing the "Bivouac before Le Bourget" (1872). His fame spread rapidly, and was increased by "The Last Cartridges" (1873; see Plate), in which it was easy to discern the vast difference between the conventional treatment of military subjects, as practised by Horace Vernet, and that of a man who had lived through the life he painted. In 1874 the "Fight on a Railroad" was not less successful, and was followed by the "Attack on a House at Villersexel" (1875) and the "Railway Bridge at Styring" (1877). In 1878 the painter exhibited (not at the Great Exhibition) "Le Bourget," the "Surprise at Daybreak," "The Intercepted Despatch-bearer," and a considerable number of drawings. He also exhibited in London some episodes of the Zulu war. In 1881 he was awarded the grade of officer of the Legion of Honour for his two pictures "The Cemetery of Saint-Privat" and "The Despatch-bearer." During these years de Neuville was at work with Detaille on an important though less artistic work, "The Panorama of Rézonville." De Neuville died in Paris, 18th May 1885. At the sale of his works after his death the State purchased for the Luxembourg Museum the "Bourget" and the "Attack on a Barricaded House," both in oils, with a water-colour picture, "The Parley," and a drawing of a "Turco in Fighting Trim."

See MONTROSIER. "Les Peintres Militaires," Paris, 1881.—"De Neuville," *La Gazette des Beaux Arts.* Paris, 1885. (H. FR.)

Nevada, one of the most westerly of the United States of America, bounded on the N. by Oregon and Idaho, on the E. by Utah, and on the S. and W. by California. Situated in the arid portion of the country, and with few streams available for irrigation, Nevada can never, under the present climatic conditions, become prominent as an agricultural state. In 1900 the area of land reported as improved and irrigated was 504,204 acres, mainly for grass, alfalfa, and other forage plants. The principal crop in 1898, apart from forage crops, was wheat, in which were planted 36,700 acres, the product being 1,064,271 bushels. The live stock interest was proportionately of greater moment than agriculture proper. In 1898 the state contained 44,305 horses, 1394 mules and asses, 240,386 cattle, 576,994 sheep, and 10,441 hogs. In 1900 there were 922 miles of railway (valued at $8,618,477), but little building had been done in the preceding fifteen years. The production of gold and silver, upon which mainly the state depends for its prosperity, has greatly diminished. In 1900 it was as follows: gold, $2,006,200; silver, coinage value, $1,756,703; giving a total of $3,762,903. Besides this 3388 tons of lead were produced as a by-product. Nevada was never prominent as a manufacturing state. In 1900 there were 133 manufacturing establishments (excluding those classified as hand trades and those having a product of less than $500). They had a total capital of $1,349,109, an average number of 534 wage-earners, and products valued at $1,405,827. At the state capital, Carson, are situated a state prison and an orphan home. A state hospital for the insane is maintained at Reno. The state maintains an excellent system of public schools. Altogether the schools numbered, in 1898, 310, upon which was expended the sum of $317,762. The State University at Reno had in 1898 an income from the state of $32,500, while expenses amounted to $28,297. The number of instructors was 28, and it was attended by 366 students. In the matter of church membership, about two-thirds of the inhabitants are connected with the Roman Catholic Church, the remainder being composed of Episcopalians, Mormons, Methodists, and Presbyterians. In 1898 the total value of real estate, as assessed, was $16,364,656; of personal property, $6,822,555. The net proceeds of mines yielded in taxation the sum of $330,034; the total amount raised by taxation was $583,492. In 1898 the debt was but $682,611, the revenue $297,997, and expenses $355,461. Before 1892, when parties first divided upon the issue of free silver, Nevada was in most elections a Republican state; but since that year the free silver party has carried each election. In the Presidential election of 1896, when silver was adopted by both Democrats and Populists, their party carried the election by a very large majority. The population in 1890 was 45,761, showing a decrease of 16,505, or more than one-fourth, from that in 1880. In 1900 it was 42,335, showing a further decrease. The population in 1900 included 25,603 males and 16,732 females. The foreign-born population numbered 10,093, and the coloured 6930, of whom 134 were negroes, 1352 Chinese, 228 Japanese, and 5216 Indians. Out of 17,710 adult males, 2271 were illiterate (unable to write), of whom 372 were Chinese and 1398 Indians. (H. G*.)

Nevada, a city of Missouri, U.S.A., capital of Vernon county, on the Missouri, Kansas and Texas and the Missouri Pacific railways, in the western part of the state, at an altitude of 860 feet. It has an elevated level site and a regular plan, divided into five wards. It has varied manufactures, including a large smelter for reducing the zinc ores from the adjoining mining district. It is the seat of Christian University and of Cottery Female College. It contains also a state insane asylum. Population (1880), 1913; (1890), 7262; (1900), 7461, of whom 235 were foreign-born and 168 negroes.

Nevis, an island in the Leeward Islands group, British West Indies. Rum, sugar, and molasses are practically the only exports. Other products, chiefly for local consumption, are corn, yams, and sweet potatoes. The island has much declined in prosperity in recent years owing to the decay of sugar production, and it suffered from a severe hurricane in 1899. Population (1881), 11,864; (1891), 13,087; (1900), estimated at 15,305. Primary education is compulsory. Most of the inhabitants are Protestants.

New Albany, a city of Indiana, U.S.A., capital of Floyd county, on the north bank of the Ohio river, opposite Louisville, Kentucky, in the southern part of the state, at an altitude of 442 feet. It has a level site, a regular street plan, and is divided into seven wards. Besides the river, which is open to navigation throughout

"Combat sur les Toits." By A. M. de Neuville.

(By permission of Goupil and Co., London.)

"Les Dernières Cartouches." By A. M. de Neuville.

(By permission of Goupil and Co., London.)

the year, its ways of commerce include four railways, the Baltimore and Ohio South-Western, the Chicago, Indianapolis and Louisville, the Louisville, Evansville and St Louis, and the Pittsburg, Cincinnati, Chicago and St Louis, bringing the city a large business. Aided by water-power from the falls in the Ohio, New Albany is a manufacturing city of much importance. In 1890 it had 298 manufacturing establishments, with a total capital of $5,342,071. The employés numbered 4506, and the products were valued at $6,631,924. These consisted in great part of glass and iron and steel goods, the former having a value of $1,117,000, and the latter of $1,178,469. Population (1890), 21,059; (1900), 20,628, of whom 1363 were foreign-born and 1905 negroes.

Newark, a municipal borough and market-town in the Newark parliamentary division (since 1885) of Nottinghamshire, England, on the river Trent, 19 miles north-east by east of Nottingham, and on the Midland and Great Northern railways. There are a new public library and public gardens, the latter including the ruins of Newark Castle; and a coffee-palace has been presented by Lady Ossington. Waterworks have been constructed at a cost of £120,000. The manufacturing industries of Newark, especially brewing, malting, and iron-works, have developed considerably of late years. Population (1881), 14,018; (1901), 14,985.

Newark, a city of Essex county, New Jersey, U.S.A., the largest city in the state. It is on the Passaic river, 4 miles from Newark Bay. It is irregularly laid out, with broad streets, less than half of which are paved, mainly with granite blocks and asphalte. Newark is upon five great trunk lines of railway, which connect it with New York, Philadelphia, and other points. These are the Central of New Jersey, the Delaware, Lackawanna and Western, the Erie, the Lehigh Valley, and the Pennsylvania. It contains an excellent public library. Two of its insurance companies have combined assets exceeding $100,000,000, and combined income exceeding, in the year 1899, $34,000,000. In 1900 it contained 3339 manufacturing establishments, with a total capital of $103,191,403. They employed 49,550 hands, and the products were valued at $126,954,049. The manufactures are extremely varied, the chief products being as follows: boots and shoes, $2,530,048; bread, &c., $2,540,245; chemicals, $3,113,095; clothing (men's and women's), $2,682,558; corsets, $1,298,754; fertilizers, $1,426,285; foundry and machine shop products, $5,536,893; hardware, $1,013,409; fur hats, $3,453,619; iron and steel, $1,169,744; jewellery, $7,364,247; leather, $10,857,192; malt liquors, $8,236,468; saddlery and harness, $1,184,178; slaughtering and meat-packing (wholesale), $3,093,396; varnish, $2,401,849. The assessed valuation of real and personal property in 1900 was $150,106,460; the tax rate, $22.40 per $1000, and the net debt was $14,177,641. The actual income of the city in 1900 was $6,080,707, and the total expenditures (exclusive of loans repaid) $7,011,401. The death-rate in 1900 was 18·44 per thousand. Population (1890), 181,830; (1900), 246,070, of whom 71,363 were foreign-born and 6694 negroes.

Newark, a city of Ohio, U.S.A., capital of Licking county, on the Licking river, the Ohio and Erie canal, and the Baltimore and Ohio and the Pittsburg, Cincinnati, Chicago and St Louis railways, in the central part of the state, at an altitude of 868 feet. It is regularly laid out on a level site, and is divided into eight wards. It is in a fertile farming region, a country also underlaid by coal and producing natural gas. The carriage works of the Baltimore and Ohio Railroad are situated here, and there are extensive and varied manufactures. Population (1890), 14,270; (1900), 18,157, of whom 1342 were foreign-born and 300 negroes.

New Bedford, a seaport city of Massachusetts, U.S.A., capital of Bristol county, on the estuary at the mouth of Acushnet river in Buzzard's Bay, in the south eastern part of the state. It has an area of 19 square miles of undulating surface, on which the city is laid out with a regular plan and divided into six wards. It has excellent water-supply and sewer systems. It is on a branch of the New York, New Haven and Hartford Railroad, and has regular steamboat communication with other points of Long Island Sound and the neighbourhood. New Bedford was at one time the headquarters of the American whaling fleet, and with the decline of that industry the city decreased in prominence. In recent years, however, the development of manufactures has revived it. In 1900 the manufacturing establishments numbered 618, the invested capital was $29,073,410, the average number of hands employed was 16,409, and the value of the products was $25,681,671. Of this sum about two-thirds, $16,748,783, represented cotton goods. The assessed valuation of real and personal property in 1900 was $57,884,452, the net debt was $3,175,011, and the rate of taxation $17.60 per $1000. Population (1890), 40,733; (1900), 62,442, of whom 25,529 were foreign-born and 1685 negroes.

Newbern, a city and seaport of North Carolina, U.S.A., capital of Craven county, in the eastern part of the state, at the junction of the Neuse and Trent rivers, at the head of their estuary. It is on the Atlantic and North Carolina and the Atlantic Coast Line railways, and has regular steamboat communication with the principal northern cities. It has a large trade in southern pine lumber, naval stores, tobacco, and cotton. Population (1890), 7843; (1900), 9090, of whom 89 were foreign-born and 5878 negroes.

New Brighton, formerly a village of Richmond county, New York, U.S.A., and since 1st January 1898 a part of the borough of Richmond, one of the five boroughs constituting New York city. Of this borough it forms the first ward. It is situated at the north end of Staten Island, across New York upper harbour from Manhattan borough, with which it is connected by ferry. It has large cotton warehouses and varied manufactures. Population (1880), 12,679; (1890), 16,423; (1900), 21,441 of whom 6575 were foreign-born and 259 negroes.

New Brighton, a borough of Beaver county, Pennsylvania, U.S.A., on the Beaver river and on branches of the Pennsylvania Railroad, in the western part of the state, at an altitude of 748 feet. It is in the coal region, and has varied manufactures. Population (1880), 3653; (1890), 5616; (1900), 6820, of whom 487 were foreign-born and 179 negroes.

New Britain, a town and city of Hartford county, Connecticut, U.S.A., on the New York, New Haven and Hartford Railroad, near the centre of the state, at an altitude of 179 feet. It has extensive and varied manufactures, consisting chiefly of iron and brass goods. In 1900 there were 226 manufacturing establishments, having a capital of $14,115,610, employing an average number of 8438 wage-earners, and turning out products valued at $12,260,782. The site was settled about 1650, and was originally comprised in the towns of Berlin and Framingham. It was incorporated as a town in 1850, and in 1871 the city of New Britain, formerly a part only of the town, was chartered. Population of the town, including the city (1890), 19,007; of the city (1890), 16,519; (1900), 25,998, of whom 9293 were foreign-born and 118 negroes.

New Brunswick, a province of the Dominion of Canada, lying between 45° 2′ and 48° 3′ N. and 63° 46′ and 69° 3′ W. Along the Bay of Fundy, and reaching inland 30 miles, the country is somewhat rugged and broken, and traversed by ridges rising 500 to 1000 feet above sea-level, with occasional summits 300 feet higher. This area is underlain by rocks of the Laurentian, pre-Cambrian, Cambrian, Devonian, and Lower Carboniferous, with considerable masses of intrusive granite. North of this, grey sandstones and conglomerates of Carboniferous age occupy a triangular area, the apex of which is near Oromocto Lake, the south side extending to Nova Scotia and the north-west side to Bathurst. Along the western border this area is 400 to 600 feet high, but near the coast it is low and flat. North-west of the Carboniferous a belt of 40 to 50 miles wide is occupied by Ordovician and pre-Cambrian formations, with large masses of intrusive granite. The Ordovician is composed of schistose, micaceous, and foliated slates and quartzites, in places highly altered and disturbed. The pre-Cambrian rocks consist of very hard cystalline reddish felsite, chloritic quartzites, and felspathic and micaceous schists. The surface of this region is rugged and broken, and traversed by mountain ranges having an elevation of 1500 to 2000 feet, with isolated peaks rising 2500 to 2700 feet above sea-level. The remainder of the province to the north-western boundary is occupied by Silurian rocks, mostly calcareous slates, and shales associated with beds of limestone. The general level of this area varies from 500 to 800 feet, with ridges rising much higher, and in it is found some of the best agricultural land. The whole province has been mantled with ice in the Pleistocene period, and boulder-clay and later modified deposits occupy the surface. Marine clay and sand containing fossil shells are found along the coast.

Climate.—The climate, though subject to extremes, is healthy. The average mean temperature in summer is 60° F., and in winter 19° F. The average rainfall for twenty-seven years (1874 to 1900 inclusive) was 31·9 inches, and the average snowfall for the same period was 99·1 inches.

Game.—Laws for the protection of game have been in force for some years, and moose, caribou, and deer have of late increased rapidly. The hunting grounds, though many miles in the unbroken forest, are readily accessible. In 1902 an Act was passed authorizing the executive to set apart a large area of the highlands at the sources of the Tobique, Nipisiquit, and Miramichi rivers for a national park and game preserve. Much of this district is covered with the primeval forest, and abounds in beautiful lakes and clear sparkling streams. It is the centre of the best hunting grounds in the province, and its selection for a park will preserve many of the fur-bearing animals from total extinction.

Area and Population.—The area of the province is about 27,911 square miles, with a population per square mile of 11·9. The following statistics show the population according to sex, occupation, and race:—

	1871.	1881.	1891.	1901.
Total population .	285,594	321,233	321,263	331,120

In 1901 there were 62,700 families, 168,639 males and 162,481 females.

Occupations of the People in 1891.—Agriculture, fisheries, and mining, 55,705; domestic and personal service, 17,437; manufactures and mechanical industries, 18,707; professional, 3863; trade and transportation, 12,005; non-productive, 1742.

In the census of 1901 the origin of the people is given as follows:—English, 104,701; Irish, 83,385; Scottish, 48,310; Dutch, 3623; French, 79,988; German, 3830; Indian, 1309; negro, 1368, and the remaining 4606 belong to twenty different nationalities. Of the whole population, 329,567 were either born in Canada or are now naturalized citizens.

Constitution and Government.—The province is represented in the Federal Parliament by ten senators, appointed for life, and fourteen members of the House of Commons, elected for a term of five years. Since the abolition of the Legislative Council in 1892 provincial affairs have been managed by a lieutenant-governor and executive council of six paid members, and from one to four without portfolios, and the House of Assembly, composed of forty-six members, elected for a term of four years.

Religion.—In 1901 the principal religious denominations and their adherents were as follows:—Church of England, 41,767; Church of Rome, 125,698; Presbyterians, 39,424; Methodists, 35,973; Baptists, 80,946; Congregationalists, 1033; Disciples of Christ, 1640; Adventists, 1124.

Education.—The total expenditure for schools in 1901 was $600,340, including the Government grant to teachers amounting to $163,952. In 1882, with a population of 321,233, the number of schools was 1411, there were 1445 teachers, and the pupils numbered 52,667. In 1901, with a population of 331,120, there were 1741 schools, 1841 teachers, and 66,760 pupils. There are three chartered institutions which grant academic degrees, viz., the University of New Brunswick, Fredericton; the University of Mount Allison College, Sackville; and St Joseph's College, Memramcook, Westmorland county.

Finance.—The province has increased its revenue by imposing succession duties on estates above a certain value, by levying a tax on banks, insurance companies, telegraph and telephone companies, &c., and by taking a share of the proceeds of liquor licences. The total revenue in 1901 was $1,031,267, including $275,692 received from the Dominion Government on an old railway claim; and the expenditure $910,346, the gross debt $3,476,502, and the assets, not including public buildings, $700,238. Value of public buildings about $370,000. Crown lands, 7,000,000 acres at $1 per acre minimum value.

Defence.—New Brunswick forms the eighth military district in the militia of Canada. The active force is composed of one regiment of cavalry (4 squadrons), two batteries of field artillery and one regiment of garrison artillery, one company of engineers, and five regiments of infantry and rifles, a total of 209 officers and 2359 non-commissioned officers and men, together with a permanent force, one company (Fredericton) of the Royal Canadian Regiment of Infantry, and No. 8 Bearer Company Medical Corps.

Production and Industry.—Although many minerals of economic importance are known to occur in the province, not much progress has yet been made in mining, as the quantity of ore in most cases has been limited. Borings are now being carried on for coal and oil. The mineral production in 1901 was valued at $450,000. The total number of occupiers of land in 1891 was 40,836; of these 37,853 were owners, 2860 tenants, and 123 employés. Much attention has been given to the co-operative manufacture of butter and cheese, and the dairy school at Sussex has done good work in disseminating knowledge regarding these subjects. In 1901 there were 56 factories in operation, which made 1,887,370 pounds of cheese, the value of which was $175,205; there were also 35 factories, which produced 542,626 pounds of butter, valued at $111,043. These amounts are exclusive of large quantities of home-made butter and cheese. The acreage and state of lands occupied is shown as follows:—in 1891 the acres were—total occupied, 4,471,250; total improved, 1,509,790; under crop, 1,018,704; in pasture, 479,607; woodland and forest, 2,961,460; gardens and orchards, 11,479. The largest crops are oats, buckwheat, and potatoes, but barley, wheat, pulse, and rye are also grown. In 1901 there were shipped to transatlantic ports 398,874,725 superficial feet of deal, &c., and 6317 tons of timber. Of the former St John contributed 176,295,257, and the port of Miramichi 125,664,411. The total value of the products of the forest exported in 1899 was $6,148,900. Animals and their products in 1891 were: horses, 59,773; oxen, 7510; milch cows, 106,649; other horned cattle, 90,533; sheep, 182,941; swine, 50,945; domestic fowl, 662,433; cheese, 39,716 ℔; butter, 7,798,268 ℔; wool, 692,898 ℔.

Fisheries.—Provision is made for the distribution of $160,000 annually among fishermen and vessels. Of this amount New Brunswick received $13,563 in 1900, divided among 234 vessels (2969 tons) and 890 men, 670 boats and 1184 men. In the same year the total number of vessels employed in the fisheries was 299 (4058 tons) manned by 1080 men, and 7050 boats manned by 11,559 men. 5440 persons were employed in the lobster canneries. The total value of vessels, boats, nets, lobster canneries, fish-houses, and all other material used in the fisheries was approximately $2,361,087. The value of the fisheries for 1900 was $3,769,742, of which the most important items were herring, $919,619; lobsters, $506,383; sardines, $293,945; cod, $345,618; and salmon, $246,540. Fish products, $223,544.

Manufactures.—Considerable progress has been made in the manufacture of cotton and pulp. In 1891 there were 5 cotton mills, employing 1752 hands, and the value of the finished product was $1,750,000. Four mills for the manufacture of pulp have been erected, 2 at Chatham and 2 near St John, with a total capacity of 140 tons of pulp every 24 hours. As large areas are covered by a heavy growth of spruce, the best wood for making pulp, there is room for great expansion in this industry. In 1891 the number of manufacturing establishments was 5429; capital invested, $15,821,855; hands employed, 26,675; total wages, $5,970,914; total value of raw material, $12,501,453; and the value of the articles produced, $23,849,655. In 1885 the exports amounted to $6,489,293, and the imports to $5,972,836; in 1901 the former reached $14,886,454, and the latter $6,741,848.

Shipping and Navigation.—The registry books for 1900 show that there were 927 sailing vessels and steamers, net tonnage, 78,708; of these 122 were steamers, gross tonnage, 10,247. In the same year 22 new vessels were built and registered; tonnage, 762.

Roads and Railways.—The provincial Government has replaced many wooden highway bridges by permanent structures of masonry and steel. Amongst new railways are the New Brunswick and Prince Edward Island Railway, from Sackville to Cape Tormentine; the Moncton and Buctouche Railway, from Moncton to Buctouche, on Northumberland Strait; the Kent Northern Railway, from the Intercolonial Railway to Richibucto and Palmerston; the Caraquette Railway and Gulf Shore Railway, from the Intercolonial near Bathurst to Tracadie; the Restigouche and Victoria Railway, under construction; the Albert Southern Railway, from Albert to Alma; the Central Railway, from Norton on the Intercolonial to Chipman in Queen's county; the Canada Eastern, connecting Fredericton with Chatham and Loggieville; St John Valley and Rivière du Loup Railway, from Fredericton to Woodstock (6 miles), under construction; York and Carleton Railway, from junction with the Canada Eastern Railway at Cross Creek station to Stanley; and the extension of the Central Railway from Chipman to Fredericton, under construction. The railways west of the St John river and the line on the east side from Fredericton to Andover are owned and worked by the Canadian Pacific Railway Company, except the Shore Line Railway, between St John and St Stephen. In 1901 there were 1444 miles of railway in operation. Telephone lines connect most of the principal places, and are also used in country settlements.

Towns.—The cities and towns are Fredericton, 7117, the capital; St John, 40,711; Moncton, 9026; Chatham, 4868; St Stephen, 2840; Campbelltown, 2652; Sackville, 1875; Woodstock, 2984; Richibucto, 1700; Bathurst, 1550; St Andrews, a favourite summer resort, 1800; St George, the seat of an extensive granite industry, 850; Dalhousie, 1000; Sussex, noted for its dairy products, 1500; Marysville has extensive lumber trade, and one of the largest cotton mills in the Dominion, 1892; Hillsborough, noted for valuable gypsum quarries, 700; Milltown has extensive lumber trade and cotton mills, 2146; Dorchester is the seat of the Maritime Penitentiary, 1000.

See GESNER. *New Brunswick*, 1847.—HANNAY. *History of Acadia.* —DAWSON. *Acadian Geology.* —MATTHEW, BAILEY, ELLS, CHALMERS, in *Geol. Survey Reports*, 1870–71 to 1902; *Bulletins of Natural History Society of New Brunswick; Collections of the Historical Society of New Brunswick; Proceedings of the Royal Society of Canada.* (W. J. W.)

New Brunswick, a city of New Jersey, U.S.A., capital of Middlesex county, on the Raritan river and the Pennsylvania Railroad. It has extensive manufactures, largely of indiarubber and iron and steel goods. Rutgers College, including the state mechanical and agricultural college, now a part of it, in 1899 had 35 instructors and 306 students. Its total income during that year was $67,253. Population (1890), 18,603; (1900), 20,006.

Newburg, a city of Orange county, New York, U.S.A., on the west bank of the Hudson river, 60 miles above New York. It has four railways, the New York, New Haven and Hartford, the New York Central and Hudson River, the Erie, and the West Shore. In 1900 it contained 253 manufacturing establishments, with a total capital of $5,214,536, and employing 3926 hands. The products were valued at $6,497,088, the chief items being clothing, valued at $1,594,475, and foundry and machine-shop products, valued at $543,356. Population (1890), 23,087; (1900), 24,943, of whom 4346 were foreign-born and 558 negroes.

Newbury, municipal borough and market-town in the Newbury parliamentary division of Berkshire, England, on the river Kennet, 17 miles west by south of Reading by rail. Municipal buildings have been erected, and a thorough system of drainage has been laid down. Newbury possesses the right to elect boys and girls to Christ's Hospital. All householders may vote. A very important wool market is held annually in July. There are well-preserved specimens of ancient houses. Population (1881), 10,144; (1901), 11,061.

Newbury, John Strong (1822–1892), American geologist, was born at Windsor, Conn., on 22nd December 1822, and received a medical education. In 1851 he settled in practice at Cleveland, but in 1855 he was appointed surgeon and geologist to an exploring party in northern California, and in 1857 his reports on the geology, botany, and zoology were published. Between then and 1861 he was employed on similar work in the region of the Colorado river, and his researches over a large area of previously unknown country in Colorado, Utah, Arizona, and New Mexico were recognized as of high value. During the Civil War he did important work as a member of the U.S. Sanitary Commission, his organizing capacity being specially marked during the operations in the Mississippi valley. In 1866 he was appointed professor of geology and palæontology at the Columbia School of Mines, where he started a magnificent collection of specimens; in 1869 he was made state geologist of Ohio and director of the Geological Survey there, and in 1884 palæontologist to the U.S. Geological Survey. His work was recognized by his inclusion in most of the learned societies of America and the Old World; he received the Murchison medal of the Geological Society of London in 1888, and was president of the American Association for the Advancement of Science (1867), of the New York Academy of Sciences (1867–91), and of the International Congress of Geologists (1891). He published several volumes dealing with his own subjects. He died at New Haven, Conn., on 7th December 1892.

Newburyport, a city and seaport of Massachusetts, U.S.A., capital of Essex county, on the south side of the Merrimac river, 3 miles above its mouth, and on a line of the Boston and Maine Railroad, in the north-eastern part of the state. Formerly prominent in shipbuilding and as a whale-fishing port, its industries now mainly comprise the manufacture of boots and shoes, cotton goods, &c. It still possesses some commerce and fisheries. Population (1890), 13,947; (1895), 14,552; (1900), 14,478. of whom 2863 were foreign-born and 97 negroes.

New Caledonia, a French island in the Pacific, at the southern extremity of Melanesia, with an area of 5,187,000 acres, or about 8100 square miles. In 1898 the population numbered 52,756, consisting of 5585 colonists, 1714 soldiers, 1762 officials, 31,874 natives, 1829 labourers from the New Hebrides, India, and China, 7477 convicts condemned to short periods of imprisonment, and 2515 freed but restricted as to residence. The centres of population are Nouméa, the capital, with 6968 inhabitants, of whom 4010 are free, Bourail, an agricultural penitentiary (1800), La Foa, in the centre of the coffee plantations, Moindu, St Louis, and St Vincent. Since the great Kanaka insurrection of 1878, order has been maintained without interruption. The colony is administered by a governor, who exercises military power through a marine infantry colonel, and civil power with the assistance of a privy council, a director of the interior, a judicial head, and a director of the penitentiary administration. There is also an elective general council. Nouméa is the seat of a superior tribunal, a tribunal of first instance, and a tribunal of commerce. The island and its dependencies are divided into five arrondissements. Nouméa alone has (since 1879) a municipality, other localities being administered by commissions. The local budget for 1900 balanced at 3,407,876 francs. More than half of the expenditure of France, 6,643,748 francs, is incurred for the penal establishment.

Of the whole area of the colony more than one-half is mountainous: 500 square miles are occupied by forests capable of being worked; 1600 are in pasture-land, and 1600 consist of cultivable lands in alluvial valleys, where coffee, maize, tobacco, sugar-cane, the vine, vegetables, potatoes, and some of the cereals are grown with success. Coffee was introduced about 1870, and so well has it prospered that there are now at least 1,500,000 coffee bushes. Cheap agricultural labour is supplied by the convicts, by the liberated convicts, the Kanakas, and labourers from the New Hebrides. The soil is in three domains: that of the state, for the working of which concessions may be granted under the decree of 1897; that of the penitentiary administration, 400 square miles; and that of the native reserve. Notwithstanding their wealth, the forests are not worked. The colony contains, besides many horses, 130,000 head of cattle and sheep, and the meat-preserving industry has begun. The mineral deposits are abundant. Gold is found in the valley of the Diahot, as well as lead and copper at Balade. Iron is found everywhere. The yearly output of nickel exceeds 20,000 tons; of chrome, 2500 tons; and these minerals, with cobalt, constitute the characteristic wealth of the island. Coal covers more than 450 square miles in five basins, and kaolin is found in places. Gypsum and marble also deserve mention. The industries have not made great progress. The chief industrial establishments are smelting furnaces for cobalt, meat-preserving works at Ouaco, sugar-works and distilleries at Nouméa and La Foa, tobacco, oil, and soap factories at Nouméa. The commerce in 1888 amounted to £480,000, of which £200,000 represented the trade with France. In 1900 the total was £820,000, of which £480,000 was for imports and £340,000 for exports, the share of France in that year having been 45 per cent. of imports and 47 per cent. of exports. The island takes wines, spirits, tissues, clothing, and ironmongery; and sends ores, nickel, cobalt, chrome, copper to the amount annually of £208,000, preserved meats and hides, £20,000 to £24,000, coffee and colonial produce to a like amount. In 1898 the shipments of coffee reached 296 tons. There are as yet only 125 miles of carriage roads, but in the mountainous regions there are many footpaths.

Annexed Islands.—The islands annexed to New Caledonia are: (1) the Isle of Pines, 30 miles south-east, with a population of 600. A decree of 1886 assigned the island as a place for hardened criminals. (2) The Wallis Archipelago, placed under the French protectorate on 5th April 1887, and for administrative purposes connected with New Caledonia by decree of 27th November 1888. There is a French Resident in the islands, which since 1891 have been connected by a regular service with Nouméa. The archipelago, lying to the north-east of Fiji, in about 13° 2′ S. and 176° W., has an area of 40 square miles. The principal islands are Uea, of volcanic formation and surrounded with coral, and Nukuatéa. It was a missionary, Father Bataillon, who in 1837 first brought the influence of France to bear on the natives. These, about 4500 in number, are of Polynesian race and live on yams, and are gentle and industrious. The trade of the islands is mainly with Samoa, whence cottons and iron goods are imported, and to which copra and roots are exported. (3) The Loyalty Islands, 60 miles east of New Caledonia, consist of three large and a multitude of small islands, with a total area of 800 square miles. The population amounts to 14,800. The natives cultivate the banana and yams, and export sandal-wood. (4) The Union Islands, 170 miles north-west of New Caledonia, are almost barren. (5) The islands of Fotuna and Alofa, discovered in 1616, to the south-east of the Wallis Islands, were placed under the French protectorate by decree of 16th February 1888. They have 1500 inhabitants.

The New Hebrides are not classed among the possessions of France, but are under the joint supervision and protectorate of France and Great Britain. The convention of 24th October 1887 entrusted to a mixed commission of naval officers on the British and French stations in the Pacific the duty of protecting life and property. France, having withdrawn her garrisons, engaged not to send her convicts to the archipelago.

See Gallet. *La Nouvelle Calédonie.* Nouméa, 1884.—Le Chartier. *New Caledonia.* Paris, 1885.—Legrand. *Au Pays des Canaques.* Paris, 1893.—Lemire. *La Colonisation en Nouvelle Calédonie.* Paris. *L'Année Coloniale*, 1900. (P. L.)

Newcastle, the second city of New South Wales, both as regards trade and population, situated at the mouth of the river Hunter, about 62 miles north of Sydney, in 32° 55′ S. and 151° 49′ E. It is the seat of a Church of England bishopric, and there are numerous churches of all denominations. The New South Wales Government has spent very large sums on the construction of breakwaters and training-walls and on dredging and blasting, so that it may now be reckoned in most respects an excellent port, though it is dangerous to enter during east-south-east gales. The amount of silt, sand, and rock removed during 1899 was 2,183,000 tons. Newcastle comprises, besides the city proper, various suburbs: these, with their population in 1901, were Newcastle (city), 12,988; Stockton, 2549; Carrington, 2547; Wickham, 7752; Hamilton, 6124; Merewether, 4547; Adamstown, 2420; Waratah, 3080; New Lambton, 1578; Lambton, 3159; Wallsend, 3820; and Plattsburg, 3177, making the total population of the city and suburbs 53,741. There are 23 coal-mines at Newcastle and in its immediate vicinity, as well as 34 mines in the surrounding district, of which Newcastle is the shipping port. These mines employed, in 1899, 7815 hands, and the quantity of coal raised was 3,259,700 tons, of which about 600,000 tons were sent to Sydney, and 2,478,400 tons exported to places outside New South Wales. There is a growing trade in other articles than coal, and in 1899, out of a total export of £1,630,814, the value of coal was £882,857, and of other goods £747,957; included in this sum was wool valued at £529,876, horses £32,579, cattle £17,289, preserved meat £48,000, silver lead £36,905, and copper ingots £15,674. Biscuit-making is one of the most important manufactures, one establishment employing 500 hands. Newcastle is the fourth port of Australasia, ranking after Sydney, Melbourne, and Adelaide. During 1899, 973 deep-sea vessels, with a tonnage of 1,283,620 tons, entered the port; the majority of these vessels arrived in ballast. In the same year 974 vessels, of 1,283,157 tons, cleared directly from Newcastle, nearly every country of the globe being represented. The Government owns nearly all the wharfage, and has constructed nearly 13,000 feet of frontage. The wharves are equipped with steam and hydraulic cranes capable of shipping 25,000 tons a day.

Newcastle is represented in Parliament by six members, and there are twelve municipalities looking after the local affairs of the city and suburbs, though one would suffice. The total revenue of these municipalities in 1899 was £38,183, of which £24,881 was derived from rates and charges placed directly on assessed properties. The disbursements amounted to £38,815. The capital value of all properties liable to assessment was £5,430,700, and the annual value £316,270. The combined debts of the municipalities amounted to £142,498. There were, in 1899, 10,414 dwellings in these municipalities, and 247 miles of streets, of which only 96 miles were properly macadamized. Newcastle city, Hamilton, Merewether, and Wickham have each twelve aldermen; the other eight municipalities have nine each. The water supply of the Hunter river district, of which the twelve municipalities form part, is pumped direct from the Hunter river, about a mile and a half above West Maitland, and is finally drawn off to six local reservoirs. The capital cost of the works was £519,000. Only a small part of Newcastle and suburbs is regularly drained. In the city proper there were, in 1899, 12½ miles of drainage, constructed at a cost of £18,251. Newcastle and Lambton are supplied with electric light by their respective municipal councils; the local council of Waratah owns its own gas-works, and there are also two private companies supplying the city and suburbs with gas. Communication between the various parts is maintained by tramways and ferry-boats. The Great Northern Railway runs from Newcastle to Wallangarra, on the Queensland border, where it joins the Queensland railway system; at Hamilton the railway from Sydney joins the Northern system, at a point 102 miles distant from Sydney. There is tramway communication with Plattsburg, Tighe's Hill, and Merewether. Steam ferry-boats run at short intervals across the harbour to Stockton and Bullock Island. The Government has established a technical college and museum and 17 public schools, several of which have from 750 to 1100 pupils on their rolls. The Roman Catholic Church has 15 schools, some of which are of considerable size, and there are 11 private undenominational schools and colleges. There is a school of arts or mechanics' institute in the city and in each suburb: the Newcastle School of Arts is a handsome building, with a library of 15,000 volumes, fine reading-room, lecture-hall, and class-rooms. There is a large hospital for the insane, two general hospitals subsidized by the state, and the Wallsend Hospital. There are also several subsidized charitable institutions. The Victoria Theatre was erected in 1891, at a cost of £20,000. The Anglican Cathedral of Christ Church, in course of erection, will cost £20,000. Several of the other churches are handsome buildings. Amongst other prominent public buildings are the Law Courts, the School of Mines and Trades Hall, and the Post and Telegraph Office, all excellently designed. The municipality has provided excellent salt-water swimming-baths in Newcomen Street. The town and harbour are defended by Fort Scratchley, on Allan's Hill. The climate is not unlike that of Sydney, except that it is a little hotter and there is a somewhat smaller rainfall. The mean temperature is 64·6°, the mean summer temperature being 72·4°, and the mean winter 55·5°. The highest recorded temperature over a long series of years was 107·5°, and the lowest 31·3°. The average rainfall is 48 inches per annum, and the number of rainy days 128. (T. A. C.)

Newcastle, a city in the western part of Pennsylvania, U.S.A., capital of Lawrence county, at the junction of the Shenango and Neshannock rivers and at the intersection of five railways; altitude 814 feet. It is in the coal-mining region, and has extensive paper, glass, iron, and steel works, including blast furnaces and machine shops. Population (1890), 11,600; (1900), 28,339, of whom 5324 were foreign-born and 463 negroes.

Newcastle-on-Tyne, a city of Northumberland, England, 273 miles north-north-west of London by rail, on the river Tyne, 8 miles from its mouth, with stations on the North-Eastern Railway and branch lines. The central station has received very extensive additions, and is connected with the south by a new railway bridge, and with the Blyth and Tyne station by an underground line. Population (1881), 146,000; (1891), 186,300; (1901), 214,803; but in 1899 the area was increased largely east and west—following the course of the river—to 5400 acres. The rateable value of the union increased from £715,000 in 1881 to £1,279,713 in 1901. Newcastle is the largest undivided parliamentary constituency in the United Kingdom, returning two members, with 35,983 voters. The government is vested in a mayor, 16 aldermen, and 48 town councillors. In 1899 there were 7780 births, 4887 deaths, and 2280 marriages; the birth-rate was 31·6 per 1000, the death-rate 20·9 per 1000. The water-supply is in the hands of a company. The reservoirs have a water area of 854 acres and a capacity of 5,051,316,362 gallons, providing for 500,000 people. A gas company (rate, 2s. per 1000 cubic feet) and two electric light companies light the town. A system of electric tramcars is in operation. The corporation has organized an excellent police force and fire brigade, and established baths and wash-houses in populous districts. Clubs for working men, of which there are seven, are an interesting social feature. Very few of the old buildings remain. The Castle, Black Gate, and some Elizabethan houses on the Side and Sandhill are all that point to bygone days. Of churches, the cathedral of St Nicholas has been improved at a cost of £20,000; especially fine are the choir-stalls, chancel, and alabaster reredos. St George's, Jesmond, built by the late Mr Charles Mitchell, is a landmark for miles around, and is celebrated for its beautiful interior. Four other new Established churches have been erected, and the Nonconformists have also built many places of worship, especially in Jesmond, now the chief residential quarter. Among scientific institutions may be mentioned the Literary and Philosophical Society, the buildings of which, after being burnt down in 1893, have been restored and extended; the Antiquarian Society; the Mining Institute; the Natural History Museum; and the Tyneside Geographical Society. The Public Library has been in existence since 1880, and two branches have been established in populous suburbs. The total number of volumes, including patents, is over 110,000, with issues to the extent of 4,840,000 a year. In the news-room there were, in 1882, 420,000 readers; in 1899, 1,550,000. Educational work has made great advances. The University of Durham has its colleges of medicine and science here. In the former, degrees in medicine and surgery are granted; in the latter, with which the school of art has been incorporated, degrees in science and literature. Both carry on their work in buildings replete with modern scientific apparatus. The Rutherford College and the Commercial Institute provide excellent technical and commercial education. The Royal Grammar School is being removed to new buildings in Jesmond, where there are also two public day-schools for girls. The school board has accommodation in its 21 schools for 23,036 children. The cost per head is £2, 11s. 7¾d., and the rate 10d., as compared with an average rate of 10¼d. in the country (London included). There are also several voluntary schools, with seating for 15,762. The Royal Infirmary (1751) is being housed in a new building, to the cost of which the public subscribed £100,000, the late Mr John Hall £100,000, and Mr Watson-Armstrong £100,000. The hospital for sick children, Moor Edge, and the eye infirmary are additions to the charities of the town. The Theatre Royal in Grey Street was destroyed by fire in 1899 and the Vaudeville Theatre (the old art gallery) in 1900. Of open spaces there are the Town Moor, Castle Leazes, Nun's Moor, and recreation ground (1269 acres); and six well-laid-out parks. The Elswick Works, founded by Messrs Armstrong in 1847, have been largely extended, particularly since the amalgamation with Mitchell and Co., the shipbuilders; and the construction of ships of all sorts, including the largest ironclads with all their armour and guns, is now carried on. Shipping business is centred in the quayside, where every facility for loading and unloading ships is provided. A large grain warehouse is at the east end of the quay, from which ships run to all parts of the world. The new exchange is in the Guildhall. As regards trade, the vessels that go right up to Newcastle are often claimed at North or South Shields. Any statistics issued for Newcastle alone in this connexion would in consequence be misleading, and the figures given below are therefore those for the Tyne ports—Newcastle and North and South Shields. The shipping returns were as follows:—

Year	Number and Tonnage Vessels registered.		Number and Tonnage of Vessels entered and cleared, with Cargoes.				Quantities of Coal and Coke exported (tons).	
	No.	Tonnage.	No.	Tonnage entered.	No.	Tonnage cleared.	Coastwise.	Foreign.
1880	1030	373,055	6847	1,740,979	16,307	5,860,224	2,974,705	5,159,624
1890	810	390,065	6110	1,780,241	14,740	7,222,145	3,874,955	5,791,802
1898	844	512.799	5485	1,862,992	12,767	7,323,458	5,352,012	6,760,621

The following table gives the value of imports and exports:—

Year.	Total Imports.	Total Exports.	Exports of Coal and Coke.
1880	£8,505,156	£5,110,457	£2,041,175
1890	8,100,031	7,711,649	4,497,002
1898	8,959,906	5,688,769	3,122,006

The figures of the exports and imports of the Tyne for 1899 show a general increase in the trade of the port. Coal exports show an increase of 149,963 tons over the figures of 1898. General exports show an increase of 13,300 tons, most countries showing increases except Italy and the Netherlands. Chemicals, especially sulphate of soda, caustic soda, were exported in larger quantities in 1899 than usually. Pig-iron, iron-work, steel, iron bars and plates, castings and machinery, fire-clay goods, and copper were largely exported. The chief imports are fruits, wheat, maize, oats, barley, iron and steel, petroleum, sulphur ore, timber and wood hoops, iron ore, potatoes. The value of imports in 1899 was £8,139,700. In 1899, 1235 British and 1711 foreign ships entered the port. (H. SH.)

Newcastle-under-Lyme, parliamentary and municipal borough of England, in the county of and 16 miles north-west from the town of Stafford, and 147 miles by rail north-west of London. Within the last few years the town has been greatly improved, the main streets have been rearranged and widened, and several handsome public buildings have been erected, notably the new town hall and the high school. It has industries of brewing and paper-making. Down to 1885 the town returned two members to Parliament, but since that date only one. Population (1891), 18,452; (1901), 19,914.

Newchwang, a treaty port at the head of the Gulf of Pechili, China. It has shown considerable vigour as a port of trade, sharing in the general prosperity of the province of Manchuria, of which it is the outlet. In 1898 the value of the trade was £4,634,470; in 1899, £7,253,650; and in 1900, £3,418,400 (when trade was disorganized by the Boxer rising), as compared with £1,850,000 in 1881. The principal exports (42·7 per cent.) are beans, bean-cake and bean oil, and wild silk. Of imports (57·3 per cent.) the principal are cotton yarn and cotton cloth, most of the latter being drawn from the United States in preference to English-made goods. The population of the town is estimated at about 60,000, and the number of resident foreigners is about 150. Railways connect the port with Tientsin and Peking on the one hand, and with the Russian territories lying to the north on the other. In 1895 Newchwang was occupied by Japanese troops, and the town was included in the cession of territory originally granted by the treaty of peace. By a supplementary convention it was retroceded by the Japanese under pressure of France and Russia. (See also CHINA.)

Newcomb, Simon (1835-——), American astronomer, was born in Wallace, Nova Scotia, on 12th March 1835. He became a resident of the United States in 1853, and graduated at the Lawrence Scientific School of Harvard University in 1858, having paid special attention to mathematics and astronomy. He assisted in the preparation of the American *Nautical Almanac* for 1857. In 1861 he became professor of mathematics in the United States navy, and was put in charge of the great 26-inch equatorial erected at Washington Observatory in 1873. In 1877 he was appointed director of the American *Nautical Almanac*, a post which he held until March 1897. In 1894 he became professor of mathematics and astronomy at the Johns Hopkins University, continuing, however, to reside at Washington. He was also editor of the *American Journal of Mathematics* for many years. In view of the wide extent and importance of his labours, the variety of the subjects of which he treats, and the unity of purpose which has guided him throughout, Simon Newcomb must be considered as one of the most distinguished astronomers of his time. A study of his works reveals an unusual combination of skill and originality in the mathematical treatment of many of the most difficult problems of astronomy, an unfailing patience and sagacity in dealing with immense masses of numerical results, and a talent for observation of the highest order. On assuming the directorship of the *Nautical Almanac* he became very strongly impressed with the diversity existing in the values of the elements and constants of astronomy adopted by different astronomers, and the injurious effect which it exercised on the precision and symmetry of much astronomical work. Accordingly he resolved "to devote all the force which he could spare to the work of deriving improved values of the fundamental elements and embodying them in new tables of the celestial motions." The formation of the tables of a planet has been described by Cayley as "the culminating achievement of astronomy," but the gigantic task which Newcomb laid out for himself, and which he carried on for more than twenty years, was the building up, on an absolutely homogeneous basis, of the theory and tables of the whole planetary system. The results of these investigations have, for the most part, appeared in the *Astronomical Papers of the American Ephemeris*, and have been more or less completely adopted for use in the nautical almanacs of all countries. A valuable summary of a considerable part of this work, containing an account of the methods adopted, the materials employed, and the resulting values of the various quantities involved, was published in 1895 as a supplement to the *American Ephemeris* for 1897, entitled *The Elements of the Four Inner Planets and the Fundamental Constants of Astronomy*. In 1867 Newcomb had published[1] an important memoir on the orbit of Neptune, which was followed in 1874 by a similar investigation of the orbit of Uranus.[2] About twenty-five years later the tables of

[1] *Smithsonian Contributions to Knowledge*, vol. xv.
[2] *Ibid.* vol. xix.

these planets were revised by him in view of all the observations which had accumulated in the meanwhile at Washington, Greenwich, Paris, and Cambridge. In the meantime the theory of Jupiter and Saturn had been thoroughly worked out by G. W. Hill, Newcomb's distinguished collaborator in the *Nautical Almanac* office, and thus was completed one important section of the work projected by Newcomb in 1877.

Among Newcomb's most notable achievements are his researches in connexion with the theory of the moon's motion. His first work on this abstruse subject, entitled *Théorie des Perturbations de la Lune, qui sont dues à l'action des Planètes*,[1] is remarkable for the boldness of its conception, and constitutes an important addition to theoretical dynamics. For some years after the publication of Hansen's tables of the moon it was generally believed that the theory of that body was at last complete, and that its motion could be predicted as accurately as that of the other heavenly bodies. Newcomb showed that this belief was unfounded, and that as a matter of fact the moon was falling rapidly behind the tabular positions. With the view of examining this question, he undertook the reduction of every observation made before 1750 which appeared to be worthy of confidence. In an elaborate memoir[2] he showed that the ancient solar eclipses described by Herodotus, Thucydides, and others, which seemed to require an increased value of the secular acceleration of the moon's mean motion to bring them into line with modern results, might safely be neglected, the ambiguity of the accounts in each case rendering uncertain either the totality of the eclipse or the place from which it was visible. In his investigation he employed the eclipses of the moon recorded in the Almagest, the Arabian eclipses between A.D. 800 and 1004, extracted from Caussin's translation of Ibn Jounis, the eclipses and occultations of Bullialdus, Gassendus, and Hevelius, of the French astronomers at Paris and St Petersburg, and of Flamsteed at Greenwich, and deduced a secular acceleration of $8''\cdot8$, agreeing very well with the theoretical value.

On taking charge of the 26-inch equatorial at the United States Naval Observatory, Newcomb devoted it almost exclusively for the first two years to observations of the satellites of Uranus and Neptune, being of opinion that it was better to do one thing well than many things indifferently. The results of these skilfully conducted observations were published in a memoir on *The Uranian and Neptunian Systems*.[3] From this research it appears that the orbits of all four satellites of Uranus are sensibly circular, and although no special search was made, he concludes that none of Sir William Herschel's supposed outer satellites can have any real existence. From the motion of the satellites he finds that the mass of Uranus is $\frac{1}{22600}$th of that of the sun, while for the planet Neptune he finds a mass equal to $\frac{1}{19380}$th of the sun, agreeing with the value previously found by him from the perturbations of Uranus within $\frac{1}{60}$th of its amount. As early as 1860 Newcomb communicated an important memoir to the American Academy,[4] *On the Secular Variations and Mutual Relation of the Orbits of the Asteroids*, in which he discussed the two principal hypotheses to account for the origin of these bodies—one, that they are the shattered fragments of a single planet (Olber's hypothesis), the other, that they have been formed by the breaking up of a revolving ring of nebulous matter.

In the *Astronomical Papers of the American Ephemeris* will be found a large number of contributions from Newcomb's pen on some fundamental and most important questions of astronomy. Among these are papers on *The Recurrence of Solar Eclipses, A Transformation of Hansen's Lunar Theory, Development of the Perturbative Function and its Derivatives*. His memoir *On the Motion of Hyperion, a New Case in Celestial Mechanics*, is in some respects one of his most original researches. He has discussed the transits of Venus of 1761 and 1769, and those of Mercury from 1677 to 1881. At the international conference, which met at Paris in 1896 for the purpose of elaborating a common system of constants and fundamental stars to be employed in the various national ephemerides, Newcomb took a leading part, and at its suggestion undertook the task of determining a definite value of the constant of precession, and of compiling a new catalogue of standard stars. The results of these investigations were published in 1899,[5] and have been in use since the beginning of 1901. In the intervals of these immense labours, on which his reputation as an astronomer will rest, he has found leisure for works of a lighter character, *e.g.*, his *Popular Astronomy* (1878), and his *Astronomy for Schools and Colleges* (1880), written in conjunction with Professor E. S. Holden. Since his retirement from official life he has published an excellent popular treatise on *The Stars, a Study of the Universe*. He has also written on questions of finance and economics.

He received the honorary degrees of D.C.L., Oxford, and Sc.D., Cambridge and Dublin. In 1872 he was elected an associate of the Royal Astronomical Society, receiving its gold medal in 1874. In 1877 he was elected a foreign member of the Royal Society, which in 1890 awarded him the Copley medal.

New Forest, one of the few woodland regions left in England, covering about 93,000 acres in the south-west of Hampshire, between the Solent, Southampton Water, and the river Avon. About two-thirds of it is Crown property, and is preserved more or less in its natural condition as open woodland interspersed with bogs and heaths. The trees principally represented are oak and beech, with some newer plantations of Scotch fir. The trees were formerly felled for building the ships of the navy, and for feeding the iron furnaces of Sussex and Hampshire. Pigs and a hardy breed of ponies find a good living in the forest; and in spite of an Act in 1851 providing for their extermination or removal, a few red deer still survive. Foxes, squirrels, otters, snakes (smooth snake, grass snake, and adder), butterflies (some of them peculiar to the district), and an occasional badger range the forest freely. The tract derives its name from the extensive afforestation carried through in this region by William the Conqueror in 1089; and the deaths of two of his sons within its confines—Richard killed by a stag, and William Rufus by an arrow—were regarded in their generation as a judgment of Heaven for the cruelty and injustice perpetrated by their father when appropriating the forest. About one-fourth of the area is under cultivation by private owners and tenants. The principal village within the forest is LYNDHURST (population, 2167 in 1901); its church contains a fresco by Lord Leighton; and there is the Verderers' Court, which since 1887 has had charge of the Crown portion of the forest. BROCKENHURST and BEAULIEU, the latter with the ruins of an abbey founded by King John, are the villages next in importance.

See J. R. WISE, *The New Forest* (4th ed. 1883), with over sixty engravings by W. J. Linton and a dozen etchings by H. Sumner; and BLACKMORE, *Cradock Nowell* (1866).

[1] *Liouville*, t. xvi. (1871), pp. 1–45.
[2] *Washington Observations*, 1875, Appendix II.
[3] *Ibid.*, 1873, Appendix I.
[4] *Memoirs of the American Academy*, vol. v. pp. 124–152.
[5] *Astronomical Papers of the American Ephemeris*, vol. viii. pts. i. and ii.

NEWFOUNDLAND.

I. Geography and Statistics.

NEWFOUNDLAND, the oldest British colony, and the nearest part of North America to Europe, occupies very nearly the same geographical position relative to the east coast of the New World which Great Britain does to the west coast of the Old, but lies rather farther south. The area of the island, which has a greatest length from north to south of 350 miles, and an average breadth of about 130 miles, is estimated at 40,200 square miles. The population in 1891 was 197,934; in 1901 it was 216,615. In 1900 the marriage-rate was 8·63, the birth-rate 31·42, and the death-rate 16·78 per 1000. There is a steady flow of emigrants to Canada and the United States. Including 3634 persons in that part of Labrador (120,000 square miles) over which Newfoundland exercises jurisdiction (see Labrador), the total population of the colony in 1901 was 220,249. Of these 76,259 were Roman Catholics, 72,650 Episcopalians, 60,812 Wesleyans, and 10,528 members of other denominations, including 6516 of the Salvation Army. Education is purely denominational, with all the defects of such a system. Each religious body receives its own separate grant and has its own inspector. In 1899 the number of schools of all kinds was: Roman Catholic, 316, with 288 teachers; Church of England, 243, with 240 teachers; Methodist, 206, with 203 teachers. Of these, the total number aided in 1898 was 662, with 28,397 pupils; and the total expenditure, including Government grants, fees, &c., was $176,345, or about £35,260. The attendance at Roman Catholic board schools in 1899 was 12,949; at Church of England, 11,373; at Methodist, 9459; giving a total of 33,781. At the colleges of the Roman Catholic, Church of England, and Methodist bodies there were 244, 199, and 452 students respectively. There is a General Council of Higher Education, on which all the denominations are represented, and which holds examinations, grants prizes, &c. A sum of about £800 is placed at its disposal annually. Much good work has been done by this body.

The administration underwent little change in the last quarter of the 19th century, and is still in the hands of a Governor appointed by the Crown, an Executive Council (increased to 9 members at the end of 1900), a Legislative Council, which must not exceed 15 members, and a House of Assembly, now consisting of 36 members elected, on a manhood franchise, from 18 districts containing (1897) 49,474 electors. The following table shows the revenue and expenditure in various years:—

	1885.	1890.	1895.	1901.
Revenue . .	£207,500	£300,000	£325,721	£402,000
Expenditure .	283,000	410,000	281,809	401,800

Of the revenue in 1899, as much as £322,000 was derived from the customs; loans provided £15,000, and the post office £11,000, these three practically supplying the whole of the revenue. The public debt in 1901 was £3,475,700, and no less than £135,000 of the expenditure went to pay the interest thereon. The other principal items of the expenditure were: public charities, £43,500; the post office, £43,000; education, £31,800; and the administration of justice, £26,800. There is no regularly constituted military organization, but a military police force numbers 150 men.

The mineral resources have been only very partially explored, but important discoveries have been made, and the island is now known to contain considerable deposits of iron, coal, and copper. Iron is distributed all over the island, but exceptionally large beds of ore have been found and are being worked on Bell Island, in Conception Bay on the east coast, and rich deposits have also been discovered on the west coast. Coal of excellent quality is found near St George's Bay and Codroy on the west coast, and in the Grand Lake district. Copper ores are at present the most valuable mineral product. In the eastern part of the island gold-bearing quartz rock and extensive deposits of silver and lead ore have been found. The Government geologist valued the total export of all minerals in the ten years 1888–98 at £1,614,500, in which total copper ore and regulus figures for £1,218,000, and iron pyrites for £314,000. The principal items in the output for 1898 were: copper ore and regulus, 66,798 tons, valued at £56,500; pyrites, 32,835 tons, valued at £33,000; and iron ore, 102,000 tons, valued at £21,000. These and smaller items brought the value of the total output up to £121,000.

The census of 1891 gave the following as the agricultural returns for the island:—

Improved land—acres	64,494	Turnips—barrels .	60,235
In pasture—acres .	20,524	Horses . . .	6,138
Wheat and barley—bushels . .	491	Milch cows . .	10,863
Oats—bushels . .	12,900	Other horned cattle .	12,959
Hay—tons . .	36,032	Sheep . . .	60,841
Potatoes—barrels	481,024	Swine . . .	32,011
		Fowl . .	127,420

Since that date there has been a marked increase in the extent of land farmed: a bonus of $20 per acre for cleared land has been offered by the Government, and the area under cultivation is over 100,000 acres. Compared with the neighbouring colonies, Newfoundland as an agricultural country is in a very backward state; but the soil on the east side of the island, where most of the inhabitants reside, and where the largest amount of cultivation is carried on, is far inferior to the land in the river valleys and on the west coast. Generally speaking, it is simply a thin gravelly loam. With abundance of manure, however, and a moist atmosphere, it produces wonderful crops of hay, oats, barley, potatoes, and turnips. On the west coast, especially in Codroy valley and round St George's Bay, there is excellent land, and a good deal of farming is carried on by settlers of Scottish and French descent coming from Lake Breton. Everywhere in the island considerable tracts of land are reserved for cattle and sheep grazing.

In spite, however, of the development which has taken place in mining and agricultural industries, these are still overshadowed in importance by the *fisheries*. In 1891, 53,502 of the inhabitants were engaged in the fisheries of all kinds and subsidiary industries, using 1242 vessels of about 74,600 tons, and 20,000 boats. The deep sea or Bank fishery is engaged in by American, French, Canadian, and Newfoundland ships, to which two or three Portuguese schooners still add themselves. The American Bank fishery is a rapidly declining industry, though supported by such high protective duties that sea fish is excessively dear in the United States. In 1880 there were 200 American schooners engaged in the Bank fishery; in 1901 the number did not exceed 100, the average annual catch of which may be set down at 150,000 quintals. (A quintal is one-twentieth of a ton.) Many of the American schooners combine halibut fishing with trawling for cod. The French Bank fishery, which once employed over 10,000 men, is also declining, notwithstanding the enormous bounties and prohibitory duties by which the industry is bolstered up. 108 vessels now come from France every year, and 187 from St Pierre, the total number of men employed being something under 5000. In good years the catch may be set down at about 350,000 quintals.

British ships from Canada and Newfoundland at one time prosecuted the Bank fishery to a very large extent, a large bounty being allowed from the Imperial funds. After this bounty was discontinued the industry rapidly declined, and though it revived for a period during 1880–1900, it has again fallen off. The annual Canadian catch on the Banks and off the coast of Labrador is about 100,000 quintals, but only about sixty vessels from Newfoundland, employing 900 men, are engaged on the Banks, and the average catch per schooner is about 1000 quintals. In short, the Bank fishery is not at all in a flourishing condition. Though productive, it is attended by heavy expenses, and the loss of human life is every year very great, the Americans alone losing from seventy to a hundred hands annually. The mainstay of the fisheries is, however, the shore fishery, prosecuted all round the coasts and off the coast of Labrador, for the total quantity of cod-fish caught annually in Newfoundland waters by ships of all nationalities amounts, on an average, to 2,500,000 quintals of the value of from £1,800,000 to £2,000,000, and in this total the Newfoundland catch figures for no less than £1,200,000. Thus, though the total value of the catch of cod-fish has decreased, owing to the decline in the Bank fishery, by about one-third, the value of the Newfoundland catch has remained fairly constant. Statistics for particular years, however, fluctuate greatly, the fisheries being largely affected by wind and weather and ice on the coast. The fish caught round the Newfoundland coast are generally of good quality, but the Labrador cure, owing to the short season, is often very inferior. The winter herring fishery, though quite subsidiary to the cod fishery, is a considerable industry, the principal share in which during the past few years has fallen to Placentia Bay. As soon as caught the fish are frozen and shipped to the United States and Canada. The tinned lobster industry has grown considerably, nearly 3,000,000 pounds weight being exported in 1898, of the value of £127,750, but in 1899 the catch was 50 per cent. short. Since 1880 the question of French rights on the west coast has become one of great importance (see below, *History*). It is only necessary to state here that the French, whose fishery on the west coast is insignificant, are not allowed by the Bait Act of 1888 to obtain bait from Fortune Bay, and that the British, by the *modus vivendi* of 1890, since renewed at intervals, are not allowed to increase the number of their lobster factories on the west side of the island.

SKETCH MAP OF NEWFOUNDLAND.

The artificial hatching of cod and lobster, started by the Government in Trinity Bay, has been a great success as a scientific experiment, but economically a complete failure. Whale fishing, once carried on extensively, has been successfully revived. Seal fishing is now engaged in almost exclusively by steamers. The seasons are regulated by strict laws: no steamer can sail before 10th March; no seals can be killed before 12th March or after 1st May; only one trip is allowed. The catch fluctuates greatly, varying from 297,000 (1895) to 190,262 (1898). The inland salmon fishery, owing to neglect, is only valued at a little over £12,000 annually. More attention is now being paid to this subject, however, and there is already manifest improvement. Sea trout and brook trout abound. Latterly Lochleven and the Californian rainbow trout have been introduced and are flourishing. The principal manufacturing establishments are at St John's. In the island generally there are about half a dozen large lumber mills and fifty smaller ones;

340 lobster factories scattered round the coast; oil factories for making seal oil, cod oil, and cod-liver oil; a large factory for the manufacture of fish guano, and one large pulp factory. The value of these and the fourteen chief establishments in St John's is estimated at over £184,000; their annual production is valued at nearly £300,000. Altogether they give employment to about 6350 persons.

The following table shows the annual value of the imports and exports at various intervals:—

	1885.	1890.	1895.	1901.
Imports .	£1,395,500	£1,313,500	£1,233,233	£1,520,000
Exports .	948,700	1,258,000	1,364,011	1,672,000

The chief imports and exports in 1899 were:—

Imports.		Exports.	
Flour (415,738 brls.) .	£300,472	Dried cod . . .	£913,362
Textiles, apparel .	235,205	Cod oil . . .	53,880
Salt pork . . .	70,298	Seal skins . . .	28,062
Molasses . . .	45,731	Seal oil . . .	51,788
Hardware . . .	52,326	Lobsters (tinned) .	116,170
Tea	32,598	Herring (pickled) .	34,183
Butter . . .	22,411	Copper and ore .	59,974
Leather . . .	32,135	Iron ore and pyrites .	66,302

Of the imports, the value of £397,607 came from Great Britain; £429,060 from Canada; £396,336 from the United States. Of the exports, the value of £296,561 went to Great Britain; £111,313 to Canada; £164,311 to Portugal; £393,055 to Brazil; £127,408 to the United States. The total number of vessels registered at St John's in 1890 was 2207 of 98,619 tons; in 1899 the total number registered in the whole colony was 2441 sailing vessels of 98,742 tons, 37 steamers of 8426 tons; total, 2478 vessels of 107,168 tons. The total tonnage of vessels entered and cleared in 1890 was 634,147 (590,006 British); in 1899 the total was 1,241,490 (1,045,572 British).

There are still only about 750 miles of postal roads and 1700 miles of district roads maintained. Railways have been greatly developed, however, north and west from St John's. A transinsular railway with various branch lines has been completed, and in 1899 there were in all 638 miles of line open. Communication between various points on the coast and between the island and the mainland is maintained by a fleet of eight first-class steamers, each of which connects with some central point on the railway. In 1899 there were 1314 miles of telegraph line open, running north and west from St John's; cables start for Europe from Heart's Content and for Canada and the United States from Placentia. The telegraph lines were given back to the Government in 1902. Throughout the greater part of the year there is regular communication between St John's and Liverpool. By various contracts the Government has made concessions to private enterprise, embracing the working of the Newfoundland Railway; mail contracts for bays, coasts, &c. (with an annual subsidy of £19,150); land grants extending to 5,000,000 acres; the graving dock at St John's; and the electric railway in the streets of St John's. There were in 1902 in St John's a Government savings bank and three Canadian banks, one of which has a branch at Harbour Grace. Before the bank crash of 1894 there were over 5000 depositors and over $2\frac{1}{2}$ millions of dollars in the savings bank; now there are 3000 depositors and about $1\frac{1}{2}$ millions of dollars.

See PROWSE. *History of Newfoundland from the Records*, 2nd ed. London, 1896. (Contains a very full bibliography.)—Dr HARVEY. *A Handbook and Tourist's Guide*, 1895. (Also, an excellent account of caribou shooting by Dr Davis.)

(D. W. P.)

II. HISTORY.

French Shore question.

Since 1884 the island and its affairs have been more prominently before the British public than at any previous period in its history. This prominence has been altogether out of proportion to its population, wealth, or developed resources, being largely concerned with the revival, in a new form, of that ancient dispute with France known as the "French Shore" question. In 1884 a convention which had been arranged between the British and the French Governments was submitted to the colonial administration by its promoters, Sir Clare Ford and Mr E. B. Pennell, C.M.G., but without commanding the support of the Newfoundland Government. In the year following, on a change of ministry in the colony, the Ford-Pennell convention was, in a slightly amended form, again offered to the Newfoundland legislature, but the joint committee of the colonial House of Assembly and the Council absolutely refused to ratify the arrangement unless the French Government would consent either to annul or to amend the system of bounties paid upon French-caught fish in Newfoundland waters. At the same time, to counteract the effect of these bounties, which pressed very hardly upon the British competition, a Bait Act was framed and carried in 1886, empowering the executive to prohibit the capture in Newfoundland waters for exportation or sale of bait fishes, except under special licence to be issued by the colonial Government. The consequence of this measure, were its provisions properly enforced, would be to place an embargo upon the local supply of bait requisite to the French fishermen—the so-called "metropolitan fleet"—on the Grand Banks. Upon being apprised of this enactment, the French Government immediately demanded that Great Britain should deny its sanction to this Newfoundland Bait Act, and pressed their objections with such persistence as to induce Lord Salisbury to disallow the measure. Nevertheless, the despatch of the governor, Sir William Des Voeux, to the colonial secretary, Sir H. Holland, was so entirely in favour of the principle of the Bill that the Newfoundland authorities became imbued with a fixed determination to urge forward the measure for Imperial acceptance.

In 1887, therefore, a delegation consisting of Sir Robert Thorburn, the Premier, and Sir Ambrose Shea visited England at a moment most propitious for obtaining the sympathy and support of the Imperial Government and the press and people of the mother country, it being the jubilee year of Queen Victoria's accession to the throne. A conference of colonial premiers was one of the notable events distinguishing that happy period, and the subject was argued before the conference at considerable length. The claim set up by the senior colony "to control and legislate for her own fisheries" met with general approval, the single dissentient being the representative of Canada, who feared that Canadian fishermen would suffer under the Bill. When an assurance was tendered that Canada's fishermen would be placed upon the same footing with those of Newfoundland, the British Government somewhat reluctantly sanctioned the Bait Act. The stipulation was made, however, that it should not be enforced until the spring following (1888). In the meantime the chagrin of the French Foreign Office at the failure of the Ford-Pennell negotiations, and the hostile attitude taken up by the Newfoundlanders in what they deemed to be the conservation of their interests, induced M. de Freycinet to devise retaliatory measures. Instructions were issued "to seize and confiscate all instruments of fishing belonging to foreigners, resident or otherwise, who shall fish on that part of the coast which is reserved to our use." Lord

Rosebery, then Foreign Secretary, protested to the French ambassador against the spirit of these instructions, which he insisted were in direct contravention of the treaty, inasmuch as they ignored the concurrent as well as those sovereign rights of Great Britain which France solemnly undertook by the treaties never to question or dispute. Nor were other opportunities soon wanting to the French to retort severely upon the Newfoundland authorities for their passage of the Bait Act, as well as to repair in large measure the injury which that Act promised to inflict upon the French industry. About 1874 a Nova Scotian named Rumkey had established the first factory for the canning of lobsters on the west coast. This concern proving profitable, others sprang up, until, at the close of the season of 1887, Captain Campbell, R.N., reported that twenty-six factories were at work, employing about 1100 hands. It was at that time understood that this was an industry which, by the very nature of the process and the permanent shore structures it involved, the French were disqualified from pursuing. So clearly was this recognized that in 1886, when Commander Browne of H.M.S. *Mallard* reported the existence of a French lobster factory at Port-aux-Choix, a substantially-built structure, roofed with corrugated iron, the French authorities conceded that the establishment was in violation of the treaties, and issued orders for its removal. But this conciliatory policy was of brief duration. The year of the Bait Act's first successful application was marked by the stoppage, by order of the French Government, of Messrs Murphy and Andrew's lobster factory, and by their contention that the lobster-canning industry formed a part of the privileges conceded under the treaties to the French, whose participation by the British fishermen would be forcibly resisted.

An exchange of notes took place between Lord Salisbury and M. Waddington, the French ambassador, in which the latter expressed an opinion which evoked a spirited protest on the part of the British Foreign Office. "France," it was then declared, "preserved the exclusive right of fishing she always possessed. This right of France to the coast of Newfoundland reserved to her fishermen is only a part of her ancient sovereignty over the island which she retained in ceding the soil to England, and which she has never weakened or alienated." This claim of the French to an exclusive fishery was held to be wholly untenable, and their classification of the lobster catching and canning industry as amongst the "fishing" privileges granted them by the treaty was denounced as contrary to both letter and spirit of that instrument. Notwithstanding this, the French agents on the Treaty Shore clamoured for the removal of several of the British factories, which (it was declared) interfered with the exclusive fishing rights of the French. The French Government also voted (1888) a special bounty for the establishment of lobster factories by their subjects on the Treaty Coast. Pending a settlement, the British Foreign Office deemed it expedient, in order not to give offence to France, to invest the French claims with a semblance of right by issuing instructions to British naval officers on the North American station to continue to interpret and enforce the treaties with regard to the Newfoundland lobster-canning industry on the same terms as they had done hitherto with regard to the cod-fishery. Acting under a statute passed in the reign of George III. empowering British naval officers to interpret and enforce the treaties, Sir Baldwin Walker and others proceeded to destroy or remove a number of British factories at the request of the French agents. In 1890 the unexpected discovery was made that the Act empowering British naval officers to enforce the provisions of the treaties with France had expired in 1832 and had never been renewed. Consequently all the proceedings of which the colonists had been the victims were illegal. One of them, Mr James Baird, immediately took proceedings against Sir Baldwin Walker in the Supreme Court, which decided in his favour, mulcting the admiral in $5000.

On an appeal to the Privy Council the decision was upheld. But before this incident had taken place, the controversy between London and Paris culminated in the *modus vivendi* of 1890, by which the lobster factories, both British and French, which were in existence on the 1st July 1889, were to continue for the present. Instantly the colony took alarm, and a deputation consisting of the island's leading men was sent to England to protest against both the principle and practice of such an arrangement. On their return they learnt that it was the intention of the Imperial Government to re-enact *verbatim et literatim* the Act for the enforcement of the treaties which had expired fifty-nine years previously. To prevent such an occurrence, delegates from both parties in Newfoundland visited London in April 1891, and, appearing at the bar of the House of Lords, promised that if the measure which was then on the eve of being introduced into that body were withdrawn, a temporary measure would be passed by the Newfoundland legislature which would answer the same purpose of enabling Great Britain to carry out her treaty obligations with France. The hope then generally entertained was that the whole question of French rights in the colony would soon be the subject of definite negotiations looking to their total extinguishment. That hope was, however, not speedily realized. For a number of years the *Modus Vivendi* Act was annually passed by the legislature, each year under protest, the conviction gaining strength in the colony that the Imperial Government was averse from renewing negotiations with France.

In 1898 the Colonial Secretary, Mr Chamberlain, yielding to the urgent requests of the senior colony, despatched a commission consisting of Sir John Bramston and Sir James Erskine, with Lord Westmeath as secretary, on a tour of investigation throughout the Treaty Shore; and the report which the royal commissioners made (though not published) touched all points of the unhappy dispute. Again, in 1901, on a suggestion put forward by the colony, Mr Chamberlain summoned Mr Robert Bond, the Newfoundland Premier, and Hon. E. P. Morris to London, for a new conference on the French Shore question, in which Lord Lansdowne, the Foreign Secretary, participated. Nothing came of this, however. Some months later, on the occasion of the visit of the Prince and Princess of Wales, Mr Bond received the honour of knighthood. In 1902 the Legislative Assembly of the colony again, under protest, passed the *Modus Vivendi* Act.

Another great source of interest in Newfoundland was the Reid contract. This instrument was itself the sequence of a period of ambitious railway development in the colony, which dates from 1880, when a line from St John's to Hall's Bay was projected, and begun in the following year. In 1885 the construction of a line, 27 miles in length, from Whitbourne to Placentia, the old French capital, was begun and finished in 1888. Shortly afterwards it was decided to resume the line northwards from St John's to Hall's Bay, which, owing to the failure of the contractors, had been discontinued, with a view ultimately to a transinsular railway. Tenders were invited; one was accepted from a well-known contractor, Mr R. G. Reid, of Montreal, and the work commenced in October 1890. But before the contractor had proceeded far with the Hall's Bay line a new survey was made, and another route determined for the proposed transinsular railway, westwards from the Valley of the Exploits, which was regarded as much more favourable than the one originally contemplated. It traversed the Exploits and Humber valleys, passing through the most fertile territory in the island, to the Bay of Islands on the west coast; from hence it skirted St George's Bay and the Codroy valley, and terminated at Port-aux-Basques, a commodious harbour 93 miles distant from Sydney, Cape Breton. The new route was chosen, and a contract signed on 16th May 1893, whereby the contractor was to be paid $15,600 per mile in Newfoundland bonds, the whole line to be completed in three years. At the same time, in order to provide for the working of the line, it was agreed between the colonial Government and Mr Reid that the latter should maintain and work it, as well as construct a system of telegraphs, for a period of ten years from the 1st September 1893 at his own expense, in consideration of a "grant in fee simple to the contractor of 5000 acres of land for each one mile of main line or branch railway throughout the entire length of the lines to be operated." Should the line, therefore, be 500 miles in length, the land grant would be 2,500,000 acres, to be situated on each side of the railway in alternate sections of one or two miles in length with the railway, and 8 miles in depth, the colony also retaining an equal amount of land with the contractor along the route. Much hostile criticism was subsequently directed towards this arrangement; but as the land was an undeveloped wilderness, valued even by the Newfoundland Government at only 30 cents an acre, and as Mr Reid announced his willingness to dispose of it in blocks at the same figure, its chief and perhaps its only value must be considered as lying in the possibilities of future development. In any case, the financial disasters which overtook the colony in the following year would probably have rendered the expense of working and maintaining the line a most burdensome one. So far, therefore, the Reid contract, apart from the vast amount of land it placed in the hands of the contractor, presented few extraordinary features. But in 1898 a new proposal was made by Mr Reid, under the terms of which he undertook to work all the railways in the island for a period of fifty years, free of cost to the Government, provided that, at the termination of the said period, the said railways should become his own property. He was also to receive a further concession of land to the extent of 2,500,000 acres on terms similar to those contained in the former contract. Mr Reid agreed to build and run seven steamers, one in each of the large bays, and one to ply in Labrador in summer, to provide an electric street railway for St John's, and also to pave a certain portion of the capital. The colony was to part with the telegraph system to the contractor, who was to acquire at a fixed price the Government dry-dock at St John's. On the other hand, to complete the bargain, $1,000,000 in cash was to be paid by the contractor to the Government within a year after the signing of the contract. This remarkable covenant, which was afterwards characterized by Mr Chamberlain as a transaction "without parallel in the history of any country," was nevertheless ratified by the legislature, and submitted to the governor, Sir Herbert Murray, K.C.B., for his approval. The governor declined to append his signature to the instrument, but upon its being referred to the imperial secretary of state, it was decided that the arrangement was one relating exclusively to the colony, and this being the case, that it would be "an unwarrantable interference with the rights of a self-governing colony" to disallow the measure. The Reid contract was therefore signed by Sir Herbert Murray, who relinquished his post early in 1898. Meanwhile considerable feeling had been manifested in the colony; numerous public meetings in support of the governor's action were held; and several petitions were despatched to England, but it was not until the spring of 1900 that Sir James Winter and his colleagues were forced to resign on account of the opposition which had been engendered. The general election brought a Liberal, Mr Robert Bond, into power; and he had hardly assumed office when the contractor approached the ministry with further proposals to convert his property into a limited liability company with a capital of £5,000,000 sterling, for which proceeding the consent of the legislature was necessary, under the terms of 1898. Mr Bond refused unless a modification of the contract was agreed to. The modifications demanded were: That the telegraphs should go back at once to the Government; that the land grants, which included a large amount of private property, should be readjusted so as to conserve the rights of those whose holdings had been confiscated; also, that it should be optional for the colony to take over the railways at the end of fifty years by paying back the sum of $1,000,000 with interest, the amount paid by Mr Reid to the colony; and a sum to be arrived at by arbitration for all improvements that may have been made on the property within the fifty years. After considerable dispute these terms were substantially agreed to, and the conversion into a company took place.

Reid contract.

The year 1892 was marked by a disastrous conflagration, which, on the 8th and 9th of July, partially destroyed the Newfoundland capital. Eleven thousand of the inhabitants were rendered homeless, and the loss proved to be upwards of $15,000,000, including the destruction of the fine English cathedral, built from designs of Sir Gilbert Scott. Since the fire the city of St John's has been rebuilt on a considerably improved plan. Commerce received a shock, but derived a salutary lesson from the bank failures which occurred in December 1894. The Union and Commercial Banks suspended payment, followed by the suspension of the savings bank, a Government institution. This at once lowered the credit of the colony abroad, and caused the utmost misfortune amongst all classes. There is little doubt but that a principal cause of the disaster was the vicious and dangerous system of credit which had been followed by the merchants in their dealings with the "planters" and commission merchants. The insolvent institutions were speedily replaced by branches of three prominent Canadian banks, and a loan of $1,000,000, procured in London by Mr Bond soon after the *débâcle*, served to tide the senior colony over its financial difficulties. Since that period a new era of prosperity has set in, and there is generally a moderate surplus of revenue over expenditure.

In politics, apart from the matters already alluded to, there occurred in 1893 the filing of petitions under the Corrupt Practices Act to unseat Sir William Whiteway and his colleagues, who had been successful at the general election of that year. The charges created no little interest in England, and the new Government was subjected to much unfair criticism, arising largely from a misapprehension of the political and administrative conditions in the colony. They were examined in detail by the Supreme Court, which finally pronounced them unsustained, and the Whiteway Government resumed office after a brief period of abdication. On the whole, it may be said that Newfoundland has passed the critical stage in her history. Between 1863 and 1900 it has been estimated that $12,000,000 worth of copper ore has been exported, and since 1898, when a discovery of iron ore made at Bell Island, Conception Bay, led to important and valuable results, the belief in the island's mineral resources, long ago entertained by geologists, received practical corroboration. Whether any portion of it will prove profitable for purposes of agriculture is a matter which will be settled when the interior has been inhabited and the capabilities of the soil put to the test on a larger scale than any that has yet been attempted.

In 1900 the British Admiralty, acting upon the repeated suggestions of Sir Charles Dilke and others interested in the manning of the navy, decided to initiate a branch of the Imperial Naval Reserve in the colony. The experiment proved a success; but in 1901 a difficulty arose as to paying the men, owing to the lack of any provision for that purpose in the Imperial Reserves Act under which they were enlisted. The colony was asked to bear the cost; its refusal was followed (1902) by the enactment of special legislation rendering the enrolment and maintenance of the reserves in Newfoundland a special Imperial undertaking. Several efforts have been made to induce Newfoundland to confederate with the Dominion of Canada, but the project has never met with any degree of favour with the electorate, and is not now discussed by either party at the general elections. Much of the disfavour with which confederation is regarded in the colony is said to be due to Sir John Macdonald's opposition on behalf of Canada to the Bond-Blaine commercial treaty, which was negotiated between an emissary from the Government of Newfoundland and Mr Blaine, then Secretary of State of the United States of America, in 1890, but which was subsequently disallowed at his request by the Imperial Government. It is, however, probable that the treaty would never have received the sanction of the American Senate. After the insolvency of the colony in 1894–95, a delegation was sent to Ottawa to see if it were possible to arrange terms of confederation; but Sir Mackenzie Bowell's Government objected to the assumption by the Dominion of the entire amount of Newfoundland's debt ($16,000,000), and the negotiations were abandoned. (B. W*.)

New Granada. See COLOMBIA.

New Guinea, the largest island (excluding Australia) in the world, lying between the equator and 12° S. and 130° 50′ and 154° 30′ E., separated from Australia by Torres Strait, and having the Arafura Sea on the south-west. Since 1884 extensive explorations have been conducted, chiefly in the portion of the country east of the 141st meridian, which have now supplied us with an accurate outline of its coasts and a largely increased knowledge of the geography of the interior. The additions to our information regarding its biology and ethnography have during the same period been perhaps still larger.

Physical Geography.—New Guinea was probably in Miocene times, if not later, united to the northern part of Queensland. The deeply indented shore of the Gulf of Papua forms the boundary of the subsided area between the two countries, and from it the land stretches out for 200 to 300 miles north and west on both sides of the Fly river in vast plains, little elevated above sea-level. From Cape Buru westwards precipitous limestone cliffs, several hundred feet high, face the sea and rise into forest-clad mountains behind. The northern extremity of New Guinea is all but severed from the mainland by the deep Macluer Inlet, running eastwards towards Geelvink Gulf, which deeply indents the northern coast. Southwards from Geelvink Gulf the north-east coast is more regular than the south-western. Off its coast-line, on the parallel of 6° S., lies the vast Bismarck Archipelago, of which Neu Pommern is the most important member; and, on the parallel of 10°, the D'Entrecasteaux Islands, with the Bennett group to their north-east; while stretching out from the south-east promontory of the mainland is the Louisiade Archipelago. The Great Barrier Reef of Australia can be traced more or less continuously round the Papuan Gulf and along the south-east coast to the extremity of the Louisiades. In a general way it may be said that on the west coast of New Guinea, from Cape Buru to the Louisiades, the sea is shallow, while on its steeper eastern side the water close in-shore is often too deep for safe anchorage. The islands on the southern margin of the Louisiade Archipelago are raised coral reefs, but the majority are mountainous, rarely, however, exceeding 3000 feet; all of them are richly forested, but of little agricultural value. The volcanic D'Entrecasteaux Islands are mostly larger, more elevated (the highest being 8000 feet), and stand in deeper water than the Louisiade group. To the east of Kiriwina (Trobriand) lies a small group of uniquely formed islets, each of which is completely surrounded by a steep forest-clad marginal rampart of coral 300 to 400 feet high, concealing a depressed inhabited central plateau.

Starting in the southern extremity of New Guinea from an abrupt face some 3000 feet high, and traversing its centre nearly parallel to both coasts, run high ranges of mountains, which, if not continuous, merge into each other in the same general direction. The Owen Stanley range —its highest summit, named by Huxley in 1850 Mount Owen Stanley, 13,120 feet—the Albert Victor mountains, the Sir Arthur Gordon range, and the Bismarck mountains form a backbone running northwards to unite probably with the westerly-tending Charles Louis range—its main summit 16,000 feet, the loftiest in New Guinea, terminating in a bluff at Cape Buru. Between this backbone and the two seas ramify other ranges, mostly of lower altitude, parallel mainly to the east and west coasts. The most important and best-known rivers are the Amberno, in the north, discharging by a wide delta at Point d'Urville; the Kaiserin Augusta, which, rising in the Charles Louis range, and entering the Pacific near Cape della Torre, is navigable by ocean steamers for 180 miles; the Ottilien, a river of great length, which discharges into the sea a short distance south of the last named; and the Mambare, navigable by steam-launch for 50 miles, which drains the eastern aspect of the Wasigororo mountains and enters the sea near the Anglo-German boundary. Below 8° S. the narrowness of the country precludes the existence of any very important rivers on either coast. The Purari, however, whose delta is 20 miles long by 20 broad, is navigable for 120 miles by steam-launch, while the Fly has been traversed by the same means for 500 and by a whale-boat for over 600 miles. The latter drains an enormous tract of country, which is so little elevated above the sea-level that it can never be of any agricultural or commercial value. West of 141° E. the geographical features of the coast, except in the region of Macluer Inlet and Geelvink Gulf, are very little known, and those of the interior even less.

Geology.—The geology has hardly begun to be seriously investigated. The mountains on the north coast of the northern peninsula are apparently of Tertiary limestones, and the central ranges of sandstones, slates, and volcanic rocks. In the north-west coal deposits occur. To the south of 8° S. we find crystalline volcanic rocks, limestones, and bedded sandstones. Mount Trafalgar is an active volcano. The D'Entrecasteaux, Kiriwina, and Louisiade islands, where they are not of upraised coral, are composed of crystalline volcanic rocks and lavas, micaceous schists, limestones, and slates. Fergusson Island clearly shows remains of extinct craters, and possesses numerous hot springs, saline lakes, and solfataras depositing sulphur and alum. In Murua (Woodlark I.) are quarries of the banded quartzite from which the best stone adzes found throughout south-east New Guinea are made. In Rossel Island (Arova) occur crystalline schistose and volcanic rocks, and in Misima (St Aignan) limestones and lavas in addition. Nearly all the rivers in New Guinea yield "colours" of gold, but only in the Louisiade Archipelago has enough been discovered to constitute the district a goldfield. No auriferous reefs have yet been found. Black magnetic iron sand covers the shore in Milne Bay. In the upper Fly and Purari ranges limestone and sandstones have been observed, with coal in the Purari sandstones. Mount Owen Stanley is composed, according to Sir W. Macgregor, of schist and diorite. In Hall Sound occur Miocene shells identical with those from the same series in Victoria and South Australia. In the Gira river the valuable metal osmiridium has been discovered. Mabadauan hill, on the west of the Fly river, is of granite, which occurs again in the Arfak mountains. No Palæozoic fossils are yet known, and of Mesozoic a few fragments only have been doubtfully assigned to the Upper Oolite or Lower Cretaceous. With these exceptions the oldest fossiliferous beds are of Pliocene age.

Earthquakes are rare on the mainland, but not infrequent in Bismarck and D'Entrecasteaux Archipelagoes.

Climate.—Since the mountains as a rule traverse the island parallel to its coasts, the eastern shores have far less rain than the western. The amount which falls, chiefly at night, varies from 30 inches on some parts of the coast to 130 at others, and to a far greater but unknown amount in the mountains. Throughout the dry or cool season the wind blows steadily and almost uninterruptedly (except for an hour or so forenoon and afternoon) from the south-east. The temperature has an extreme range of from 72° to 95° F., with a mean of about 80°. At an elevation of 3000 feet the climate is pleasantly cool; at 13,000 feet ice forms in the night, but disappears with the heat of the sun. No snow is known certainly to fall, though it is alleged to have been seen from the sea lying on the summits of the Charles Louis range. Fever is very prevalent on the coasts, and even in the interior at 2000 feet above the sea. Though generally of a mild character, it is persistently recurrent, and slowly saps and wears out the constitution; too often it is virulent and rapidly fatal.

Fauna.—New Guinea shares in the poverty in mammals of the Australian sub-region. Monotremes (2 species) and marsupials (4 families and 44 species) predominate, but are not abundant. Among the latter two genera, *Distœchurus* and *Dorcopsis*, are peculiar. A pig (*Sus papuensis*), a dingo, several species of mice (of which *Chiruromys* is a peculiar genus), a few squirrels, and a considerable number of *Chiroptera* (bats) inhabit the country. The island is specially remarkable for the number and beauty of its birds. The most recent lists record over 500 species as found in the Papuan area, and of these between 50 and 60 genera are peculiar to it. The birds of paradise, which are confined to the sub-region, give special celebrity to its fauna. Between 70 and 80 species have already been described, many of them the

New Guinea.

most gorgeously adorned, and others, such as the *Pteridophora albertisi*, the most wonderful of feathered creatures. They are absent from the Louisiades, but species occur in the D'Entrecasteaux Islands which have not been seen on the mainland opposite. The zoology of the Bismarck Archipelago is but little known. The species of birds so far described from it number 178 (referable to 38 families), of which 74 are peculiar to it, though closely allied to Papuan forms. It contains, however, no *Paradiscidœ*. The *Amphibia*, to which the sea is a barrier, are almost exclusively of Australian affinities. Turtles and tortoises are plentiful on the coast. *Ceratochelys insculpta* of the Fly river, a chelonian peculiar to New Guinea, is remarkable in having its nearest affinities (as have the Papuan tortoises) with South American species. Of the lizards, 3 of the 6 species of *Varanidœ*, 16 of the 30 *Scincidœ*, 8 *Geckonidœ*, and 8 out of the 11 *Agamidœ* are peculiar. Salamanders, toads, and frogs are numerous, and crocodiles abound. Only 4 genera and 5 species of snakes are peculiar to New Guinea, many of them poisonous. Butterflies, moths, and bees are very abundant, the former being remarkable for their size and splendid coloration; but these groups have not been exhaustively enough investigated to afford a correct idea of their number or their true affinities. Although the list of *Coleoptera* already known is long, it represents only a fraction of the species remaining to be discovered. The land molluscs show relationship with the Indian and the Malayan sub-regions; but many forms have here their centre, and have spread hence into Australia and the Pacific islands.

Flora.—Most of the foreshores of New Guinea are eucalyptus-dotted grass lands; in the interior dense forests prevail to a height of many thousand feet. Vast tracts of the country have been, however, deforested by fire, and these are covered by the tall ineradicable grass, *Imperata arundinacea*. So far the highest altitudes yet botanically investigated are those of the Owen Stanley range and the mountains in Kaiser Wilhelms Land, but of the flora of the highest range of all—the Charles Louis mountains—nothing is known. The vascular plants already described number about 1500 species. In the low and sub-mountainous lands the flora is a mixture of Malayan, Australian, and Polynesian forms. There are, according to Müller, twice as many palms known from New Guinea as from Australia. The alpine flora, commencing at 6000 feet, is specially characterized by its rhododendrons, pines (*Araucaria* and *Libocedrus*), and palms, by numerous superb species of *Agapetes* (*Ericaceœ*), and on the summits by an extraordinary association of species characteristically European (*Rubus, Ranunculus, Leontodon, Aspidium*), Himalayan, New Zealandian (*Veronica*), Antarctic, and South American (*Drymus, Libocedrus*). Good pasture grasses are numerous, but pasture lands are limited. The usual tropical food plants are cultivated. Tobacco has been found growing in the interior, and may be indigenous, as is in some districts the Kava pepper (*Piper methysticum*). At Dorey a cotton plant (*G. vitifolium*) grows wild, and is also cultivated.

The People.—So large an area of New Guinea remains unexplored that it is impossible, except approximately, to state the number of its inhabitants, but probably 600,000 is under rather than over the mark. The people are broken up into numerous isolated tribes differing greatly in feature, colour, and language. Ethnically they belong as a whole to what should be more correctly designated the Melanian race, whose remaining members are the African negroes, the Australians, and the Melanesians of the Western Pacific. The study of their languages and of their arts and customs—by Mr Ray and Prof. Haddon—has greatly aided in clearing up the tangle of their affinities. The interior would seem to be inhabited by the aborigines, for there is no evidence of there ever having been any other occupiers. Where they are absent from the coast they have been forced inland by various more powerful immigrants, by Melanesians from the western Pacific on the north, north-east, and south-east coasts, and by Malays on the north-west. The Papuan, who is shorter than the European, less well-built than the Polynesian, but taller than the Malay, is smooth-skinned and in colour sooty-brown—deeper than the Melanesian's—or even black. He has long arms, long thin legs, a small dolichocephalous head, prominent nose, high narrow forehead, and dark eyes. His hair is black and frizzled, worn generally in a mop, often of large dimensions, but sometimes worked into plaits with grease or mud. The Melanesian closely resembles him, but is lighter in colour, of stronger build, coarser in feature, and less prognathous. The Papuan scarifies his skin; the Melanesians, especially the women, practise tattooing; ceremonies at the initiation of lads into manhood and symbolic dances are practised among the former, but are unknown to the Melanesians, who, on the other hand, make pottery, a craft of which the Papuans are ignorant. The Melanesians have ousted the Papuans from the coasts of the Port Moresby region, Hood Bay, South Cape, Milne Bay, and East Cape, and occupy as well the Louisiade, D'Entrecasteaux, and Bismarck Archipelagoes. The stream of Melanesian immigration, in Mr Ray's opinion, passes from the westward round the north of New Guinea to the Bismarck Archipelago, the Solomons, and the New Hebrides, whence a reflex wave has stranded some of the people on its south-eastern shores and among its islands. The Papuan languages have nothing in common with the Melanesian; their great peculiarity is their extraordinary diversity—"one language agrees with another neither in grammatical details, in constructive particles, nor in vocabulary." They apparently belong to "separate linguistic stocks," but there is "no evidence connecting them with any others outside the limits of New Guinea, unless there be a connexion with Australia" (Ray). It is not surprising, therefore, that the speech of people of villages only a few miles apart is quite unintelligible to each other. In character and disposition the Papuan and the Melanesian are equally devoid of forethought or ambition; they are rude, boisterous, and full of fun. Though they have no idea of hospitality, and at times practise a species of cannibalism, connected with sympathetic magic, they are less savage, cruel, and treacherous than report makes them. They have really been kindly disposed and friendly, on their first contact, with Europeans; they are not of a quarrelsome disposition among themselves or generally, and they are amenable to discipline; they are affectionate to their children, and not infrequently commit suicide from grief on the death of a relative or friend. The Papuan's decorative art, which has been copied by the Melanesian, is eminently artistic.

The *constitution of society* is everywhere simple. The people live in village communities whose members appear to be more or less inter-related. There are no priests and no hereditary chiefs. Totemistic clans have been observed in Torres Strait, and on the Finsch and west coasts. Throughout the whole island chiefship is quite unrecognized, except on the Keriwina islands. Possessions, such as gardens, houses, pigs, &c., belong to individuals and not to the community, and pass to the owner's heirs, who differ in relationship in different districts. The land within certain boundaries belongs to the tribe, but a member may take possession of any unappropriated portion. There are certain degrees of relationship within which a man may not marry. In some districts he may not marry into his own village, or into his mother's tribe; in others he may select a wife from certain tribes only. Payment, or a present, is always made for a wife to her father, brother, or guardian (who is generally her maternal uncle). Presents are also often made to the bride. Except in the region where is found the communal-house, each family has its own house, or the young people may occasionally share the parent's. Polygamy is practised, but not frequently, and from the wife (or wives) there comes no opposition. The child belongs sometimes to the mother's, sometimes to the father's tribe. The woman is the household drudge, and does the greater part of the outdoor work, but the man assists in clearing new gardens and in digging and planting the soil.

It is impossible to say that there is any idea of *religion* in our sense among the people. They all believe that within them resides an invisible other self, or spirit, which, if it occasionally wanders for a hurried tour from its home in the hours of sleep, goes forth for good at death, to hover for some period at least round the scenes of its embodied life before departing to some lone island or inaccessible summit. This ghost acquires supernatural powers, which at any time it may return to exercise inimically to relations or acquaintances who offend it. Being timid and suspicious, the natives live in constant dread of the darkness of the night, and in traversing the forest depths or volcanic mountains, as at such times and in such places malevolent—never embodied—spirits love to be abroad. These are the spirits which, taking up their abode in a village, cause disease and death; and to escape from such attacks the inhabitants may have to fly the village for good, and, by dwelling scattered in the recesses of the forest for a time before choosing a new site, they hope to throw their enemy off their trail. Spirits of evil, but not of good, therefore require to be propitiated. The powers of nature—thunder, lightning, and storm, all supposed to be caused by evil and angry spirits—are held in the greatest dread. Under the category of religious observances may perhaps come those held previously to the departure of the great trading or *lakatoi* fleet: their tabu-proclaiming customs, their ceremonial and sacred initiation ceremonies for boys and girls on reaching puberty, when masks are worn and the "bull-roarer" swung, as also the harvest festivals, at which great trophies of the produce of field and forest are erected, preparatory to a big feast enlivened with music and dancing. In the north and north-east of New Guinea ancestor-worship is widely practised. Amulets are worn to ensure success in buying, selling, hunting, fishing, and in war, as well as for protection against evil. Circumcision is practised in some regions, although Mahommedanism does not exist.

The more virulent, intractable, and fatal forms of disease are considered the machinations of some evil influence, acting directly, or through the witchcraft of an enemy. The dead are disposed of in various ways. The body is either buried or laid underground for a time, and then disinterred and the bones cleaned and deposited in or near the deceased's dwelling or in some distant cave; or the body is exposed on a platform or dried over a fire, and the mummy kept for a few years. Sometimes the head and portions of the skeleton are preserved as relics. Little houses are frequently erected over the grave as a habitation for the spirit. Soon after death food is offered to the departed, and that he may have no wants, his earthly possessions, after being broken, are laid near his resting-place, so that they also, following their owner, may be ready to his needs. A widow must shave her head, smear her body with black and the exudations of the corpse, and wear mourning for a long time. If ever the dead require to be mentioned, they are referred to by some roundabout phrase, and never by name, for this might have the dangerous result of bringing back the spirit.

In regard to *food*, yams, taro, and sweet potatoes constitute in some districts the main food of the people, while in others sago is the staple of their diet. Flesh, forest fruits, and vegetables also form additions to their food. Maize and rice—which are not indigenous—are eagerly sought after, and are now being rapidly introduced into cultivation. Cooking pots, made at various parts of the coast, form one of the great exchanges for sago; but where such vessels do not reach, food is cooked by the women on the embers, done up in leaves, or in holes in the ground over heated stones. The sexes eat apart. In the interior salt is an article specially craved and appreciated. In the Fly river region, kava, prepared from *Piper methysticum*, is drunk without any ceremonial importance. Tobacco is indigenous in some parts, and is smoked everywhere, except on the north-east coast and on the islands, where its use is quite unknown. In some few districts a species of clay is eaten.

The architectural abilities and taste of the people are seen in their *dwellings* and *bridges*. In the north, the east, and south-west of the island immense communal houses are met with. In some districts the sexes live not apart but together in one of these giant structures, each family having a stall for itself. Communal dwellings on a much smaller scale occur at Meroka, east of the Astrolabe mountains. As a rule, elsewhere each family has its independent dwelling. In some parts of the north-east coast the houses are built on the ground, but oftener they stand on a platform or verandah raised on piles, with the ridge-pole projecting considerably at the gables so that the roof may cover it at each end. Under this shade the inmates spend much of their time; here their meals, which are cooked on the ground beneath the house, are served. In a few districts villages are built at a short distance off the shore, as a protection against raids by the inland tribes. The interior villages are frequently situated on hill crests, or a-top of steep-faced rocks as difficult of access as possible, whence a view clear all round can be had. Where such natural defences are wanting the village is protected by high palisades and by fighting platforms on high trees commanding its approaches. On the north-east coast many of the villages are tastefully kept, their whole area being clean swept, nicely sanded, and planted with ornamental shrubs, and have in their centre little square palaver-places laid with flat stones, each with an erect stone pillar as a back-rest. Excellent suspension bridges span some of the larger rivers, made of interlaced rattan ropes secured to trees on opposite banks, so very similar to those seen in Sumatra as to suggest some Malay influence.

The *arts of war* are more conspicuous than those of peace on one's first acquaintance with the Papuan, for every man carries with him some form of weapon (or at least did so till lately). His armoury consists of the bow and arrow (in the Fly river region, the north, and north-east coasts); a beheading knife of a sharp segment of bamboo; a shafted stone club—rayed, disc-shaped, or ball-headed (in use all over the island); spears of various forms, pointed and barbed; the spear-thrower (on the Finsch coast); and hardwood clubs and shields, widely differing in pattern and ornamentation with the district of their manufacture. In British New Guinea alone is the man-catcher (a rattan loop at the end of a handle with a pith spike projecting into it) met with. In the D'Entrecasteaux Islands the sling is in use. For war actualities the natives smear themselves in grotesque fashion with lime or ochres, and in some parts hold in their teeth against the chin a face-like mask, supposed to strike terror into the foe, against whom they advance warily (if not timidly), yelling and blowing their war-trumpets. The war canoe, which is a long, narrow dug-out outrigger, capable of holding twenty-eight men, is only a transport, for they never fight in it. Victorious warriors wear as insignia of their success large white *ovula* shells, or the beak of a hornbill suspended on their forehead. The conch-shell is the trumpet of alarm and call to arms. The vendetta—resulting, when successful, in the bringing back the head of the slain as a trophy to be set up as a house-ornament—is very widely practised.

The *arts of peace*, on closer knowledge of the people, are after all more conspicuous than those of war. Attention to attire is everywhere observable, notwithstanding that in some districts the men go practically in a state of nudity. Except in one or two localities (on the north-east and west), the women are invariably decently clothed, and they are the most modest and virtuous perhaps of any "savages." The male attire is little more—indeed, often less—than is necessary for our ideas of decency. With this and the head encircled by a coronet of dogs' teeth, and covered by a network cap or a piece of bark cloth, the septum of the nose transfixed by a pencil of bone or shell, and perhaps a shell or fibre armlet or two, the Papuan is in complete everyday attire. On festal occasions he decks his well-forked-out and dyed hair with feathers and flowers, and sticks others in his ear-lobe holes and under his armlets; while a warrior will have *ovula* shells and various bones of his victims dangling from ringlets of his hair, or fixed to his armbands or girdle. The women almost universally wear a longer or shorter petticoat of grass or palm fibre suspended from the waist, the rest of the body, except when in mourning, being uncovered. The adornment of their persons—the tattooing of the skin, and the ornamentation of their belongings by carving, burning, or inlaying (generally of high artistic excellence)—enters largely into the occupation of their lives. The building of canoes is done by all tribes, yet some districts are the seats of professional boat-builders of great skill, the most elegant and most serviceable craft coming from East Cape and the Louisiades. These boats are either plain dug-outs, with or without outriggers, or regularly built by planks tightly laced and well caulked to an excavated keel. The most remarkable, however, of their vessels is the "lakatoi," composed of several capacious dug-outs, each nearly 50 feet long, which are strongly lashed together to a width of some 24 feet, decked, and fitted with two masts, each carrying a huge mat sail picturesquely fashioned. On the deck high crates are built for the reception of some thousands of pieces of pottery for conveyance annually to the Fly river district to exchange for sago. The natives are keen hunters by pursuit and snare. Fishing is done from catamarans mainly, the fish being speared, seined in excellent nets, or driven (by beating the water) into weirs. Music is the great peaceful art of the people, and is diligently extracted from Pan-pipes, a Jew's-harp of the Papuans' own fabrication, and the flute; the music of ceremony and occasion, however, can be evoked only from the drum—always open at one end—tapped by the fingers. To the accompaniment of the drum, dancing—as a rhythmic but stationary movement of the feet or an evolutionary march—almost invariably goes, but rarely singing. All sorts of jingling sounds also are music to the ear, especially the clattering in time of strings of beans in their dry shells, and so these and other rattles are found attached to the drum, leg-bands, and many of the utensils, implements, and weapons. The natives have domesticated no animals except the dog and the pig; they seldom keep cage birds, and still more rarely fowls, unless where they have been influenced by Europeans or Malays.

History.—The surveys and reports of Captain Moresby in 1874 brought home to Queensland (and Australia generally) the dangers possible to her commerce were the coasts opposite to Torres Strait and the entrance to the splendid waterway inside the Barrier Reef to fall into the possession of a foreign power. By authority, therefore, of Queensland, the mainland of New Guinea, opposite her shores east of the 141st meridian, was annexed to that colony in 1883. But this action was disallowed by the British Government, as Yule's (in 1846) and Moresby's (in 1874) had been. Finally, however, in 1884 a British protectorate was authoritatively proclaimed by Commodore Erskine over the region "lying between the 141st meridian eastward as far as East Cape, with the adjacent islands as far as Kosman Island." In 1885, after Germany had established a trading company on the north-east coast, the two countries agreed to fix their boundaries through the then neutral areas of the country. The result of this was the assignation to Great Britain of the portion now known as BRITISH NEW GUINEA, lying between the extreme limits of 5° and 12° S. and 141° and 155° E. To Germany were assigned all the territory and islands to the north of the British boundary under the name of Emperor William's Land (KAISER WILHELMS LAND), while all to the west of the 141st meridian remained under its old flag as DUTCH NEW GUINEA.

BRITISH NEW GUINEA.—The colony as defined above has an area of about 90,000 square miles, and a population estimated at 350,000, of whom only 250 are Europeans.

Government.—The British Protectorate, with its seat of government at Port Moresby, was subsidized by the three Australian colonies of Queensland, New South Wales, and Victoria, and lasted, under the administration of two successive special commissioners (Major-General Sir Peter Scratchley and the Hon. John Douglas), till the 4th September 1888, when it was proclaimed by the first Administrator—afterwards Lieutenant-Governor—Sir William MacGregor, a possession of Queen Victoria. Its constitution is that of a Crown colony in association with Queensland. The Lieutenant-Governor is aided by an executive and a legislative council, and advised by a native regulation board. Justice is administered by petty sessions in the four magisterial districts into which the possession is divided, with a central court at Port Moresby having the jurisdiction of a supreme court, from which in certain cases an appeal lies to the Supreme Court of Queensland. Order is maintained by an armed constabulary force, under a European officer, of over 100 natives from different districts, whose members are found to be very efficient and trustworthy. Queensland guaranteed the colony £15,000 for ten years, but that sum is contributed to by Victoria and New South Wales as well as Queensland, so that all the three states have a voice in its administration. The expenditure has been kept more or less to the limit assigned, and the revenue, mainly derived from customs duties, is rapidly increasing to meet all needs. Only £5110 in 1895, it was in 1899 £11,683.

Commerce and Trade.—The making of mats, fishing-nets, shell ornaments, decorated gourds, and stone implements, and the manufacture of pottery, canoes, and sago, constitute the chief native industries, which are the subject of barter between different regions. European industries include gold mining, in which 500 miners, besides natives, are engaged (chiefly as yet in the Louisiade Archipelago, where, though small quantities of the metal are found alluvially over a wide area, no reefs have been discovered), and the bêche de mer and pearl-shell fisheries, which were formerly more productive than at present. Copra is naturally largely prepared, as cocoa-nut palms are very numerous, and are being every year extensively planted. A small amount of tortoise-shell is collected. The rubber industry is, according to Sir W. MacGregor, "important and promising." Species of *Palaquium*, the genus from which, in the Indian Archipelago, the best gutta-percha is obtained, occur on the hills, and from their cultivation there might in time be obtained a large revenue independently of European labour. Timber of economic value is scarce. Red cedar (*Cedrilla*) abounds in the riverine flats, but the quality is poor and commercially valueless; and oaks are plentiful, but the wood is coarse. Small quantities of ebony and sandal-wood are exported. "There can be no reasonable doubt that the sugar-cane, which is native and present in a great many varieties, sago, cotton, probably also indigenous and of exceptionally fine quality, will eventually be valuable" (MacGregor). The trade of British New Guinea is exclusively with the Australian colonies. Imports were valued at £72,286 in 1899–1900 (an increase of over £20,110 in the year), and exports (including the gold mines) at £56,167 (£68,500 in 1898–99). In foreign trade 112 vessels of 20,733 tons entered and 95 of 19,110 tons cleared; in the coasting trade 528 vessels of 13,221 tons entered and cleared. The postal movement in 1898–99 included 7767 letters, 2120 newspapers, and 640 packets. (H. O. F.)

GERMAN NEW GUINEA.—The German protectorate of New Guinea, so called after the island which contributes the greatest area, comprehends, besides the islands which are now commonly called the Bismarck Archipelago—viz., Neu Pommern, Neu Mecklenburg (New Ireland), with Neu Hannover and the Admiralty Islands (New Britain)—the Solomon Islands (Bougainville and Buka). There are besides nearly 200 smaller islands and islets scattered amongst their greater neighbours. The mainland district is designated Kaiser Wilhelms Land, for the physical geography of which see the introduction to this article.

Annexation.—New Guinea was annexed on the 16th November 1884, when the German flag was raised in Friedrich Wilhelm Hafen.

European Enterprise.—In 1884 New Guinea was absolutely wild, not a single white man living on what is now the German part. On the islands Neu Pommern (New Britain) and Mioko only two trading firms had their establishments; and on Neu Lauenburg (Duke of York) the Wesleyans had a mission station. After the annexation commercial enterprise set in at once, hand in hand with political administration. Now on the mainland and in the islands plantations have been established and tobacco and cotton have been successfully grown. Three German mission societies formed settlements on New Guinea, with a branch one on the Gazelle peninsula. The protectorate is included in the Universal Postal Union; each harbour has its post office, also a leading official with a number of assistants to control the natives and the revenue. It is divided into two districts with separate administrations, New Guinea and the Bismarck Archipelago; over both presides the governor, whose residence is Friedrich Wilhelm Hafen on New Guinea. A small police force of natives has been formed. In each district there is a registry of deeds and a court of law, and in New Guinea a court of appeal, of which the governor is president. A line of steamers plies between New Guinea, the Bismarck Archipelago, and Singapore. A special silver coin of rupee value has been introduced. The area of the protectorate is approximately 91,000 square miles. It is impossible to speak with any precision of the number of the population, but a density of 4 per square mile may not give too high a figure.

Statistics.—The revenue of New Guinea is derived from taxes, dues, and licences, and amounted on the 31st of March 1892 to about £3000; on the same rate, 1901, to £3750. The annual revenue is averaged at £5000, and the expenditure at £4200. The New Guinea Company was to receive £20,000 for transferring proprietorship to Government. The New Guinea Company imported in 1885, £37,145; 1890, £24,722; 1895, £21,915; 1899, £53,000; 1900, £36,600; and exported in 1895, £30,906; in 1899, £46,955; in 1900, £17,500. In 1895 there were 138 Europeans, 7 trading firms; in 1901 there were 301 Europeans, 6 trading firms, with 56 trading stations in various parts of the country.

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(J. VON P.)

DUTCH NEW GUINEA comprises all the western portion of the island. The boundary on the east, separating it from British New Guinea and German New Guinea, was finally settled in 1895. Starting from the south coast, it follows 141° 1′ 48″ E. up to the Fly river, which it mounts until 141° 1′ is reached, when it once more follows the meridian up to the north coast. The area of the territory is about 150,000 square miles, and the inhabitants have been conjectured to number some 200,000. A few missionaries have established themselves, but otherwise the Dutch have scarcely occupied their possession, which at present merely forms part of the residency of Ternate in the Moluccas. Dutch New Guinea has, however, better natural advantages than either the British or German possessions in the island, and should eventually prove of real value to the Netherlands.

Recent History.—The treaty concluded in May 1895 between Great Britain and Holland finally settled the new boundaries. Roughly speaking, that partition had allotted about 48·6 per cent. of the superficial area of New Guinea to the Dutch East Indian empire, 28·3 per cent. to Germany, and 23·1 per cent. to Great Britain. Dutch New Guinea now covers the western and, according to some authorities (see, *e.g.,* Guillemard, *The Cruise of the "Marchesa"*), the best half of the whole island. A great deal has been done since Wallace visited it in 1858 and stayed some months at Dorey in the north. At regular intervals the steamers of the Dutch Royal Steam Packet Company now call at Dorey and other points, whilst administrative posts have been established elsewhere in lieu of others previously attempted but abandoned. Nominally the sultan of Tidore (see MOLUCCAS) is still the suzerain of western New Guinea, but his authority is scarcely recognized, except on some few shores and adjacent islands, and practically Dutch New Guinea used to be administered partly from Ternate and partly from Timor, upon more peaceful lines than was the case when the rule of the Dutch in New Guinea largely consisted of the sending of a warship now and again to some distant island or bay to burn a *kampong,* to punish rebellious villagers, and thus assert or reassert Dutch authority, or that of the sultan, who is their vassal. In 1901, however, a more serious effort was made to establish some kind of government in the southern province of Dutch New Guinea, at Merawkay, where a small Dutch-Indian garrison was stationed with the professed object of preventing raids by bands of savages into the British territory near by. Such raids had been rather frequent, the invaders attacking the natives who live under British protection, burning their huts, murdering the men, carrying off the women and children as slaves, and returning scot free to their own haunts laden with booty. There is now also an assistant Resident at Merawkay, whose immediate chief is the Dutch Resident at Ternate, and who is the civil administrator of the province of southern Dutch New Guinea. Assistant Residencies have also been established at Manokvary in northern Dutch New Guinea, which has been formed into a new province, under Ternate, and at Fakfak, in western Dutch New Guinea, likewise created into a new province, also under Ternate. By 1902, therefore, Dutch New Guinea formed a new government, with its headquarters at Ternate, divided into the three provinces aforenamed.

A curious discussion arose in the Dutch States-General when the Government was seeking legislative sanction for the above measures, with a provisional credit to cover the first establishment expenses. It was seriously contended in one part of the House that, as eminent men of geographical and ethnographical science had settled the question, whether New Guinea belongs to Asia or Polynesia, in favour of the latter, a New Guinea colonization scheme could not properly be proposed and decided upon in a section of the Dutch-Indian budget. This budget concerned only the Asiatic possessions of Holland, not the Polynesian ones, and Dutch New Guinea must, consequently, have its own budget. Finally, the majority of the States-General, backed by Government, decided that New Guinea must still be reckoned to belong to Asia.

As the so-called "Wallace line" of demarcation—a name proposed by Professor Huxley and accepted by the scientific world since Dr Alfred Russel Wallace, the famous naturalist, first propounded it (October 1859) in the *Ibis*—has played a *rôle* in these discussions, it is well to point out that this line is entirely a zoological boundary, and does not apply at all to the geographical distribution of man. Wallace's line of demarcation, which runs southwards from the Philippines, separating Borneo from Celebes and Bali from Lombok, was suggested to him, as he explained in a paper written in defence of his scientific boundary against attacks upon it from various quarters, "by his own observations, showing the abrupt and remarkable change in the forms of life that occur in passing from Bali to Lombok and from Borneo to Celebes." The sudden change was, he maintained, "connected with the fact that the sea between those islands suddenly deepens, marking the eastern termination of the great shallow bank which connected the larger Sunda Islands with the Asiatic continent."

The boundary line between the races inhabiting the Malay Archipelago and Australia lies much farther east than Wallace's zoological frontier, the Malays extending to Celebes, the Moluccas, Sumbawa, and Timor, but already meeting and mixing with Papuans on several of the easternmost islands of the Malay Archipelago. Professor Huxley believed that the aborigines of New Guinea, generally called Papuans (but only by the Europeans and their descendants, the name being unknown to any native tribe), were more closely allied to the negroes of Africa than any other race. The hypothesis of some later scientists, who have endeavoured to identify the Papuans with the Negritos of the Philippines and the Semangs of the Malay Peninsula, has met with more success. Dr Alfred Russel Wallace pronounced himself against this hypothesis in an appendix to his *Malay Archipelago* (1883 edition, p. 602), where he observes that "the black, woolly-haired races of the Philippines and the Malay Peninsula . . . have little affinity or resemblance to the Papuans." But Dr A. B. Meyer, who spent several years of scientific travel and exploration in the Malay Archipelago and New Guinea, and who became the director of the Natural History Museum at Dresden after his return, developed a contrary conclusion in his *Die Negritos der Philippinen* (1878). Dr Meyer held, after a special inquiry, that the Negritos and Papuans *are* identical, and that possibly, or even probably, the former are an offshoot of the latter, like some other Polynesian islanders. Professor Haddon (of Cambridge), while discussing, in *Nature* (September 1899), a later paper by Dr A. B. Meyer in English on the same subject (*The Distribution of the Negritos,* Dresden, 1899), practically adopts Meyer's views, after an independent examination of numerous skulls. But Professor Haddon truly remarks that much more needs to be known than is at present available before deciding as to how the Papuans, who are undoubtedly the aborigines of New Guinea, may have peopled other islands surrounding their own and much more distant.

Since 1870 Dutch scientific exploring expeditions have penetrated deeper into many of the unknown parts of Dutch New Guinea than their predecessors, such as Wallace, Beccari, and d'Albertis. Among the more important of such expeditions may be mentioned those of Messrs Van der Crab, Teysmann, Coorengel, Langeveld, Von Hemert, and Swann, undertaken for the Dutch-Indian Government 1871–72, 1875–76 (reports published at The Hague in 1879); of Von Rosenberg in the Geelvink Gulf districts in 1869–70 (report published at The Hague in 1875); of Von Oldenborgh in 1879–81 (published at The Hague); of Monod de Froideville and Boreel in 1882 (published at The Hague), &c. Their reports and the reports of various missionary societies, both Dutch and German, having settlements in western and northern New Guinea, in Netherlands territory, have thrown a great deal of light on the natural history of the island, on its resources, and the islanders. Extensive coal-fields have been discovered near the north-western coast.

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New Hampshire, one of the original thirteen states of the American Union, belonging to the New England group, of which it is the third in size. The population is slowly increasing. In 1880 it was 346,991, of whom 170,526 were males and 176,465 females; in 1890 it was 376,530, of whom 186,566 were males and 189,964 females; and in 1900 it was 411,588, of whom 205,379 were males and 206,209 were females. The increase in population from 1880 to 1890 was 8·5 per cent.; from 1890 to 1900, 9·3 per cent. In 1890 the density per square mile was 44·8, and in 1900 it was 45·7. The movement of the population is, as elsewhere, towards the cities. Between 1880 and 1890 three of the four distinctively agricultural counties lost 2528 in population, and from 1890 to 1900 the loss was 2024, while the manufacturing counties steadily gained. The urban population, classing as such all persons living in cities of more than 4000 inhabitants, increased between the census of 1880 and that of 1890 from 26·3 per cent. to 34·2 per cent. of the total population, and at the taking of the census of 1900 it had reached 46·7 per cent. of the total population. There are eleven incorporated cities in the state, each of which has a population of over 5000, and of these the chief manufacturing centres, as Manchester, Nashua, and Laconia, have in particular largely increased in size since 1880. In 1900 the population of Manchester was 56,987; of Nashua, 23,898; of Concord, 19,632; of Dover, 13,207; of Portsmouth, 10,637; and of Laconia, 8042. The gain in population is partly from natural growth and partly from immigration, mainly from Canada. In 1890 there were resident in New Hampshire 46,321 persons born in Canada or Newfoundland, and also 64,016 persons born in other states of the Union, while 124,520 natives of New Hampshire were resident in other states. In 1880, 86·66 per cent. of the population were native-born; in 1890, 80·79 per cent.; and in 1900 only 78·6. The total number of foreign-born inhabitants in 1900 was 88,107. There were only 662 negroes in the state. In 1899 there were for each 1000 of the population 18·53 marriages, 21·56 births, and 17·29 deaths. The size of the family continues to decrease, as it has done since 1850, the average being 4·31 in 1890, against 4·32 in 1880 and 5·15 in 1850. The percentage of births where both parents were foreigners was 38·77 in 1896 and 36·67 in 1899. Divorces have pretty steadily increased; in 1882 there was one divorce to 10·93 marriages, and in 1899 one divorce to 8·90 marriages. Among the causes of mortality consumption held the first place till 1898, although the percentage of deaths from it fell somewhat steadily from 14·01 per cent. of all deaths in 1884 to 9·92 per cent. in 1897, the average being 10·89. Pneumonia came next, varying between 7·06 in 1884 and 9·17 in 1897, averaging 8·67, and now holds the first place, 753 having died from pneumonia in 1899, against 582 from consumption. The ratio of deaths resulting from zymotic diseases during the fourteen years was 13·51 per cent. of the total. The death-rate for the entire state in 1890 was 18·2; in 1900 it was 18·52.

Charitable Institutions.—In 1900 there were 1303 paupers in the various almshouses of the state, of whom 423 were insane. On 1st October of the same year there were 425 insane patients in the state insane asylum. Within the period 1890–1900 there has been an important movement in the establishment of hospitals, with most of which are connected training-schools for nurses. In nearly all the cities hospitals have been opened, partially at the public expense, and in many of the towns "cottage hospitals" have been erected, mainly or wholly by private generosity. The Mary Hitchcock Hospital at Hanover is a model of its kind.

Manufacturing.—Manufacturing is the principal industry, and the amount of capital invested in it, the value of materials employed, and the value of products are steadily advancing, as shown by the comparison of the statistics of 1880, 1890, and 1900:—

	1880.	1890.	1900.
Number of establishments .	3,181	3,229	4,671
Capital	$51,112,263	$79,375,160	$100,929,661
Wage-earners (average number)	48,831	60,111	70,419
Total wages	$14,814,793	$21,927,290	$27,620,247
Value of products . . .	$73,978,628	$85,770,549	$118,669,308

New Hampshire ranks sixth in the Union in the manufacture of cotton goods, fifth in that of woollen, and twenty-fourth in the general value of its manufactures. Its eight chief industries in 1900 were as follows:—

Industries.	Number of Establishments.	Capital.	Wage-earners.		Value of Products.
			Average Number.	Total Wages.	
		$		$	$
Boots and shoes (factory products) . .	67	8,123,481	12,007	4,971,954	23,405,558
Cotton goods . .	23	29,261,835	20,454	6,759,422	22,998,249
Wool manufactures .	45	11,280,295	5,461	2,045,316	10,381,056
Lumber and timber products . . .	553	11,382,114	4,188	1,654,965	9,218,310
Paper and wood pulp .	29	8,163,081	2,391	1,036,856	7,204,733
Foundry and machine-shop products . .	87	2,894,474	1,979	945,154	3,049,334
Leather (tanned, curried, and finished) .	12	1,900,277	552	219,292	2,664,942
Hosiery and knit goods	22	2,525,286	2,492	790,558	2,592,829

Agriculture.—The agricultural products of the state vary but little from year to year, having had an annual value of $13,500,000 to $14,500,000 (in 1890, $13,761,050); but the census of 1900, with a changed method of computing, gave the value of the product for 1899 as $21,929,988. The principal crops in 1899 were as follows:—

	Acreage.	Production.	Value.
Buckwheat .	1,835	43,360 bushels	$19,334
Barley . .	1,596	46,680 ,,	25,189
Indian corn .	25,694	1,080,720 ,,	538,738
Oats . . .	12,589	497,110 ,,	184,025
Potatoes . .	19,422	2,420,668 ,,	1,090,495
Hay and forage .	615,042	654,973 tons	6,336,252

The crop of apples for the same year was 1,978,797 bushels. In 1900 there were 29,324 farms, and their average size was 1231 acres. The total improved acreage was 1,076,879 acres, and the unimproved was 2,532,985. The value of farms, exclusive of stock and implements, was $70,124,360. Sheep-raising, which was formerly a prominent industry, has steadily declined, and horses have taken the place of oxen in farm work, but the introduction of creameries has increased the dairy interest. The value of live stock in 1900 was $10,554,646. The relative proportion of farm stock in various years is shown by the subjoined table:—

	1880.	1890.	1900.
Horses	46,773	52,458	54,866
Dairy cows . . .	90,564	109,423	115,036
Other neat cattle . .	141,831	113,465	111,756
Sheep (not including lambs)	211,825	131,611	65,318
Swine	53,437	58,585	51,211

A fish and game commission has in charge the stocking of the inland waters of the state with fish. There are eleven hatcheries, from which there were distributed in 1900 to the various ponds and brooks 3,256,000 fry, mainly of salmon, salmon trout, brook trout, and lake trout. The principal fresh-water fish are trout, pickerel, black bass, eels, and pout. Under the operation of the game laws there has been a marked increase of the fish throughout the state, and of deer in the forests of the northern part.

Railways.—There was little railway construction during the period 1880–1900, the total mileage in 1901 being only 1189·5 miles, against 1051 in 1880; but there has been a steady movement towards consolidation. The sentiment of the state was formerly very hostile to the absorption, or even the leasing, of one line by another, but the excessive expense of maintenance, and the actual or threatened bankruptcy of many short lines, led in 1883 to the passage of a law, under which, since 1886, when there were thirty-four companies working within the state, one line after another has been leased or absorbed, till now all are merged in three systems—the Boston and Maine, the Maine Central, and the Grand Trunk. The Boston and Maine controls 1037 miles of the state mileage. Up to 1889 the cost of the railways of New Hampshire was about $40,000,000, and since that time about $7,000,000 have been spent in improvements and enlargements. All of the three systems have a large or major part of their mileage out of the state. There is some movement towards the building of electric lines in various parts, but few have been actually constructed.

The ordinary highway roads are very poor, varying according to soil and the knowledge and skill of local supervisors. The question of their improvement has become a public one, and the governor has urged upon the legislature the adoption of measures looking towards the intelligent development of a system of good roads throughout the state. "Good roads" institutes are also held under the direction of the Board of Agriculture.

Education.—The "rural school" has been and still is one of the most difficult problems in New Hampshire, but there has been a gradual tendency to centralize, when possible, and to diminish the number while increasing the efficiency of the schools. In comparison with 1882 the statistics are as follows:—

	Number of Schools.	Graded.	High.	Teachers.
1882	2644	481	56	3075
1900	2198	773	61	2740

	Enrolment.		Expenditures.	Average Length (Weeks).
	Public.	Private.		
1882	64,349	4,275	$584,527·74	22·9
1900	65,668	10,315	1,052,202·36	29·53

The expenditures of 1900 include $113,423.32 for buildings, permanent repairs, and the payment of interest and debt. The enrolment includes all who attended school two weeks or more, the average attendance being 47,276. In 1899 an Act was passed allowing towns to form "supervisory districts for the purpose of employing superintendents of public schools therein." In certain cases a part of the salary of such superintendents is paid by the state, which annually appropriates $25,000 for that purpose. In 1890 the illiterates over ten years of age formed 6·81 per cent. of the population. The Normal School receives an annual appropriation of $10,000 from the state. There are two institutions of higher learning, Dartmouth College at Hanover, and the New Hampshire College of Agriculture and the Mechanic Arts, at Durham. With Dartmouth College, which has classical, literary, and scientific courses, there are connected graduate schools in medicine, civil engineering, and administration and finance. The college has a faculty of 65 members, 768 students, 7164 alumni, and a library of over 85,000 volumes. The College of Agriculture and the Mechanic Arts has a faculty of 23 members, 134 students, 204 graduates, and its library contains about 7000 volumes. In 1891 in connexion with education a law was passed, authorizing the establishment in each town of a free public library, and granting under certain conditions state aid. In 1895 this was changed to a modified requirement, so that in 1898, 15 towns were accumulating a library fund by annual assessment, and 204 towns had free libraries, containing 403,942 volumes, having an annual appropriation of $48,789. There were also 277 other libraries, containing 703,787 volumes. The state library had 48,810 volumes.

Banks.—The banking facilities have undergone little change. On 30th September 1901 there were fifty-two national banks, with a capital of $5,380,000, surplus and undivided profits of $2,329,502, circulation of $4,599,769, deposits of $14,341,009, and loans and discounts of $13,467,698. There were also ten state banks and trust companies, with a capital of $610,000 and deposits of $1,073,318. The savings banks made remarkable progress until 1893, the year of their greatest prosperity. Then hard times seriously affected them, no less than twenty-five having gone into voluntary or forced liquidation. The condition of these banks at successive periods is as follows:—

	Number of Banks.	Depositors.	Average Deposits.	Total Deposits.
1880	67	89,934	$313.61	$28,204,791
1890	72	162,782	411.35	65,727,019
1893	70	174,654	425.85	74,377,278
1900	52	129,135	399.07	51,535,748

In 1893 there were also fourteen trust companies with savings bank departments, having deposits of $4,144,097, so that the total savings deposits of the state for that year were $78,521,376 in solvent companies. In 1900 there were seven such solvent institutions having deposits of $2,510,005, making the total of such deposits $54,045,753, in addition to $8,445,704 in banks in liquidation. In the same year there were seventeen building and loan associations, with assets of $1,863,507.

Finances.—In 1900 the assessed valuation of the state was $208,080,845, and the equalized valuation, including the inventories of the towns, savings banks deposits, and capital of railway and insurance companies, was $287,635,476. The total taxation, including the state tax of $425,000, was $4,728,337, or $11.49 per caput. The net debt of the state was, 1st June 1900, $1,118,798, that of the counties was $683,889, that of the towns was $7,796,145, and of the precincts $1,415,539—a total indebtedness for the state of $11,014,371, or $26.67 per caput. The gross debt was $13,269,286.

Religion.—The statistics of the larger religious denominations of the state for 1899 are given below. Those of the Methodists include a few towns in Massachusetts, and exclude a few in eastern New Hampshire associated with a Maine conference.

	Churches.	Ministers.	Members.	Sunday School Scholars.	Value of Property.
					$
Baptist .	84	96	9,719	10,490	547,200
F. W. Baptist .	101	86	8,240	7,098	416,850
Congregational.	195	212	20,251	21,178	1,500,000[1]
Episcopal. .	46	35	3,894	1.898	443,121
Roman Catholic	77	93	100,000	...	...
Unitarian .	27	23	3,252[1]	...	357,200[1]
Universalist .	34	...	1,250	1,500	260,000

There are also two communities of Shakers, three conferences of Christians, four churches, and ten societies of Christian Scientists in the state.

Politics.—Since 1874, when it elected a Democratic governor, New Hampshire has been a Republican state, though for many years the elections were very close, and in several years the legislature has chosen the governor, no candidate having attained the majority necessary for election. As showing the relation of the two principal parties, the votes for governor and for President of the United States are given below, the vote for 1896 being specially noticeable, as indicating the split in parties brought about by the silver movement.

	Governor.		President.	
	Republican.	Democratic.	Republican.	Democratic.
1880	44,435	40,866	44,852	40,794
1884	42,513	39,637	43,250	39,189
1888	44,904	51,201	46,735	43,457
1892	43,776	41,501	45,543	42,094
1896	48,387	28,383	57,444	21,271
1900	53,891	34,956	54,799	35,489

The mechanism of the state government has undergone no change during the period 1886–1900, except that since 1888, when slight

[1] Figures of 1895.

changes were made in the state constitution, the legislature meets biennially in January instead of June.

In the Spanish-American war New Hampshire furnished under the first call one regiment of 1009 officers and men, which, however, was not called into active service, and was mustered out 12th October 1898. Under the second call 318 volunteers were furnished.

AUTHORITIES.—The statistics of the industries of the states are given in the reports of the United States census and in reports issued by various state commissions annually or biennially.

(J. K. L*.)

Newhaven, a seaport and parish in the Eastbourne parliamentary division of Sussex, England, 8½ miles east by south of Brighton by rail, at the mouth of the river Ouse. There is a daily service of fast steamers to Dieppe. Steamers also leave for Caen, St Nazaire, and Jersey. A new quay has been opened for the Continental service, and two piers and a breakwater (2700 feet long) have been constructed at a cost of £562,000. In 1890 1579 vessels of 349,741 tons entered, and 1582 of 354,005 tons cleared; in 1900, 2471 vessels of 505,009 tons entered, and 2426 of 499,020 tons cleared. Population (1881), 4009; (1901), 6772.

New Haven, a town and the largest city of Connecticut, U.S.A., capital of New Haven county, situated at the head of New Haven Harbour, an inlet from Long Island Sound, in the southern part of the state, and at the intersection of several branches of the New York, New Haven, and Hartford Railway. The plan is irregular, with broad, well-shaded streets, which are paved with brick or granite blocks in the business sections, and in the residence sections are in part macadamized. It is divided into fifteen wards. Its water supply, derived by pumping from Lake Whitney, is in private hands. It is the seat of Yale University. The city has a large commerce by rail and by steamers on Long Island Sound. In 1900 it contained 1236 manufacturing establishments, employing a total capital of $30,463,066. The average number of hands was 20,536, and the products had a value of $40,762,015. These products were very varied; carriages and waggons, and materials for the same, had a value of $2,984,953; hardware, $2,218,032; corsets, $1,893,956; and foundry and machine-shop products, $1,716,028. The assessed valuation of real and personal property in 1900 was $115,698,807; the net debt was $3,690,909, and the rate of taxation, $16.50 per $1000. The receipts, apart from loans, amounted to $1,680,384, and the expenditures, exclusive of loans repaid, to $1,739,946. The death-rate in 1900 was 15·89. Population (1890), of the town, including the city, 86,045; of the city, 81,298; (1900), of the city, 108,027, of whom 30,802 were foreign-born and 2887 negroes.

New Hebrides. See NEW CALEDONIA.

New Iberia, a city of Louisiana, U.S.A., capital of Iberia Parish, on the Bayou Teche and on the Southern Pacific Railway, in the southern part of the state. It is in a lumber region, and its industries consist chiefly in the manufacture of cypress lumber. Sugar, cotton, and rice are raised, with cultivation, in the surrounding country. Population (1890), 3447; (1900), 6815, of whom 234 were foreign-born and 3309 negroes.

New Ireland, now NEU-MECKLENBURG. See NEW GUINEA (GERMAN).

New Jersey, an eastern state of the United States, situated between 41° 21′ 22·6″ N. and 38° 55′ 40″ N., and 73° 53′ 39″ W. and 75° 35′ W. The extreme in length is 166 miles, in breadth 57 miles; its narrowest part is 33½ miles. The total frontier measures 487 miles, of which all but 48 miles is defined by natural boundaries, rivers, bays, and oceans. The highest land has an elevation of 1803 feet. The area is 8,224·44 square miles, or 5,263,641 acres; of this the land surface is 7514·40 square miles, or 4,809,218 acres.

Population.—Notwithstanding its comparatively small area, New Jersey stood with a population in 1890 of 1,444,933, just midway among the states, and in 1900 of 1,883,669, of whom 941,760 were males and 941,909 females, the rate of increase from 1890 to 1900 being 30·4. In density of population for the land area New Jersey was third in rank in 1900, there being at that time to each square mile of land area an average population of 250·3. There were (1900) ten cities, the population of each of which exceeded 25,000, namely:—Newark, 246,070; Jersey City, 206,433; Paterson, 105,171; Camden, 75,935; Trenton, 73,307; Hoboken, 59,896; Elizabeth, 52,130; Bayonne, 32,722; Atlantic City, 27,838; Passaic, 27,777. The percentage of increase of the five largest of these cities during the decade 1890–1900 was as follows:—Newark, 35·5; Jersey City, 26·6; Paterson, 34·2; Camden, 30·2; Trenton, 27·5. The aggregate of population in these ten cities in 1890 was over 900,000, or about half of the total population of the state. In 1900 there were 32 cities or incorporated places, having each a population of more than 2000 and less than 5000, and having an aggregate population of 107,571; and 40 places having more than 5000 inhabitants each, and an aggregate population of 1,232,669. The village and rural population in 1870 was 469,435, in 1895, 514,176, and in 1900, 543,429. For the last generation, therefore, the rural population has remained comparatively stationary, while the population of the cities has increased about threefold. The proportion of foreign residents in 1880 was 3·65 per cent., and in 1890, 3·56. The state seems, therefore, to have received its full share of immigrants, for the total population of New Jersey in the census of 1890 was 2·25 per cent., and its area one-quarter of 1 per cent. of that of the United States. Since 1870, while the increase of native-born residents has nearly kept pace with the increase of foreign-born, much of the native population has sprung from foreign parentage, the census of 1900 showing that over 50 per cent. of the total population have both parents foreign-born. The percentage of the negro population to the total population has increased slightly, being 3·7 per cent. in 1900, and numbering 69,844. Proximity to the coast and a milder climate have given the state a somewhat larger proportion of coloured persons than western states on the same parallel of latitude.

Instruction.—The Constitution provides (1) That the state shall maintain an efficient system of public schools for all children between the ages of five and eighteen; (2) That the legislature shall not pass any private, local, or special law providing for the management and support of the public schools; (3) That no apportionments of any kind shall be made for the support of denominational schools. The state Board of Education prescribes rules for the enforcement of the school law, and appoints county superintendents. The state superintendent, appointed by the governor, apportions the school funds among the counties, and has a general oversight of the schools of the state. County superintendents, holding office for three years, apportion school moneys among the several townships and districts, and examine and license teachers. School trustees, nine in number, hold office for three years; may be women, chosen by voters of the district; employ teachers and fix their salaries; erect and keep in repair school buildings. Cities have separate boards of education and a city superintendent. Under the control of the state Board of Education are—a normal school for the training of teachers, with which are connected a model school, a preparatory school, a school for the deaf, and a manual training and industrial school for coloured youth. The state Board of Education also exercises general control of—(1) graded schools in cities and in a union of school districts; (2) district schools. Each municipality constitutes a school district. The sources of support for schools are—(1) a permanent school fund; (2) annual state school tax; and

(3) special district tax. Acts of the legislature of 1816 and 1817 began the creation of a school fund by the investment for that purpose of certain stock shares, belonging to the state. The Revised Constitution of 1844 guarantees the security and permanence of the funds, and the legislature from time to time has provided for its maintenance and increase by diverting to its purposes state revenues, arising from various sources. From the income of this fund annual apportionments are made. The principal of the school fund in 1901 was $3,773,351, from which the total income was $186,428. A large part of the cost of maintaining the schools is met each year by a school tax on the taxable property at the rate of 2¾ mills on each dollar of ratcables, which in 1901 amounted to $2,287,395. The largest part of the cost of the schools is met by a district tax and city taxes. In 1901 these special taxes aggregated $4,027,575. By the school census of 1900 the children of school age numbered 463,565; of these 322,575 were enrolled in the public schools. The enrolment in the normal school for the year 1901 was 645; in the model school, 536. In the year 1900 there were in the state 1091 children over 10 years of age unable to read, and 7236 under 15 employed in factories, mines, and stores. The total value of school buildings is given as $15,634,471. The number of teachers was, men 998, women 6536. The average monthly salary for men was $86.63; for women, $50.07. In 1900 reports were received from twenty-one communities throughout the state showing an expenditure for that year for manual and industrial training of $88,944. In New Jersey alone of the thirteen original colonies was there, prior to the War of Independence, more than one chartered institution of higher education. Princeton University received its charter in 1746 as the college of New Jersey, and, though it has never had direct relations with the state, has during its career been of inestimable value to the state and nation. At the sesquicentennial celebration in 1896 this college took the name of Princeton University. Rutgers College, founded in 1766 as Queen's College, is situated at New Brunswick. The Rutgers Scientific School was designated under the auspices of the United States Law of 1862 as the State College for the benefit of agriculture and the mechanic arts, and as such maintains courses in agriculture, biology, chemistry, electricity, and engineering, in which students from New Jersey to the number of 290 are, under certain conditions, admitted to free tuition. As a department of this State College, by a law of the United States of 1887, an agricultural experiment station was organized, which, in co-operation with a similar state station established in 1880, has been of great service to the agriculture of New Jersey, and to agricultural science in general.

Charitable Institutions.—There are for the care of the insane two state hospitals and nine county asylums, containing in the aggregate, for 1899, 4063 patients cared for by the state at a cost of $334,342.85. Provision was made in the same year for the blind, feeble-minded, and deaf mutes at a cost of about $120,000. A village for epileptics was opened in 1898. The penal institutions are the state prison at Trenton, with 1119 inmates at the close of the year 1899, whose cost of maintenance, exclusive of salaries and gratuities to discharged prisoners, was $86,756; the reform school for boys at Jamesburg with 405 inmates; the industrial school for girls at Trenton, and the new state reformatory at Rahway.

Religion.—In 1890 the total number of religious organizations in New Jersey was 2085, and of edifices, 2204; the value of church property was $29,490,414; the number of communicants or members was 508,351, being 38·18 per cent. of the total population. Reports for the years named give the following statistics for the various denominations: Methodists in 1900, 577 churches, 439 ministers, 91,027 members, value of church property, $6,425,670; Presbyterians (1900), 328 churches, 452 ministers, 68,278 members, value of church property in 1890, $6,800,000; Baptists (1899), 312 churches, 330 ministers, 52,874 members, value of church property, $4,527,526; Protestant Episcopal (1900), 243 churches, 237 ministers, 40,311 members, and church property in 1890 valued at $3,860,350; the Reformed Church in America (1900), 122 churches, 143 ministers, 26,549 members; the Roman Catholics (1899), 347 priests, 183 churches, the Roman Catholic population in the same year amounting to 329,510.

Agriculture.—In 1900 there were 34,650 farms, containing 2,840,966 acres. The improved land amounted to 1,977,042 acres, and the unimproved to 863,924 acres. The total value of farm property was $189,533,660, and was made up as follows: land improvements and buildings, $162,591,010; implements and machinery, $9,330,030; live stock, $17,612,620. During the preceding year $6,720,030 was expended on labour, and $2,165,320 on fertilizers. Of the total number of farms, 70·1 per cent. were worked by the owners, 15·3 per cent. by cash tenants, and 14·6 per cent. by share tenants. The total value of farm products in 1899 was $43,657,529; the acreages, quantities, and values of the principal crops were as in table following. The three most important orchard fruits are apples, peaches, and pears. The number of trees in 1900 and the quantity of fruit produced the preceding year were: apples,

Crops.	Acres.	Quantity.	Value.
Indian corn	295,258	10,978,800 bushels	$4,533,473
Wheat	132,571	1,902,590 ,,	1,347,650
Oats	75,959	1,601,610 ,,	492,341
Rye	68,967	831,410 ,,	442,446
Hay and forage	444,610	542,796 tons	5,544,970
Potatoes	52,896	4,542,816 bushels	2,192,456
Sweet potatoes	20,588	2,418,641 ,,	1,213,010
Miscellaneous vegetables	76,897	...	4,914,803
Small fruits	25,371	...	1,406,049
Orchard fruits	80,634	6,168,480 bushels	2,594,981
Flowers and plants	614	...	1,953,290
Forest products	...	...	469,005

1,810,793 trees, 4,640,896 bushels; peaches, 2,746,607 trees, 620,928 bushels; and pears, 926,117 trees, 790,818 bushels. The number and value of farm animals in 1900 were as follows: 154,409 dairy cows, $5,840,228; 82,577 other neat cattle, $1,358,879; 94,024 horses, $7,582,274; 4931 mules and asses, $356,492; 26,363 sheep (not including lambs), $118,924; 175,387 swine, $926,179.

Manufacturing.—New Jersey ranks among the chief manufacturing states in the Union. The manufacture of silk goods (included in the following statistics under textiles) is the leading industry, which employed in the year 1900 an average of 24,157 hands, and turned out products valued at $39,966,662. The general statistics of manufacture in 1890 and in 1900 were as follows:—

	1890.	1900.	Increase.
Establishments	9,225	15,481	67·8
Capital	$250,805,745	$502,824,082	100·5
Salaried employés	13,620 [1]	16,283	19·6
Salaries	$13,834,618 [1]	$19,688,946	42·3
Wage-earners	173,778	241,582 [2]	39·0
Total wages	$82,944,118	$110,088,605	32·7
Miscellaneous expenses	$18,458,052	$42,654,076	131·1
Cost of materials used	$189,365,740	$360,945,843	90·6
Value of products	$354,573,571	$611,748,933	72·5

The product of each of fifteen leading industries exceeded $5,000,000. These were—chemical products, $12,207,289; electrical apparatus and supplies, $6,447,154; foundry and machine-shop products, $32,621,229; glass, $5,093,822; iron and steel, $24,381,699; jewellery, $7,379,777; leather, $13,747,155; malt liquors, $14,386,456; lumber, planing-mill products, including sashes, doors, and blinds, $5,107,217; petroleum refining, $29,649,460; pottery, brick, and fire-clay products, $8,940,723; rubber and elastic goods, $8,458,274; sewing machines and attachments, $6,643,348; textiles, $72,921,528; tobacco, $10,435,974.

Railways.—There are 116 railway and canal companies subject to taxation. The total length of railways in 1897 was 2263 miles; of canals, 173 miles. The total trackage was 4590 miles, of which four-fifths was laid with steel rails, the remainder with iron. The number of railway miles to each 100 square miles of area was 29·72, being largely in excess of that of any other state in the Union. There is scarcely a place that is more than 5 miles distant from a railway line. The total value of railway property is very considerable, as the terminals of most of the railways affording transportation to New York City are within New Jersey.

Finance.—In 1899 the total taxable property was valued at $866,030,048. The value of all property, including railway and canal property, exempt property and deductions for debt, was $1,223,815,062. The total assessed valuation, for 1898, of railway and canal property was $222,417,748, and the amount of tax levied thereon in the year 1899 for state uses was $1,112,088; for local uses, $427,019; a total of $1,539,107. The school tax is the only direct state tax levied upon the people. This in 1899 amounted to $2,284,310. The state is without debt. The last of the bonds issued for the Civil War, amounting to $71,000, fell due upon the 1st of January 1902. On 31st October 1901 there was a balance in the treasury of $2,351,683. The disbursements from the state treasury for all purposes for the year ending 31st October 1901 were $3,480,350.

Banking.—On the 1st of January 1900 there were 108 national banks, with an aggregate paid-up capital of $14,795,215; resources, $110,555,252; and with individual deposits amounting to $71,274,754. The 26 savings banks in the state had at the same date total resources of $61,184,322; deposits, $54,713,698; depositors, 191,572; the average amount of each account being $285. The state banks numbered 20, having capital paid up, $1,753,750; total resources, $12,315,993; deposits, $8,826,840.

[1] Includes proprietors and firm members, with their salaries.

[2] Includes 181,879 men, 51,661 women, and 8042 children under sixteen years of age.

The trust companies numbered 25; total capital, $3,657,400; total resources, $43,029,692; deposits, $33,856,403. These three kinds of banks under state control have aggregate resources of $116,530,007; deposits, $97,396,941. There were in New Jersey in 1897, 334 co-operative building and loan associations, whose net assets were $44,842,336; and whose shareholders numbered 116,739; and borrowers, 30,842. The total invested on bond and mortgage was $40,941,291; the aggregate receipts were $19,833,241; and the disbursements, $18,403,551. The number of houses acquired or begun building by borrowers from loan associations during the year was 2381.

National Guard.—In 1899 a commission was appointed with a view to the reorganization of the national guard, and the codification and amendment of the National Guard Law. The national guard, well maintained and highly efficient, consists of 238 officers and 3455 enlisted men, organized into 4 regiments of 12 companies each of infantry, 2 Gatling gun companies, and 2 troops of cavalry. The naval reserve consists of 2 battalions of 2 divisions each. The state expended for the national guard during the year 1899, $277,903; and for the naval reserve, $16,528. New Jersey supplied to the United States forces in the Spanish-American War 4 regiments of national guard volunteer infantry of 12 companies each, numbering 5348 officers and men, and 343 men from the naval reserve.

Legislation.—The State Constitution adopted 2nd July 1776 was maintained as the organic law until 1844, when it was thoroughly revised. In 1875 important amendments were incorporated forbidding the use of public moneys for sectarian purposes; guaranteeing public schools for ever; and forbidding special legislation. In 1893 laws were passed legalizing race-track gambling, which were, however, speedily repealed; and in 1897 the Constitution was amended so as to prohibit the passing of laws authorizing pool-selling, book-making, or gambling of any kind. Legislation permitting the incorporation of so-called trusts has had a vast economic and political importance, but the policy of encouraging by law the massing of capital for the promotion of industries is more than 100 years old in New Jersey. In the first seven months of 1899 there were organized under the laws of New Jersey 1336 corporations, with an aggregate capital of more than $2,000,000,000, and of corporations with a capital of over $10,000,000 there were formed in the same time in New Jersey 61, in all the other states 60. New Jersey was among the very first of the states to pass a law allowing state aid for the improving of public roads. The first State Aid Law of this kind, passed in 1892, appropriated $75,000 annually, to meet equal appropriations on the part of the counties. Later legislation increased this annual appropriation to $300,000. The total outlay for state highways during 1893–1900 was more than $2,150,000, and New Jersey at the end of the 19th century had more miles of improved roads than any state in the Union. Legislation in the interest of labour and laws equalizing taxation and assessing railways and other corporations have been a marked feature.

Political Life.—The population of New Jersey, of mixed origin —Dutch, Swedish, Scotch, Irish, English—embracing early settlements of Quakers, Calvinists, Episcopalians, and other sects, under the successive governments of lords proprietors, royal charters, and republican constitutions, has from the first developed personal independence and democratic ideas. Conservatism has been a marked feature of its history. This is noticeable in the judicial system, for example, the Court of Chancery being retained in New Jersey, though rejected by the other original states of the Union; the judiciary is also appointive and not elective. In recent years the great industrial growth, ready means of quick communication, facilities for easy transportation, a large influx of residents whose business interests are chiefly in the great cities of New York and Philadelphia, have made the state responsive to the influence of forces which dominate in large spheres of action throughout the Union. In twenty of the twenty-nine Presidential elections since the formation of the National Government the vote of New Jersey has been recorded in favour of the successful candidates. Since the Civil War the state has generally favoured the Democratic party. In the Presidential elections of 1896 and 1900, however, the majorities, greater than ever before given by the state, have been in favour of the view of the money question taken by the Republican party. This question and that of racecourse legislation have also in recent years placed the state legislature and administration in the hands of the Republican party. The popularity of the late Vice-President Garret A. Hobart, who was a citizen of New Jersey, contributed to this result. (A. SC.)

New Kensington, a borough of Westmoreland county, Pennsylvania, U.S.A., on the Allegheny river and the Allegheny Valley Railway, 18 miles north-east of Pittsburg, in the western part of the state. It has extensive glass, iron and steel, and white-lead works. It was founded in 1891. Population (1900), 4665, of whom 1042 were foreign-born and 86 negroes.

Newlands, John Alexander Reina (1838–1898), English chemist, was born in 1838. He was one of the first, if not quite the first, to propound the conception of periodicity among the chemical elements. His earliest contribution to the question took the form of a letter published in the *Chemical News* in February 1863. In the succeeding year he showed, in the same journal, that if the elements be arranged in the order of their atomic weights, those having consecutive numbers frequently either belong to the same group, or occupy similar positions in different groups, and he pointed out that each eighth element starting from a given one is in this arrangement a kind of repetition of the first, like the eighth note of an octave in music. The Law of Octaves thus enunciated was at first ignored or treated with ridicule as a fantastic notion unworthy of serious consideration, but it was subsequently elaborated by Mendeléeff and other workers, and as the Periodic Law has taken its place as one of the most important generalizations in modern chemical theory. Newlands, who was of Italian extraction on his mother's side, and fought as a volunteer in the cause of Italian freedom under Garibaldi in 1860, died in London on 29th July 1898. He collected his various papers on the atomicity of the elements in a little volume on the *Discovery of the Periodic Law* published in London in 1884.

New London, a city and seaport of Connecticut, U.S.A., capital of New London county, on the Thames river, a short distance above its mouth, in Long Island Sound, in the south-eastern part of the state. It has an excellent harbour, probably the best on the Sound, and a large commerce, having daily steamboat communication with New York. It has two railways—the New York, New Haven, and Hartford, which passes through it, and the Central Vermont, which has here its southern terminus. In the palmy days of the whale industry, New London was one of the principal home ports of vessels engaged in that industry, but with its decline the city lost in importance. In recent years, owing largely to the introduction of manufactures, it has received a new impetus. It produces silk and woollen goods, and other minor products. In 1900 there were 238 manufacturing establishments, having a total capital of $4,522,003, employing 2658 wage-earners, and turning out products valued at $5,569,615. The inter-collegiate races between Yale and Harvard Universities are commonly rowed on the river at New London. Population (1890), 13,757; (1900), 17,548, of whom 3743 were foreign-born and 378 were negroes.

Newlyn School of Painting. See SCHOOLS OF PAINTING.

Newman, Francis William (1805–1897), English scholar and miscellaneous writer, younger brother of Cardinal Newman, was born in London, 27th June 1805. Like his brother, he was educated at the Rev. Dr Nicholas's school at Ealing, and subsequently at Oxford, where he had a brilliant career, obtaining a double first class in 1826. He was elected fellow of Balliol in the same year. Conscientious scruples respecting the ceremony of infant baptism led him to resign his fellowship in 1830, and he went to Baghdad as assistant in the mission of the Rev. A. N. Groves. In 1833 he returned to England to procure additional support for the mission, but rumours of unsoundness in his views on the doctrine of eternal punishment had preceded him, and finding himself generally looked upon with suspicion, he gave up the vocation of missionary to become classical tutor in an unsectarian college at Bristol. His letters written home during the period of his mission were collected and published in 1856, and form an interesting little volume. Newman's views matured rapidly, and in 1840 he became professor of Latin in Manchester New College, the celebrated Unitarian seminary long established at York, and eventually the parent of Manchester College, Oxford. In 1846 he quitted this appointment to become professor in University College, London, where he remained until 1869. During all this period he was assiduously carrying on his studies in mathematics and Oriental languages, but wrote little until 1848, when he published anonymously a *History of the Hebrew Monarchy*, intended to introduce the results of German investigation in this department of Biblical criticism. In 1849 appeared *The Soul, her Sorrows and Aspirations*, and in 1850, *Phases of Faith, or Passages from the History of my Creed*—the former a tender but searching analysis of the relations of the spirit of man with the Creator; the latter a religious autobiography detailing the author's passage from Calvinism to pure Theism. It is on these two books that Professor Newman's celebrity will principally rest; having in both to describe his personal experience, his intense earnestness has kept him free from the eccentricity which marred most of his other writings, excepting his contributions to mathematical research and Oriental philology. There was, indeed, scarcely a crotchet, except "spiritualism," of which he was not at one time or another the advocate. His versatility was amazing: he wrote on logic, political economy, English reforms, Austrian politics, Roman history, diet, grammar, the most abstruse departments of mathematics, Arabic, the emendation of Greek texts, and languages as out of the way as the Berber, and as obsolete as the dialect of the Iguvine inscriptions. In treating all these subjects he showed signal ability, but, wherever the theme allowed, an incurable crotchetiness; and in his numerous metrical translations from the classics, especially his version of the Iliad, he betrayed an insensibility to the ridiculous which would almost have justified the irreverent criticism of Matthew Arnold, had this been conveyed in more seemly fashion. His miscellaneous essays, some of much value, were collected in several volumes before his death: his last publication, treating of the early life of his celebrated brother, was generally condemned as deficient in fraternal feeling. He was far from possessing his brother's subtlety of reasoning, but he impresses by a transparent sincerity and singleness of mind not always displayed by the more celebrated writer; his style is too individual to be taken as a model, but is admirable for its simplicity and clearness. His character is vividly drawn by Carlyle in his life of Sterling, of whose son Newman was guardian: "a man of fine attainments, of the sharpest-cutting and most restlessly advancing intellect, and of the mildest pious enthusiasm." It was his great misfortune that this enthusiasm should have been correlated, as is not unfrequently the case, with an entire insensibility to the humorous side of things. After his retirement from University College, Professor Newman continued to live for some years in London, subsequently removing to Clifton, and eventually to Weston-super-Mare, where he died on 7th October 1897. He had been blind for five years before his death, but retained his faculties to the last. He was twice married. (R. G.)

Newman, John Henry (1801 – 1890), Cardinal, the most remarkable English ecclesiastic of the 19th century, was born in the City of London, 21st February 1801, the eldest son of Mr John Newman, banker, of the firm of Ramsbottom, Newman, and Co. The family was understood to be of Dutch extraction, and the name itself, spelt "Newmann" in an earlier generation, further suggests Hebrew origin. His mother, Jemima Fourdrinier, was of a Huguenot family, long established in London as engravers and paper manufacturers. John Henry was the eldest of six children. The second son, Charles Robert, a man of ability but of impracticable temper, a professed atheist and a recluse, died in 1884. The youngest son, Francis William, an excellent philologist, was for many years professor of Latin in University College, London. He was a devout theist but a keen critic of orthodox Christianity, and as a humanitarian he gained the reputation of a faddist. He died in 1897. Two of the three daughters, Harriett Elizabeth and Jemima Charlotte, married brothers, Thomas and John Mozley; and Anne Mozley, a daughter of the latter, edited in 1892 Newman's Anglican *Life and Correspondence*, having been entrusted by him in 1885 with an autobiography written in the third person to form the basis of a narrative of the first thirty years of his life. The third daughter, Mary Sophia, died unmarried in 1828.

At the age of seven Newman was sent to a private school conducted by Dr Nicholas at Ealing, where he was distinguished by diligence and good conduct, as also by a certain shyness and aloofness, taking no part in the school games. He speaks of himself as having been "very superstitious" in these early years. He took great delight in reading the Bible, and also the novels of Scott, then in course of publication. At the age of fifteen, during his last year at school, he was "converted," an incident that throughout life remained to him "more certain than that he had hands or feet." It was in the autumn of 1816 that he thus fell under the influence of a definite creed, and received into his intellect impressions of dogma never afterwards effaced. The tone of his mind was at this date evangelical and Calvinistic, and he held that the Pope was anti-Christ. Matriculating at Trinity College, Oxford, 14th December 1816, he went into residence there in June the following year, and in 1818 he gained a scholarship of £60, tenable for nine years. But for this he would have been unable to remain at the university, as in 1819 his father's bank suspended payment. In that year his name was entered at Lincoln's Inn. Anxiety to do well in the final schools produced the opposite result; he broke down in the examination, and so graduated with third-class honours in 1821. Desiring to remain in Oxford, he took private pupils and read for a fellowship at Oriel, then "the acknowledged centre of Oxford intellectualism." To his intense relief and delight he was elected, 12th April 1822. E. B. Pusey was elected a fellow of the same society in 1823.

On Trinity Sunday, 13th June 1824, Newman was ordained, and became, at Pusey's suggestion, curate of St Clement's, Oxford. Here for two years he was busily engaged in parochial work, but he found time to write articles on "Apollonius of Tyana," on "Cicero," and on "Miracles" for the *Encyclopædia Metropolitana*. In 1825, at Whately's request, he became vice-principal of St Alban's Hall, but this post he held for one year only. To his association with Whately at this time he attributed much of his "mental improvement" and a partial conquest of his shyness. He assisted Whately in his popular work on logic, and from him he gained his first definite idea of the Christian Church. He broke with him in 1827 on the occasion of the re-election of Peel for the University, Newman opposing this on personal grounds. In 1826 he became tutor of Oriel, and the same year R. H. Froude, described by Newman as "one of the acutest, cleverest, and deepest men" he ever met, was elected fellow. The two formed a high ideal of the tutorial office as clerical and pastoral rather than secular. In 1827 he was a preacher at Whitehall. The year following Newman supported and secured the election of Hawkins as provost of Oriel in preference to Keble, a choice which he later defended or apologized for as having in effect produced the Oxford

Movement with all its consequences. In the same year he was appointed vicar of St Mary's, to which the chapelry of Littlemore was attached, and Pusey was made regius professor of Hebrew. At this date, though still nominally associated with the Evangelicals, Newman's views were gradually assuming a higher ecclesiastical tone, and while local secretary of the Church Missionary Society he circulated an anonymous letter suggesting a method by which Churchmen might practically oust Nonconformists from all control of the Society. This resulted in his being dismissed from the post, 8th March 1830; and three months later he withdrew from the Bible Society, thus completing his severance from the Low Church party. In 1831–32 he was select preacher before the University. In 1832, his difference with Hawkins as to the "substantially religious nature" of a college tutorship becoming acute, he resigned that post, and in December went with R. H. Froude, on account of the latter's health, for a tour in South Europe. On board the mail steamship *Hermes* they visited Gibraltar, Malta, and the Ionian Islands, and subsequently Sicily, Naples, and Rome, where Newman made the acquaintance of Dr Wiseman. In a letter home he described Rome as "the most wonderful place on earth," but the Roman Catholic religion as "polytheistic, degrading, and idolatrous." It was during the course of this tour that he wrote most of the short poems which a year later were printed in the *Lyra Apostolica*. From Rome Newman returned to Sicily alone, and was dangerously ill with fever at Leonforte, recovering from it with the conviction that he had a work to do in England.


CARDINAL NEWMAN.
(From a photograph by Barraud, London.)

In June 1833 he left Palermo for Marseilles in an orange boat, which was becalmed in the Strait of Bonifacio, and here he wrote the verses, "Lead, kindly Light," which later became popular as a hymn. He was at home again in Oxford, 9th July, and on the 14th Keble preached at St Mary's an assize sermon on "National Apostasy," which Newman afterwards regarded as the inauguration of the Oxford Movement. In the words of Dean Church, it was "Keble who inspired, Froude who gave the impetus, and Newman who took up the work"; but the first organization of it was due to Mr H. J. Rose, editor of the *British Magazine*, who has been styled "the Cambridge originator of the Oxford Movement." It was in his rectory house at Hadleigh, Suffolk, that a meeting of High Church clergymen was held, 25th to 29th July (Newman was not present), at which it was resolved to fight for "the apostolical succession and the integrity of the Prayer-Book." A few weeks later Newman started, apparently on his own initiative, the *Tracts for the Times*, from which the movement was subsequently named "Tractarian." Its aim was to secure for the Church of England a definite basis of doctrine and discipline, in case either of disestablishment or of a determination of High Churchmen to quit the establishment, an eventuality that was thought not impossible in view of the State's recent high-handed dealings with the sister established Church of Ireland. The teaching of the tracts was supplemented by Newman's Sunday afternoon sermons at St Mary's, the influence of which, especially over the junior members of the University, was increasingly marked during a period of eight years. In 1835 Pusey joined the movement, which, so far as concerned ritual observances, was later called "Puseyite"; and in 1836 its supporters secured further coherence by their united opposition to the appointment of Hampden as regius professor of divinity. His Bampton Lectures (in the preparation of which Blanco White had assisted him) were suspected of heresy, and this suspicion was accentuated by a pamphlet put forth by Newman, *Elucidations of Dr Hampden's Theological Statements.* At this date Newman became editor of the *British Critic*, and he also gave courses of lectures in a side-chapel of St Mary's in defence of the *via media* of the Anglican Church as between Romanism and popular Protestantism. His influence in Oxford was supreme about the year 1839, when, however, his study of the monophysite heresy first raised in his mind a doubt as to whether the Anglican position was really tenable on those principles of ecclesiastical authority which he had accepted; and this doubt returned when he read, in Wiseman's article in the *Dublin Review* on "The Anglican Claim," the words of St Augustine against the Donatists, "*securus judicat orbis terrarum*," words which suggested a simpler authoritative rule than that of the teaching of antiquity. He continued his work, however, as a High Anglican controversialist until he had published, in 1841, *Tract 90*, the last of the series, in which he put forth, as a kind of proof charge, to test the tenability of all Catholic doctrine within the Church of England, a detailed examination of the XXXIX. Articles, suggesting that their negations were not directed against the authorized creed of Roman Catholics, but only against popular errors and exaggerations. This theory, though not altogether new, aroused much indignation in Oxford, and A. C. Tait (afterwards archbishop of Canterbury), with three other senior tutors, denounced it as "suggesting and opening a way by which men might violate their solemn engagements to the University." The alarm was shared by the heads of houses and by others in authority; and, at the request of the bishop of Oxford, the publication of the Tracts came to an end. At this date Newman also resigned the editorship of the *British Critic*, and was thenceforth, as he himself later described it, "on his deathbed as regards membership with the Anglican Church." He now recognized that the position of Anglicans was similar to that of the semi-Arians in the Arian controversy; and the arrangement made at this time that an Anglican bishopric should be established in Jerusalem, the appointment to lie alternately with the British and Prussian Governments, was to him further evidence of the non-apostolical character of the Church of England. In 1842 he withdrew to Littlemore, and lived there under monastic conditions with a small band of followers, their life being one of great physical austerity as well as of anxiety and suspense. To his disciples there he assigned the task of writing lives of the English saints, while his own time was largely devoted to the completion of an essay on the development of Christian doctrine, by which principle he sought to reconcile himself to the elaborated creed and the practical system of the Roman Church. In February 1843 he published, as an advertisement in the *Oxford Conservative Journal*, an anonymous but otherwise formal retractation of all the hard things he had said against Rome; and in September, after the secession of one of the inmates of the house, he preached his last Anglican sermon at Littlemore and resigned the living of St Mary's. But still an interval of two years elapsed before he was formally received into the Roman Catholic Church (9th October 1845) by Father Dominic, an Italian Passionist. In February 1846 he left Oxford for Oscott, where Bishop Wiseman, then vicar-apostolic of the Midland district, resided; and in October he proceeded to Rome, where he was ordained priest and was given the degree of D.D. by the Pope. At the close of 1847 he returned to England as an Oratorian, and resided first at Maryvale (near Oscott); then at St Wilfrid's College, Cheadle; then at St Ann's, Alcester Street, Birmingham; and finally at Edgbaston, where spacious premises were built for the community, and where (except for four years in Ireland) he lived a secluded life for nearly forty years. Before the house at Edgbaston was occupied he had established the London Oratory, with Father Faber as its superior, and there (in King William Street, Strand) he delivered a course of lectures on "The Present Position of Catholics in England," in the fifth of which he protested against the anti-Catholic utterances of Dr Achilli, an ex-Dominican friar, whom he accused in detail of numerous acts of immorality. Popular Protestant feeling ran very high at the time, partly in consequence of the recent establishment of a Roman Catholic diocesan hierarchy by Pius IX., and criminal proceedings against Newman for libel resulted in an acknowledged gross miscarriage of justice. He was found guilty, and was sentenced to pay a fine of £100, while his expenses as defendant amounted to about £14,000, a sum that was at once raised by public subscription, a surplus being spent on the purchase of Rednall, a small property picturesquely situated on the Lickey Hills, with a chapel and cemetery, where Newman now lies buried. In 1854, at the request of the Irish bishops, Newman went to Dublin as rector of the newly-established Catholic university there. But practical organization was not among his gifts, and the bishops became jealous of his influence, so that after four years he retired, the best outcome of his stay there being a volume of lectures entitled *Idea of a University*, containing some of his most effective writing. In 1858 he projected a branch house of the Oratory at Oxford; but this was opposed by Manning and others, as likely to induce Catholics to send their sons to that university, and the scheme was abandoned. In 1859 he established, in connexion with the Birmingham Oratory, a school for the education of the sons of gentlemen on lines similar to those of the English public schools, an important work in which he never ceased to take the greatest interest. But all this time (since 1841) Newman had been under a cloud, so far as concerned the great mass of cultivated Englishmen, and he was now awaiting an opportunity to vindicate his career; and in 1862 he began to prepare autobiographical and other memoranda for the purpose. The occasion came when, in January 1864, Charles Kingsley, reviewing Froude's *History of England* in *Macmillan's Magazine*, incidentally asserted that "Father Newman informs us that truth for its own sake need not be, and on the whole ought not to be, a virtue of the Roman clergy." After some preliminary sparring between the two—Newman's pamphlet, "Mr Kingsley and Dr Newman: a Correspondence on the Question whether Dr Newman teaches that Truth is no Virtue," published in 1864 and not reprinted, is unsurpassed in the English language for the vigour of its satire: the anger displayed was later, in a letter to Sir William Cope, admitted to have been largely feigned—Newman published in bi-monthly parts his *Apologia pro Vita Sua*, a religious autobiography of unsurpassed interest, the simple confidential tone of which "revolutionized the popular estimate of its author," establishing the strength and sincerity of the convictions which had led him into the Roman Catholic Church. Kingsley's accusation indeed, in so far as it concerned the Roman clergy generally, was not precisely dealt with; only a passing sentence, in an appendix on lying and equivocation, maintained that English Catholic priests are as truthful as English Catholic laymen; but of the author's own personal rectitude no room for doubt was left.

In 1870 he put forth his *Grammar of Assent*, the most closely reasoned of his works, in which the case for religious belief is maintained by arguments differing somewhat from those commonly used by Roman Catholic theologians; and in 1877, in the republication of his Anglican works, he added to the two volumes containing his defence of the *via media* a long preface and numerous notes in which he criticized and replied to sundry anti-Catholic arguments of his own in the original issues. At the time of the Vatican Council (1869–70) he was known to be opposed to the definition of Papal infallibility, and in a private letter to his bishop (Ullathorne), surreptitiously published, he denounced the "insolent and aggressive faction" that had pushed the matter forward. But he made no sign of disapproval when the doctrine was defined, and subsequently, in a letter nominally addressed to the duke of Norfolk on the occasion of Mr Gladstone's accusing the Roman Church of having "equally repudiated modern thought and ancient history," Newman affirmed that he had always believed the doctrine, and had only feared the deterrent effect of its definition on conversions on account of acknowledged historical difficulties. In this letter, and especially in the postscript to the second edition of it, Newman finally silenced all cavillers as to his not being really at ease within the Roman Church. In 1878 his old college (Trinity), to his great delight, elected him an honorary fellow, and he revisited Oxford after an interval of thirty-two years. At the same date died Pope Pius IX., who had long mistrusted him; and Leo XIII. was encouraged by the duke of Norfolk and other distinguished Roman Catholic laymen to make Newman a cardinal, the distinction being a marked one, because he was a simple priest and not resident in Rome. The offer was made in February 1879, and the announcement of it was received with universal applause throughout the English-speaking world. The "creation" took place on 12th May, with the title of St George in Velabro, Newman taking occasion while in Rome to insist on the lifelong consistency of his opposition to "liberalism in religion." After an illness that excited apprehension he returned to England, and thenceforward resided at the Oratory until his death, 11th August 1890, making occasional visits to London, and chiefly to his old friend, R. W. Church, dean of St Paul's, who as proctor had vetoed the condemnation of *Tract 90* in 1841. As cardinal Newman published nothing beyond a preface to a work by the present writer on the *Anglican Ministry* (1879) and an article on Biblical criticism in the *Nineteenth Century* (February 1884).

Newman's influence as controversialist and preacher (*i.e.*, as reader of his written sermons, for he was never a speaker) has been very great. For the Roman Church his conversion secured great prestige and the dissipation of many prejudices. Within it his influence was mainly in the direction of a broader spirit and of a recognition of the important part played by development both in doctrine and in Church government. And although he never called himself a mystic, he showed that in his judgment spiritual truth is apprehended by direct intuition, as an antecedent necessity to the professedly purely rational basis of the Roman Catholic creed. Within the Anglican Church, and even within the more strictly Protestant Churches, his influence has been greater, but in a different direction, viz., in showing the necessity of dogma and the indispensableness of the austere, ascetic, chastened, and graver side of the Christian religion. If his teaching as to the Church has been less widely followed, it is because of doubts as to the thoroughness of his knowledge of history and as to his freedom from bias as a critic. Some hundreds of clergymen, influenced by the movement of which for ten or twelve years he was the acknowledged leader, made their submission to the Church of Rome; but a very much larger number, who also came under its influence, failed to learn from him that belief in the Church involves belief in the Pope. The natural tendency of his mind is often (and correctly) spoken of as sceptical. He held that, apart from an interior and unreasoned conviction, there is no cogent proof of the existence of God; and in *Tract 85* he dealt with the difficulties of the Creed and of the canon of Scripture, with the apparent implication that they are insurmountable unless overridden by the authority of an infallible Church. In his own case these views did not lead to scepticism, because he had always possessed the necessary interior conviction; and in writing *Tract 85* his only doubt would have been where the true Church is to be found. But, so far as the rest of the world is concerned, his teaching amounts to this: that the man who has not this interior conviction has no choice but to remain an agnostic, while the man who has it is bound sooner or later to become a Roman Catholic.

He was a man of magnetic personality, with an intense belief in the significance of his own career; and his character may be described as feminine, both in its strength and in its weakness. As a poet he had inspiration and genuine power. Some of his short and earlier poems, in spite of a characteristic element of fierceness and intolerance in one or two cases, are described by Mr R. H. Hutton as "unequalled for grandeur of outline, purity of taste, and radiance of total effect"; while his latest and longest, "The Dream of Gerontius," is generally recognized as the happiest effort to represent the unseen world that has been made since the time of Dante. His prose style, especially in his Catholic days, is fresh and vigorous, and is attractive to many who do not sympathize with his conclusions, from the apparent candour with which difficulties are admitted and grappled with, while in his private correspondence there is a charm that places it at the head of that branch of English literature. He was too sensitive and self-conscious to be altogether successful as a leader of men, and too impetuous to take part in public affairs; but he had many of the gifts that go to make a first-rate journalist, for, "with all his love for and his profound study of antiquity, there was something about him that was conspicuously modern." Nevertheless, with the scientific and critical literature of the years 1850–90 he was barely acquainted, and he knew no German. There are a few passages in his writings in which he seems to show some sympathy with a broader theology. Thus he admitted that there was "something true and divinely revealed in every religion." He held that "freedom from symbols and articles is abstractedly the highest state of Christian communion," but was "the peculiar privilege of the primitive Church." And even in 1877 he allowed that "in a religion that embraces large and separate classes of adherents there always is of necessity to a certain extent an exoteric and an esoteric doctrine." These admissions, together with his elucidation of the idea of doctrinal development and his eloquent assertion of the supremacy of conscience, have led some critics to hold that, in spite of all his protests to the contrary, he was himself somewhat of a Liberal. But it is certain that he explained to his own satisfaction and accepted every item of the Roman Catholic creed, even going beyond it, as in holding the Pope to be infallible in canonization; and while expressing his preference for English as compared with Italian devotional forms, he was himself one of the first to introduce such into England, together with the ritual peculiarities of the local Roman Church. The motto that he adopted for use with the arms emblazoned for him as cardinal—*Cor ad cor loquitur*, and that which he directed to be engraved on his memorial tablet at Edgbaston—*Ex umbris et imaginibus in veritatem*—together seem to disclose as much as can be disclosed of the secret of a life which, both to contemporaries and to later students, has been one of almost fascinating interest, at once devout and inquiring, affectionate and yet sternly self-restrained.

There is at Oxford a bust of Newman by Woolner. His portrait by Ouless is at the Birmingham Oratory, and his portrait by Millais is in the possession of the duke of Norfolk, a replica being at the London Oratory. Outside the latter building, and facing the Brompton Road, there is a marble statue of Newman as cardinal.

The chief authorities for Newman's life are his *Apologia*, and the *Letters and Correspondence*, edited by Miss Mozley, above referred to. The letters and memoranda dealing with the years 1845–90, and entrusted by Newman to the Rev. W. Neville as literary executor, have not yet been published. Works by R. W. Church, J. B. Mozley, T. Mozley, and Wilfrid Ward should also be consulted, as well as an appreciation by Mr R. H. Hutton. Adverse criticism will be found in the writings of Dr E. A. Abbott, while some minor traits and foibles were noted by the present writer in the *Expositor*, September, October, and November 1890. (A. W. Hu.)

Newmarket, a market town in the Newmarket parliamentary division of Cambridgeshire, England, partly also in Suffolk, 13 miles east by north of Cambridge by rail. There are generally from 1500 to 2000 horses in training on the downs. Population (1891), 8631; (1901), 10,686. (See also HORSE-RACING.)

New Mexico, a south-western territory of the United States, bounded on the N. by Colorado, on the E. by Oklahoma and Texas, on the S. by Texas and Mexico, and on the W. by Arizona. It has advanced rapidly in all material matters since the advent of the first railway in 1879. The population was 91,874 in 1870, 119,565 in 1880, 153,593 in 1890, and 195,310 in 1900. The rate of increase from 1890 to 1900 was 27·2 per cent., as compared with 28·5 per cent. for the preceding decade, and the average number of persons to the square mile in 1900 was 1·6. The principal cities are Albuquerque (population, 6238), Las Vegas (3552), and Santa Fé (5603). In 1900 the males numbered 104,228, the females 91,082; the native-born 181,685, and the foreign-born 13,625. The negro population was only 1610, and the Indian 13,144. Of the 55,067 males of 21 years and over, 15,585 were illiterate.

Education.—In 1891 a law was enacted establishing an excellent public school system, which has very much increased the facilities for general education. At its head is a board of four members consisting of the governor, superintendent of public instruction, and two college presidents, the executive functions being exercised by the superintendent. The lack of a school fund of any kind has been a serious impediment to educational progress, but in 1899 sections 16 and 36 in each township of the public domain were granted to the territory as school lands, and each of the territorial institutions received a substantial donation of the public lands. The total average daily attendance in 1900 in the common and city schools was 20,505, as against 12,397 in 1891. Of sectarian schools the Roman Catholics had 18, with 1602 pupils; the Presbyterians 25, with 1105 pupils; the Methodists 11, with 462 pupils; and the New West educational commission had 5, with 219 pupils—making in all 59 schools, with 3388 pupils. In 1889 and 1890 the University at Albuquerque, the Agricultural College at Las Cruces, and the School of Mines at Socorro began their work with substantial buildings; soon afterwards a normal school was established at Silver City, and more recently another at Las Vegas. There is also a military institute at Roswell. In 1900 the number of students in the higher institutions was 800. The total amount of money raised for the common and city schools and the territorial institutions was $511,990.

Penal and Charitable Institutions.—The penitentiary at Santa Fé is a substantial stone structure. It contained in 1900 over 200 prisoners, and was admirably conducted. The principal business, brick-making, was very successful. The territorial insane asylum is situated near Las Vegas, and is always full, as its capacity is not equal to the growth of the territory. The number of patients in March 1902 was 109, 56 males and 53 females. Hospitals at Santa Fé and Silver City have been established many years, and are maintained by the territory according to the number of cases treated. The orphan home at Santa Fé has in charge an average of 33 children, and actually received from territorial appropriation about $3300.

Religion.—The prevailing religion is Roman Catholic, as the original settlement was by Spaniards, whose descendants still constitute the great body of the population, but Methodists, Baptists, Episcopalians, Congregationalists, Presbyterians, Jews, and Mormons have congregations in various localities.

Mining.—Mining progresses favourably in almost all parts. The decrease in the value of silver and the increase of that of lead and copper have caused more attention to be given to the mines which contain the latter. The most important of the newer mines are those at Bland, which contain vast bodies of gold ore of moderate grade; those in Taos county, where important copper and gold mines have been put in operation; those in Rio Arriba, with placer dredging on the Chama river and the production of mica near Petaca, and copper in Copper Cañon and near Coyote are progressing; in Doña Aña, where important copper properties are being worked in addition to the older silver-lead mines in the Organ mountains; in Otero county, where extensive deposits of turquoise have been discovered; and in the vicinity of the old mining districts of Grant, Socorro, and Sierra, where renewed activity has added largely to the output. Iron ore is being shipped in large quantities from the Hanover region of Grant county, and also from the vicinity of Glorieta. The total product of coal in the year ending 30th June 1899 was 1,409,038 tons, principally from Gallup, Cerrillos, and Raton.

Agriculture.—Since 1880 the cultivation of alfalfa has very largely increased, and sorghum has been introduced in many localities. Extensive orchards have been planted everywhere, as all the fruits of the temperate zone grow to great perfection both as to size and flavour. The cultivation of the sugar beet is very successful; the percentage of saccharine matter in the roots is found to be larger in New Mexico, and notably in the vicinity of Santa Fé, than elsewhere in the United States, averaging 16 per cent. and frequently exceeding 20 per cent. This high percentage is attributed to the almost perpetual sunshine. A beet sugar factory has been established at Eddy, and successfully run for several years. The average yield per acre was somewhat over 16 tons. In all of its products, mineral, horticultural, agricultural, and of animal industry, New Mexico is showing a steady and healthful progress.

Irrigation.—Extensive irrigation systems of a modern character have greatly enlarged the area of cultivated land. These have been established in the north-west, in the valleys of the San Juan and its tributaries; in the north-east of the great domain of the Maxwell Grant; in the south-east on the Pecos, where the system is in certain respects the largest in the entire country; in the south-west on the Mimbres, and in the central west on the Blue Water. An important improvement is the establishment of a modern low-line ditch in the valley of the Rio Grande from Peña Blanca to Albuquerque.

Manufactures.—The following table shows the manufacturing and mechanical industries in 1890 and 1900:—

	1890.	1900.
Number of establishments	127	420
Capital	$965,938	$2,698,786
Wage-earners, average number	849	2,600
Total wages	$470,361	$1,350,586
Cost of material used	$691,420	$2,914,138
Value of product	$1,516,195	$5,605,295

New Mexico is a mining and stock-raising region, with agriculture ranking next in importance. The most important manufacturing industry is railway repair works, followed by carpentering, lumber, and timber products, and flour and grist mills.

Railways.—The chief railways are the Denver and Rio Grande, the Atchison, Topeka, and Santa Fé, and the Southern Pacific. The total mileage within the territory in 1900 was 1693.

Banks.—There are national banks in all the principal towns, including Santa Fé, Albuquerque, Las Vegas, Raton, Roswell, and Silver City. Banks conducted under the territorial laws, with a capital smaller than that required for national banks, exist in a number of towns, some of the best known being at Taos, Springer, Whiteoaks, Deming, Eddy, Roswell, Hillsboro, and Las Cruces. Several of the large mercantile houses have a banking department which affords most of the facilities provided by regular banks.

Finance.—The financial condition of the territory is good. The assessed valuation has not varied much from $45,000,000 during the decade 1890–1900. The territorial indebtedness began to be paid off in 1891. The rate of interest on parts of the public indebtedness has been reduced to 4 per cent., which speaks well for the credit of the territory.

Land Claims.—The most important official event in the closing years of the 19th century was the establishment by Congress of the United States Court of Private Land Claims, which is adjudicating the titles of all grants of land made by the Spanish and Mexican authorities, and not previously confirmed. For nearly twenty years earnest efforts had been made without success to secure such a tribunal, and it was finally secured by sending a committee of twenty-five leading citizens, headed by the governor, to Washington, in 1890. It has adjudicated nearly all of the unconfirmed land grants in the territory, thus settling the title to many millions of acres, of which the larger proportion has been restored to the public domain.

Legislation.—The judges of the Supreme Court have been increased from three to five, each presiding in the courts of his own district, and the entire bench forming the appellate tribunal of the territory. The Public School Act of 1891 provided for a territorial superintendent of public instruction. With these exceptions, the government remains as it was in 1880, and probably no important change will occur until New Mexico becomes a state.

Politics.—In politics the territory is Republican, especially on the issues of protection, as the principal products of New Mexico, which are wool, coal, lumber, and lead, are all benefited by a tariff. At the election in 1900 the vote for delegate in Congress was, Republican, 21,567; Democratic, 17,857. (L. B. Pr.)

Newmilns, a burgh of barony and police burgh of Ayrshire, Scotland, 7½ miles east by south of Kilmarnock by rail. Muslin and lace curtain-making is the chief industry, and the manufacture of mosquito-nets has been added. There are a town hall, a workmen's institute, a public library, and an endowed school for girls. Population (1881), 2860; (1901), 4466.

New Orleans, the twelfth city of the United States in population, the capital of the state of Louisiana, and the chief seaport of the Mississippi valley. Until the end of the third quarter of the 19th century it owed its growth and importance in the world at large almost wholly to the fact of its being a gate of export for vast agricultural harvests. The close limitation of its business to the handling of raw products, without giving them the larger values of skilled manipulation, tended to keep this great port comparatively unwealthy, and to retard its growth, so that its relative standing among the American cities with which it was obliged to compete was steadily reduced. Its largest shipments were cotton. After 1875, however, while its cotton exports materially increased, another source of power and expansion was found in a growth, proportionately much larger, of its exports of other great staples; and at the same time a number of influences, some welcome, others unwelcome, turned an increasing share of the city's activities into avenues of business more lucrative and even more stimulative of high social conditions than were, or can be, the mere receipt, sale, and reshipment of staple crops. Under these combined influences the population expanded from 216,090 in 1880, and 242,039 in 1890, to 287,104 in 1900. Of the last number 30,325 were foreign-born and 77,714 were negroes. Out of 75,440 adult males, 10,078 (of whom 7125 were negroes) were illiterate (unable to write). The death-rate in 1900, on the basis of the Federal census of that year, was 28·9 per thousand, the highest of any of the large cities of the United States. This high death-rate is often attributed in great part to the large coloured population, among whom the mortality is estimated to be about 90 per cent. higher than among the whites; but it must be remembered that in New Orleans the coloured population largely comprises that labouring element whose faulty provision for health and sickness in every large city swells the death-rate, so that it is an error to explain away the high figure by this means alone.

Manufactures and Commerce.—In 1890 there were 1961 manufacturing establishments with 25,221 employés, a capital of $26,319,277, and products valued at $48,295,449 (or nearly two and one-half times as much as in 1880). In 1900 there were 1525 manufacturing establishments, having a capital of $46,080,061, employing 19,512 hands, and turning out products valued at $63,574,388. The most important industries, and the value of their products, were as follows: bags (other than paper), $3,443,468; men's clothing, $2,036,069; foundry and machine-shop products, $2,199,854; malt liquors, $1,472,062; rice, cleaning and polishing, $2,924,564; sugar and molasses, refining, $22,684,920. The foreign commerce of the port has increased more rapidly than the population. During the year ending 30th June 1900, in the foreign trade, 1220 vessels with a tonnage of 1,675,434 entered the port, and 1187 vessels with a tonnage of 1,720,008 cleared. During the same period the principal exports were as follows: mules, $2,978,884; Indian corn, $11,423,335; wheat, $6,587,218; cotton (unmanufactured), $66,148,722; oil-cake and oil-cake meal, $4,838,024; cotton-seed oil, $3,347,063; tobacco (unmanufactured), $3,115,389. A change calculated to benefit greatly the commerce of the port came into effect 29th May 1901, when the wharves of the city passed from private to municipal control, a marked reduction was made in the port charges from the schedule under the previous lease system, and a number of important improvements were instituted. During the year ending 30th June 1901 the total exports amounted to $152,776,599, and the imports to $20,462,307.

The growth of the city during the last quarter of the 19th century, moreover, was not merely commercial. In the face of grave reverses—floods, widely disastrous frosts, and a revisitation of epidemic yellow fever in 1897 after an immunity of nineteen years, with its accompanying commercial blight of outside quarantine—visible aspects and social conditions have greatly improved. The modern metamorphosis of the world's carrying trade has altered the inland relations of New Orleans from those of a great river port to those of a still greater railway terminus, and has brought in the more alert energies of modern modes of business. Ocean steamers, loaded in large part by elevators, now bear away the exports for which a swarm of sailing-ships of much lighter draught and average freight-room once made long stays at its wharves. Its passenger traffic on the rivers has practically vanished, and its shrunken fleets of river steamers are devoted to the carrying of slow freights and the towing of barges; but railway traffic has grown immensely, and the city is now entered by six trunk lines: the Illinois Central, Louisville and Nashville, Queen and Crescent, Southern Pacific, Texas and Pacific, and Yazoo and Mississippi Valley. The total number of square yards of streets paved in 1899 was 3,649,000, of streets unpaved, 8,800,000. The mileage of paved streets in 1900 was 205¾ miles, or two and a quarter times what it was in 1880. In 1900 the streets were lighted by 1624 arc lights. The immense crowds on gala days and nights are handled with an extraordinary effectiveness on 163 miles of electric street railway.

Public Improvements.—In keeping with this growth and change, unprecedented efforts are in full progress for the establishment of a system of sanitation so complete as to be a guarantee against any return of epidemic fevers, near or remote. This great public improvement was decided upon by a vote of the taxpayers in 1899, and the work of construction is now going forward rapidly. Hitherto the city had been without a sewerage system in the modern sense, open gutters being the only substitute. The main feature of the new system is an underground piping of the entire city that will carry off all sewage, the backwaters of Gulf storms, and the tremendous rainfalls peculiar to the region. A new water system is also projected, the supply for which is to be procured from the Mississippi river, and to be purified by mechanical precipitation and other means. The revenues of the present Sewerage and Water Board are derived from a fixed tax on real and personal estate of two mills on the dollar, the tax being first collected in 1899. To these measures of such vast practical utility are added many æsthetic improvements, conspicuously the embellishment of one or two public parks and several smaller pleasances. Certain drawbacks that remain are of kinds which naturally wait for their removal upon larger changes in manners and customs. The city's political conditions are variable, and popular modes of improving them are still somewhat too fitful and imperious to ensure the best, if even abiding, results; nevertheless some admirable reforms have been effected. The cause of public education enjoys an increased annual outlay ($426,924 in 1900, not including cost of new buildings), but a very grave proportion of the population of school age appears to be making no use of either public or parochial schools. In 1890 there were 71 public school buildings (valued at $1,600,000) and 752 teachers, but only 31,521 enrolled pupils out of 94,606 persons of school age (5 to 20 years inclusive). Tulane University, named after its benefactor, Paul Tulane, was founded in 1884, and in it was merged the former University of Louisiana. It has grown in many directions, notably by the addition of the H. Sophie Newcomb Memorial College for Women (founded in 1886). In 1900 it had in all its departments 77 instructors and 1145 students, and supplies valuable facilities for higher education; but neither the commercial value of an educated working class, nor the unsafety, both political and sanitary, of letting any large element rest in contented ignorance seems as yet to be effectually recognized.

Recent History.—The history of New Orleans during the period 1880–1900 has been marked by no more violations of public order than other American cities equally large; but one outbreak, on account of the international character that it assumed, should perhaps be recorded. In October 1890 the city chief of police was assassinated, declaring as he expired that the deed had been committed by Italians. He had been active in proceedings against certain Italians accused of crime, and it was popularly believed that his death was the work of a *maffia*, or sworn secret society. The following month eleven Sicilians were indicted for his murder. When nine of them were brought to trial in February 1891, six were acquitted, and three escaped conviction on the ground of a mis-trial. On 14th March 1891 a mob broke into the gaol and lynched the entire eleven. The Italian Government demanded that the lynchers should be punished, entered claims for indemnity in the case of those of the lynched Sicilians who had been Italian subjects, and, failing to secure a satisfactory answer from the American Government, withdrew its ambassador from Washington. The dispute was settled the following year by the payment to Italy by the United States of the sum of $25,000.

Among material things probably the leading obstacle to the best advancement of this thriving city is one the removal of which lies within the province of the national Congress, and has suffered an unfortunate delay. The jettied mouth of the Mississippi river, South Pass, has not for several years given a depth of channel sufficient for the steadily-increasing draught of the vessels that must make use of it if New Orleans is either to retain its vast shipments of raw produce, expand its manufactures, or multiply its markets across the waters of the Mexican Gulf, the Spanish Main, and the Pacific Ocean; but at length Congress has settled an improvement of South-West Pass destined to establish a channel 1000 feet wide and 38 feet in depth.

The city is governed under a charter passed by the state legislature in 1896, as amended by the Acts of 1898 and 1900. In 1900 the total assessed valuation of property was $139,230,232, of which $98,809,815 was real estate and $40,420,417 personal property. The rate of taxation per $1000 was $29, of which $22 was for city purposes. In May 1900 the bonded debt was $20,278,917, which was increased by $12,000,000 later in the year by the sale of public improvement bonds for water and sewerage purposes. During the decade from 1891 to 1900 the expenditures for permanent public improvements (including sewerage, lighting, paving, levees, and improvements in connexion with street and steam railways, docks, &c.) amounted to about $30,000,000, and nearly as much more was spent in the erection of private residences, stores, and other buildings. In 1900 the Board of Assessors placed the valuation of the real estate belonging to the city (including engine-houses, schools, public squares, markets, public buildings, &c.) at $4,731,675. In December 1900 arrangements were made to transfer the extensive markets from the lessee system to direct municipal control. In 1900 the city had a total area of 196·25 square miles, and contained 209 churches, 25 hotels, 7 theatres, and 25 public markets. The total vote cast at the election for mayor, 7th November 1899, was 32,559. In 1900 there were 75,440 males 21 years of age and over.

In the comforts and graces of private life New Orleans retains the peculiar attractiveness for which its society has been noted, while such changes as have taken place have been pointedly advantageous. The old Creole or Franco-American element is at length affiliating socially with the Anglo-American, and the gain and the charm of this better homogeneity is felt alike by the resident and the sojourner. The growth of social refinements, visible in many ways, is in no external feature more beautifully indicated than in the improved taste of the domestic architecture, and in the multiplication and high keeping of the innumerable private gardens of this city of perpetual bloom. (G. W. Ca.)

New Philadelphia, a city of Ohio, U.S.A., capital of Tuscarawas county, on the Tuscarawas river and the Ohio Canal, at the intersection of several railway lines, in the north-east part of the state. Population (1890), 4456; (1900), 6213, of whom 554 were foreign-born.

Newport, a municipal borough and market town in the Isle of Wight, Hampshire, England, on the river Medina, navigable to the town quay, which is 7 miles west-south-west from Ryde. A railway line to Freshwater and Yarmouth has been opened. Population (1881), 9357; (1901), 10,911.

Newport, a municipal and county borough, contributory parliamentary borough, seaport, and market town, in the Monmouth parliamentary district of boroughs, Monmouthshire, England, on the Usk, 4 miles from its confluence with the Severn, 145 miles by rail west of London. The town council consists of 10 aldermen and 30 councillors. In 1889 Maindee was incorporated with Newport, and constitutes one of its five wards. With Monmouth and Usk, Newport returns one member to Parliament. The docks have an area of 60 acres. Modern erections are the town hall (1885), the county council offices (1892), the market hall, almost entirely rebuilt in 1889, baths (1890), and museum and art gallery (1895). There are two daily newspapers. The industries include shipbuilding, with dry docks for repair of ships, the making of railway plant, chemical manures, and agricultural implements. In 1888, 112 vessels of 32,146 tons were registered; in 1900, 82 of 23,654 tons. Ships entering port in 1888 numbered 4164 of 1,729,332 tons; clearances, 4135 of 1,718,515 tons. In 1900 entrances numbered 6726 vessels of 2,179,300 tons; clearances, 6717 of 2,166,020 tons. Imports of foreign and colonial produce for 1900 were valued at £1,125,869, against £764,725 for 1888; exports of produce and manufactures of the United Kingdom for 1900 at £3,355,623, against £1,816,647 in 1888. Area of county borough, as extended in 1889, 4924 acres. Population (1881), 38,469; (1891), 54,707; (1901), 67,290.

Newport, a city of Campbell county, Kentucky, U.S.A., on the Ohio river, at the mouth of Licking river, opposite Cincinnati, in the northern part of the state, at an altitude of 515 feet. It is connected with Cincinnati and with Covington, on the other side of Licking river, by railway and waggon bridges. It is on the Chesapeake and Ohio and the Louisville and Nashville railways. The city is well laid out, with six wards, has a water supply owned by the city, and is paved mainly with macadam. It is to a large extent a residential suburb of Cincinnati, but it has also important industries of its own. In 1900 its manufacturing establishments numbered 272, with a total capital of $2,848,435. The average number of wage-earners employed was 2561, and the products were valued at $4,888,169. The principal item was foundry and machine-shop products, which had a value of $922,014. The assessed valuation of real and personal property was, in 1898, $10,373,900; the net debt of the city was $1,303,676, and the rate of taxation $26.35 per $1000. Population (1890), 24,918; (1900), 28,301, of whom 4081 were foreign-born and 424 were negroes.

Newport, a city of Rhode Island, U.S.A., capital of Newport county, and one of the two capitals of the state, at the southern end of Rhode Island in Narragansett Bay. It is the most fashionable seaside resort in the United States, the town proper being surrounded by splendid villas, with beautiful drives in different directions. Its pre-eminence as a seaside resort is due probably to the excellence of its harbour, appreciated by the yachting fraternity, its fine bathing beaches, its accessibility, being connected by rail and daily boat with New York, and its insular climate, which tempers the summer heat. Newport has little commerce. In 1900 there were 290 manufacturing establishments, with products valued at $3,442,998. The harbour is defended by Fort Adams, on a point across the harbour from the city. On Coasters Harbour Island are the Naval War College, torpedo station, and naval training school. Population (1890), 19,457; (1900), 22,034, of whom 5563 were foreign-born and 1613 negroes. These are the figures of the resident population, excluding summer visitors, who come in large numbers in August.

Newport News, a city and seaport of Virginia, U.S.A., on the point to the north of the entrance to James river and on Chesapeake Bay. Though within the limits of Warwick county, it is independent of county government. It has a level site and a regular plan, a water supply, and other municipal improvements. It is the eastern terminus of the Chesapeake and Ohio Railway, and, having a very fine harbour, is rapidly becoming a seaport of great importance, rivalling its much older neighbour, Norfolk. Its imports for the year ending 30th June 1901 amounted to $4,090,451; its exports amounted to $32,567,912, and consisted mainly of bread-stuffs, cattle, cotton, lard, and tobacco. It has a large iron shipbuilding plant, the capacity of which is shown by the fact that several vessels of the U.S. navy have been built there, including two of the largest battleships, which were constructed simultaneously. In 1900 there were 123 manufacturing establishments, having a capital of $14,999,735, employing 5675 hands, and turning out products valued at $6,976,670. Population (1890), 4449; (1900), 19,635, of whom 1614 were foreign-born and 7698 negroes.

Newquay, a popular English watering-place, in the St Austell parliamentary division of Cornwall, 14 miles north of Truro, with a station on a branch of the Great Western Railway. Since 1894 it has been governed by an urban district council. The cliff scenery of the coast is very grand, and there is a fine sandy beach two miles long. The harbour admits vessels of 250 tons. The chief exports are iron and other ores, china-clay, granite, fish, and grain. The imports are coal, salt, and manures. Population of urban district (1891), 1891; (1901), 2935.

New Rochelle, a city of Westchester county, New York, U.S.A., on the shore of Long Island Sound and on the New York, New Haven, and Hartford Railroad, in the south-eastern part of the state. Its site is undulating and its plan fairly regular. It is little more than a residential suburb of New York City, having little commerce or manufactures. Population (1880), 5276; (1890), 9057; (1900), 14,720, of whom 4425 were foreign-born and 777 negroes.

New Ross, a market town and urban sanitary district, county Wexford, Leinster, Ireland, on the left bank of the Barrow, 85 miles south-south-west of Dublin by rail. It ceased to be a parliamentary borough in 1885, and in 1898 the portion situated in Kilkenny was added to Wexford. New quays have been erected. Population (1881), 6626; (1891), 5847; (1901), 5876.

Newry, a maritime town, urban sanitary district, and parliamentary borough (returning one member) in the province of Ulster, Ireland, on the Newry water at the head of Carlingford Lough, 63 miles north of Dublin by rail. In 1898 the portion situated in Armagh was added to Down. The port admits vessels of 2000 tons to Victoria Locks, three miles from the town, but vessels drawing 15 feet can go up the ship canal to the Albert Basin, three miles from the sea. The Newry Navigation have deepened the river at a cost of £53,000. In all, 1522 vessels of 198,661 tons entered in 1900, and 1017 of 153,829 tons cleared. A railway connects the Great Northern system with the deep-water harbour at Greenore, and an electric line has been constructed to Bessbrook. Population (1881), 15,085; (1891), 12,961; (1901), 12,587.

New Siberia Archipelago, a group of islands situated off the Arctic coast of Siberia, from 73° to 76° 6′ N., and 135° 20′ to 148° E. The name is loosely applied either to the northern group only of these islands, for which the name of New Siberia Archipelago, or of Anjou Islands, ought properly to be reserved, or to this northern group as well as to the southern, which ought to maintain its name of Lyakhoff Islands. Some confusion prevails also as to whether the islands Bennett, Henrietta, and Jeannette, discovered by the *Jeannette* expedition, ought to be included in the same archipelago, or described separately as the Jeannette Islands. The first of these three belongs geographically, and probably geologically, to New Siberia Archipelago, from which it is only 97 English miles distant, but for the present it must be counted separate. As to Henrietta and Jeannette Islands, situated 200 English miles north-east of New Siberia Island, under 157° to 159° E., they can hardly be included in New Siberia Archipelago. There seems, moreover, to exist, due north of Kotelnyi Island of New Siberia Archipelago, in 78° N., a land which was sighted first by Sannikoff and described as Sannikoff Land. It has been sighted also by Baron Toll.

The *New Siberia* or *Anjou Islands* consist, beginning from the west, of Kotelnyi, the largest of them (116 miles long, 100 miles wide), having the small island Byelkovskiy near its western shore; Thaddeus (Faddyéevskiy), in the middle; and New Siberia (Novaya Sibir), in the east (90 miles long, 40 miles wide). Kotelnyi is the highest and the most massive of the four, reaching a maximum altitude of 1200 feet in the Malakatyn-tras mountain. Its north-east portion consists of Upper Silurian coral limestones (Llandovery division), containing a rich fossil fauna, and representing a series of folds running north-north-west. The same Silurian deposits are widely spread on the mainland as far as Olenek. The western portion of Kotelnyi is built up of Middle Devonian limestones and slates, folded the same way, of which the fossil fauna is similar to that of the Urals. Triassic slates appear in the south-east. Diabases pierce to Devonian rocks, and Olivine rocks appear as dykes amidst the Triassic deposits. The Malakatyn-tras is also made up of volcanic rocks. The eastern portion of the island, named Bunge's Land, is thickly covered with Post-Tertiary deposits. The geology of Thaddeus Island, which has a long promontory, Anjou, protruding north-westwards, is not yet known.

As to New Siberia Island, it attains altitudes of from 200 to 300 feet in its western portion. A range of hills, composed of Tertiary deposits, and named Hedenström's Mountains, runs along its south-western coast, and the same rocks form a promontory protruding northwards. The so-called Wood Mountains, which were supposed to be accumulations of floating wood, are denudations of Miocene deposits containing layers of brown coal with full stems of trees. These Tertiary deposits are characterized by a rich fauna; fully developed leaves of poplars (*Populus arctica* and *P. Richardsoni*, Heer), numerous fruits of the mammoth tree (*Sequoia Langsdorfii*, Brogt.), needles of several conifers (*Taxites tenuifolia*, Schmidt; *Taxodium distichum miocenum*, Heer), &c., being found in them, thus testifying to a once very much warmer climate. The only representative of tree vegetation now is a dwarf willow one inch high.

The *Lyakhoff Islands* consist of the Bolshoi (Large), or Blizhniy (Nearest), which is separated by Lapteff Strait, 27 miles wide, from Cape Svyatoi of Siberia; Malyi (Small), or Dalniy (Farthest), to the north-west of Blizhniy; and three smaller islands—Stolbovyi (Pillars), Semenovskiy, and Vasilievskiy—to the west of Malyi. Dr Bunge found Large Island consisting of granite protruding from beneath non-fossiliferous deposits; while Svyatoi Nos promontory represents basalt hills 1400 feet high. Along the southern coast of Large Island Baron Toll found immense layers of fossil ice, 70 feet thick, evidently relics from the Ice Age, covered by an upper layer of Post-Tertiary deposits containing numbers of perfectly well-preserved mammoth remains, rhinoceros, *Ovibos*, and bones of the horse, reindeer, American stag, antelope, *saiga*, and even the tiger. The proof that these animals lived and fed in this latitude (73° 20′ N.), at a time when the islands were not yet separated from the continent, is given by the relics of forest vegetation which are found in the same deposits. A stem of *Alnus fruticosa*, 90 feet high, was found with all its roots and even fruits.

Basalts and Tertiary brown coal deposits enter into the composition of the southern extremity of Bennett Island, and the mountains of Sannikoff Land, seen by Toll, have the aspect of basaltic "table mountains."

The climate of these islands is very severe. In 1886 the winter ended only in June, to begin anew in August (21st May, $-21°$; 16th October, $-37°$ Celsius). The highest summer temperature was 10°. Notwithstanding that, flocks of *Larus argentatus*, geese, and *Somateria spectabilis* come to the islands from the north (Bunge and Toll), as also *Tringa islandica* and the gull *Lestris pomarina*, which feeds chiefly on the lemming (*Lemmus obensis*). The lemmings are very numerous, and undertake in certain years migrations to the mainland and back. Reindeer, followed by wolves, come also every year to the islands; the polar fox and the polar bear, both feeding on the lemmings, are numerous. Hunters come in numbers to the Lyakhoffs, which must have been known long since to Arctic hunters. A Yakutsk Cossack, Vaghin, wintered on Large Island in 1712, but it was a merchant, Lyakhoff, who first described the two greater islands of this group in 1770, and three years later reached on sledges the largest island of the New Siberia group, which he named Kotelnyi. The Lyakhoffs were mapped in 1777. J. Sannikoff, with a party of hunters, discovered in 1805–8 Stolbovyi, Thaddeus, and New Siberia Islands, and a merchant, Byelkoff, the Byelkovskiy Islands. He sighted the land in the north of Kotelnyi and the land in the north-east of New Siberia (now Bennett Island). Hedenström, accompanied by Sannikoff, explored the archipelago and published a map of it in 1811. Lieutenant Anjou revisited it in 1821–23. A scientific expedition under Dr Bunge (including Baron Toll) explored these islands in 1885–86. Baron Toll with Lieutenant Shileiko revisited them in 1893, and again in 1900.

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(P. A. K.)

NEW SOUTH WALES.

I. GEOGRAPHY AND STATISTICS.

NEW SOUTH WALES, the oldest state of the Australian Commonwealth, lies on the eastern side of the island-continent, and is bounded on the N. by Queensland, on the E. by the Pacific, on the S. by Victoria, and on the W. by South Australia.

Geology.—Exploration has added very materially to our knowledge of the sedimentary formations found in the state. To the Rev. W. B. Clarke is due the credit of making the first systematic classification of these formations; this classification has, however, been somewhat modified, and the rocks as they are now known are classified as follows:—

Cainozoic	Post-Tertiary	Recent.
		Pleistocene.
	Tertiary	Pliocene.
		Miocene.
		Eocene.
Mesozoic	Cretaceous	Upper Cretaceous—Desert Sandstone.
		Lower Cretaceous—Rolling Downs Formation.
	Jurassic.	
	Triassic—Hawkesbury Series	Wianamatta Shales.
		Hawkesbury Sandstones.
		Narrabeen Shales.
Palæozoic	Permo-Carboniferous	Upper Coal Measures.
		Dempsey Beds.
		Middle Coal Measures.
		Upper Marine Series.
		Lower Coal Measures.
		Lower Marine Series.
	Carboniferous.	
	Devonian.	
	Upper Silurian.	
	Lower Silurian.	

Palæozoic rocks extend throughout almost the whole eastern portion of the state, principally on the western watershed of the main dividing range, in the country where the Murrumbidgee, Lachlan, and Abercrombie rivers rise. They appear on the eastern watershed, along part of the coast near Bateman's Bay, and, striking inland, are found in the basin of the Clyde and the upper valley of the Shoalhaven. Slates containing Lower Silurian fossils (graptolites) have been found at three localities in New South Wales, on the border of Victoria, to the south and south-west of Delegate; at Myall Reefs, near Tomingley, and at Cadia, near Orange. The Upper Silurian rocks extend as far north as Mudgee, where they are overlain by the Permo-Carboniferous strata of the Hunter Valley, and by the belt of volcanic rocks extending along the Liverpool range. They reappear farther north, in the upper valley of the Macleay river on the east slope, and in the basin of the Namoi, on the west side of the dividing range. The Silurian rocks consist of sandstone, slate, and limestone, and exhibit evidence of metamorphism, particularly in the country around Bathurst and Hill End. Limestone beds of considerable extent are scattered throughout this formation. These are chiefly composed of crinoids and corals, which outcrop prominently in the Wellington district, near Molong and Gulgong, at Tuena, and also in the Murrumbidgee district. In the limestone formations are found magnificent caves, such as the Wellington, Wombeyan, Jenolan, Bungonia, and Abercrombie, the fame of which has spread even beyond the confines of Australia. The caves at Yarrangobilly, in the Kiandra district, are also very attractive. The Devonian rocks are well seen at Mount Lambie, near Rydal, where the late Mr C. S. Wilkinson measured a section of strata showing a thickness of not less than 10,000 feet. They also occur in the northern, southern, and western districts.

The coal-bearing rocks are of three distinctive systems, the first of which is in all probability of Lower Carboniferous age; but the coal is full of bands, and otherwise too dirty to be of any economic value.

The second system, known as the Permo-Carboniferous, contains many seams of workable coal. Productive Coal Measures occur in this system on three horizons: the first and lowest of these is the Greta (Stony Creek) series, the second the Tomago (East Maitland) series, and the last and uppermost, the Newcastle series. The total thickness of this system and its associated strata at Newcastle is about 11,000 feet, containing a total thickness of about 150 feet of coal, without taking into account seams of less than 3 feet in thickness. Borings at Cremorne, a point on the northern margin of Sydney harbour, as well as at Holt-Sutherland and Liverpool, show the continuous extension of at least the upper or Newcastle series of coal-seams between Newcastle on the north and Bulli on the south.

The third system comprises the Clarence Carboniferous basin, and is of Mesozoic age. Professor David estimates the length of that part of it which contains the principal seams to be about 65 miles from east to west, while its width is about 37 miles from north to south. The most remarkable beds in the Clarence basin are a series of massive whitish sandstones, which were considered by Mr C. S. Wilkinson to be the equivalents of the Hawkesbury sandstones, and were named by him "The Middle Clarence Series," occupying as they do an intermediate position between the upper and lower coal-beds of the basin. None of the seams in this coal-field have as yet been proved to be of commercial value. Professor David estimates the top seam to contain 1 foot 9 inches, out of a total thickness of 5 feet 7½ inches, of coal fit for ordinary consumption, while the second and third seams have not been sufficiently tested to allow of a definite opinion being formed of their value. It is probable, however, that even if the seams prove to be of insufficient thickness and purity to yield coal fit for purposes of export, they may supply coal of fair quality for local requirements.

The Hawkesbury and Wianamatta series, which overlie the Carboniferous formation of that part of the country through which the Hawkesbury and its principal tributaries flow, belong to the Mesozoic period. It is in this series that the wonderful gorges of the Blue Mountains and the beautiful harbours of Port Jackson, Port Hacking, and Broken Bay occur. The rocks consist of grey, purple, and chocolate-coloured shales and yellowish-grey sandstones, and the maximum thickness of the strata is estimated at 1700 feet. The Triassic rocks form the principal store-house of the artesian water-supply of the north-western portion of the state, where they underlie the rolling downs or Lower Cretaceous formation. Most of the deeper bores in this arid region obtain the bulk of their supply of water from the Triassic sandstones. The Wianamatta formation extends round Sydney, and covers a space in the shape of an irregular triangle, the angular points of which rest at Picton on the south, Richmond on the north, and Sydney on the east. The beds are composed of fine sedimentary deposits of argillaceous shales, and are of comparatively little thickness. They appear to have been deposited in hollows worn by denudation out of the sandstone on which they directly rest. Neither the Narrabeen shales, nor the Hawkesbury sandstones, nor the Wianamatta shales, contain any remarkable seams of coal. All three formations are intersected by igneous dykes, which have also intruded the underlying Permo-Carboniferous rocks; and where they have come in contact with the coal-seams, the latter have been converted into coke, sometimes to a thickness of 3 feet or more. Jurassic rocks have been recognized in only one locality in New South Wales, viz., on the Talbragar river, about 20 miles north of Gulgong, where they occupy a denuded hollow in the Hawkesbury sandstones. They are of small extent, and consist of yellowish shales containing numerous fish and plant remains.

The Cretaceous formations occupy the north-western part of the state, extending from the Barwon westwards towards the north-western corner. Water-bearing strata have been reached at depths varying from 89 feet to 2070 feet, and large quantities of water have been obtained, though principally from the underlying Triassic sandstones. The existence of subterranean water throughout this extensive region has been practically demonstrated.

To the Cainozoic period belong the deposits covering the greater portion of the central and western districts of the state. It therefore embraces the valleys of the great western rivers and their chief tributaries. The formation is, however, intersected by a broad broken belt, chiefly of Silurian rocks, extending across its centre, from the Bogan river towards the Great Barrier Range on the farther side of the Darling. Large patches of Devonian rocks are also met with in the same region. Making these deductions, the Post-Tertiary rocks cover more than one-third of the whole state. The vast alluvial plains were formed during the Pliocene and Post-Pliocene periods. The alluvial deposits are of variable thickness, sometimes shallow; but in the great plains, between the main rivers which intersect the country, the deposits are of very great depth.

The area occupied by Igneous and Metamorphic rocks comprises one-eighth of the colony—the principal rocks belonging to the series consisting of varieties of granite, quartz-porphyry and felstone, diorite, basalt, and serpentine. Granite occurs for the most part in the northern and southern masses of the great dividing range, but is found outcropping throughout the Silurian deposits, which cover so large a part of the centre of the state. Diorite and basalt occur principally in the country between the Macleay and Manning rivers, and on both slopes of the Liverpool Range, between the upper waters of the Namoi and Macleay. Serpentine is found scattered in different parts of the state, chiefly at Gundagai, Bingara, Lucknow, Nundle, Yulgilbar on the Clarence river, and Port Macquarie. The granites, quartz-porphyries, and felstones have been recognized as belonging to the Palæozoic age, whilst the volcanic rocks, basalts, and others are chiefly contemporaneous with the Tertiary series. At Kiama there is an immense development of interbedded basalt lavas and tuffs in the Permo-Carboniferous rocks.

Artesian Water.—Before actual boring operations proved that the belief was well founded, it had long been scientifically demonstrated that there was every probability of water being obtained in the Cretaceous formation which underlies the whole of the north-west portion of New South Wales—a region favoured with only a sparse rainfall; and from an examination which has been made of this formation occurring in the western and north-western portions of the state, it is considered probable that the artesian water-bearing basin will be found to extend much farther south than it was previously supposed to do. It may, indeed, be yet found to extend approximately along the course of the Lower Darling. An important discovery has also been made that artesian water is obtainable in other than Cretaceous rocks. This is borne out by palæontological evidence; and some of the most successful bores, such as those at Coonamble, Moree, Gil Gil (Moree to Boggabilla), and Euroka (Walgett to Coonamble), have pierced rocks of Triassic age, corresponding with the Ipswich Coal Measures.

As to the *natural features* and *climate*, nothing need be added to what was said in those respects in the ninth edition of this work (vol. xvii. p. 408), the correctness of which extended observations have served to confirm.

Population.—The population on the 1st January 1901 was 1,359,943, viz., 713,896 males and 646,047 females. The total includes 10,974 Chinese and 7434 aborigines and half-castes. Since 1860 New South Wales has added more largely to its population than any of the other Australian states. In the year named the population was 348,546; in 1890 the number was 1,121,860. From 1890 to 1901 the population increased 238,083, or at the rate of 21·2 per cent. By far the largest part of the increase is due to excess of births over deaths, for out of the increase of over 1,000,000 since 1860, only 350,000 was due to immigration. In 1899 there were 36,461 births and 15,901 deaths; these figures are equal to 27·10 and 11·82 per thousand respectively. The birth-rate has fallen very much, especially during the last ten years of the 19th century. In 1861–65 it was 42·71 per 1000; in 1896–99 it was only 27·92 per thousand. Illegitimacy is increasing in New South Wales, and in 1899 the proportion of illegitimate births was 7·16 per cent. of the total births. In 1871–75 it was 4·09 per cent. of the total births; in 1896–99 it had risen to 6·84 per cent. The marriage-rate for 1899 was 6·89 per thousand, and the persons married 13·78 per thousand. The mean for 20 years was 7·39. The chief cities are Sydney and suburbs, population in 1901, 488,382; Newcastle and suburbs, 54,991; Broken Hill, 27,518; Parramatta, 12,568; Goulburn, 10,610; and Maitland (East and West), 10,085. There are nine other towns with between 5000 and 10,000 inhabitants each.

Administration.—Some important changes have been made in the electoral system. The number of members of the Legislative Assembly has been fixed at 125, and the boundaries of the electoral districts are from time to time adjusted so as to preserve, as far as possible, an equality in the number of electors in every district. The suffrage is extended to all males over twenty-one years of age, with the usual restrictions in regard to the pauper and criminal classes. An elector has only one vote, which is attached to the district in which he resides. Members of the Legislative Assembly are allowed a salary of £300 a year. There were in 1899 about 325,000 electors. Each electoral district returns one member. Local government is confined to the centres of population. There are 189 municipalities, embracing an area of 2824 square miles, which is an insignificant proportion of the whole area of the colony (310,700 square miles). The municipalities, however, contain 815,000 persons, out of a total population of 1,359,943. Rates are levied on the estimated fair annual rental of properties liable for assessment, and in 1900 the assessed value was £7,905,350, representing a capital value of £124,541,800, the value of Sydney and suburbs being £5,069,630 annual and £88,116,600 capital value. The revenues of all the municipalities in 1900 amounted to £806,057. Where water-supply has been provided to municipalities the local bodies control the works. In 1900, 17 municipalities owned their own gasworks and 6 had electric lighting. The various local bodies had outstanding loans to the extent of £2,731,334, of which £1,344,004 had been raised in London, and the balance in Sydney. The municipalities maintained 7500 miles of road, about half this length being formed; the state maintained about 42,000 miles, so that there were nearly 50,000 miles of road communications.

Religion.—The proportions of the leading denominations have not altered to any considerable extent since 1891. The proportions then were:—Church of England, 44·8 per cent.; Roman Catholic, 25·5; Presbyterian, 9·7; Wesleyan and other Methodists, 9·8; Congregationalist, 2·1; Baptist, 1·2; others, 6·9. In 1901, 72·18 per cent. of the population were Protestants and 25·96 per cent. Roman Catholics. Sydney is the seat of Anglican and Roman Catholic archbishoprics; the Anglican archbishop is also primate of Australia and Tasmania.

Education.—The state has in its employ 2755 male and 2308 female teachers, and maintains 2745 schools. The law requires that all children over six years and under fourteen years shall attend school, and in 1900, 250,000 children of these ages, as well as 49,000 others below or beyond the school ages, were receiving instruction, making a total of 299,000. Of this number 239,000 were in state schools and 60,000 in private schools. The majority of the private schools are controlled by one or other of the religious bodies. The Roman Catholic Church has 325 schools, with 1617 teachers and an attendance of 32,000 pupils. The total expenditure of the state on public instruction, science, and art during the year ended 30th June 1900 was £873,824. During the calendar year 1900 a sum of £780,216 was expended on primary instruction. The fees from pupils amounted to £82,494, making the actual cost of primary instruction £697,722. There are a university and a technical college in Sydney.

Finance.—The revenue is derived from three main sources, viz., taxation, sale and lease of lands, railways, tramways, and other services. In 1900 the sums received under these headings were:—From taxation, £2,618,066; from land, £2,116,076; and from services rendered (railways, tramways, posts and telegraphs, &c.), £4,992,521: there were miscellaneous receipts to the extent of £244,014, so that the total revenue was £9,970,677. The direct taxation is represented by a tax of one penny in the pound on the unimproved value of land, sixpence in the pound on the annual income derived in the state from all sources, except the use and occupation of land and improvements thereon. There are also various stamp duties. The land revenue is derived partly from the alienation of the public estate, either absolutely or under conditions, and partly from the occupation of the public lands. There is also a small revenue from mining lands, timber licences, &c. The state still holds 150 million acres out of a total of 198 million acres, having alienated about 48 million acres. The principal heads of expenditure were:—Interest on public debt, £2,310,271; redemption of loans, £264,562; working expenses—railways, £2,025,720; posts and telegraphs, £722,110; public instruction, £769,576; hospitals and charities, £394,637; military and naval, £212,405; other services, £3,189,696, making a total of £9,888,977. The expenditure has been fairly stationary since 1893. The public debt in 1900 was £65,332,993, equal to £48 per inhabitant. The public debt has risen from £14,903,919 since 1880. Of the total debt in 1900 (£65,332,993) the amount of £2,181,584 was unfunded, and £55,060,650 was held in London.

Defence.—The defence force at 30th June 1900, exclusive of Rifle Club reservists to the number of 1500, mustered 9152; of these 824 were permanent troops, 4440 partially paid, 3305 volunteers, and naval volunteer force 583. The annual expenditure upon defence in 1900 was £249,271. Besides the maintenance of the military forces, there is an annual expenditure from loans upon fortifications; this for the year 1900 amounted to £29,427. There is also a small expenditure upon the maintenance of the works at the naval station at Port Jackson, which have been erected at a cost to the state of £312,481.

Production.—Very material changes have taken place since 1882 in the industrial position, due to a variety of causes, chief amongst which were the opening of the Broken Hill silver mines, the extension of agriculture, and the opening up of the central districts, with the substitution of small holdings for the large pastoral areas under which the land was previously held. In 1880 there were 39,918 holdings over one acre in extent, embracing 22,721,603 acres; while in 1900 the separate holdings numbered 68,098, and their area was 45 million acres, in all cases excluding land leased from the Crown. This change in the character of the occupation of the country has had a very natural effect upon all rural industries and on trade generally. The main changes are briefly alluded to hereunder.

Agriculture.—New South Wales is essentially a pastoral country, and the cultivation of the soil has always been secondary to stock-breeding. This circumstance is by no means due to lack of good land, nor can it be ascribed to defects of the climate. But success in tillage in New South Wales is altogether independent of the mere fitness of the soil for cultivation. An irregular rainfall and a want of uniformity in the seasons, which are the chief characteristics of the climate of a large part of the interior, have impeded the advance of agriculture, especially on the great western plains. And to these obstacles there may be added the cost of transport, which, owing to the great distance that produce would have to be carried by land before it can reach a seaport, has told greatly against cultivation for export, which must be the chief hope of the farmers in a country so sparsely populated and affording such a small home market. These reasons will explain how it has happened that for many years such slow progress was made in agriculture. In 1882 the breadth of land under cultivation was 733,582 acres, which is slightly less than one acre per inhabitant; in 1900 the total area under cultivation was 2,440,968 acres, which is equal to 1·86 acres per inhabitant. The area devoted to each of the principal crops was as follows:—Wheat, 1,840,979 acres; maize, 214,697 acres; oats, 134,529 acres; barley, 8623; other cereals, 4885; lucerne and other green crops, 107,880; sugar-cane, 22,517; potatoes, 34,968; oranges, 14,533; vines, 8278; other fruits, 31,716; other crops, 17,363. The total value of all produce harvested in 1900 was £5,582,000. Although the coastal districts are still important, as the crops yielding the largest returns per acre are grown there, as regards total area under crop they are of much less importance compared with the whole state than formerly. For agricultural purposes New South Wales is naturally divided into six zones; these, with the total area under crop in each, are as follows:—Coast districts, 316,403 acres; tablelands, 663,030; western slopes of tableland, 1,004,456; Riverina, 387,710; western plains—east-Darling, 23,303; western plains—trans-Darling, 6066. On the great western plains, comprising an area of 136,896 square miles, less than 30,000 acres are cultivated. The soil of that part of the country is for the most part suitable for cultivation, and there are large areas of rich land, but the rainfall is too light and irregular for the purposes of agriculture.

In 1898 New South Wales for the first time became an exporter of wheat, but a small import was again necessary in 1899. Hay crops and maize rank next in importance to wheat. The cultivation of various kinds of fruit is receiving increased attention, but the growing of sugar-cane and tobacco and the production of wine, until recently so promising, are, if not declining, at least stationary, in spite of the suitability of the soil of many districts for these crops. The progress of agriculture since 1880 will be seen from the fact that in that year the total area cropped was 635,641 acres, and in 1900 it was 2,440,968 acres.

Grazing.—In spite of the great attention now bestowed upon agriculture, the grazing industry still holds the chief place amongst the productive industries. The number of stock depastured in 1900 was, however, much less than in any year since 1886, due solely to the droughts, which during the preceding five years (1895–99) played havoc with the flocks. In 1894 the flocks and herds numbered 518,000 horses, 2,465,000 horned cattle, 57,000,000 sheep, and 273,000 swine; in 1900 the numbers had fallen to 481,417 horses, 1,983,116 horned cattle, 40,020,506 sheep, and 256,577 swine. The vast majority of the sheep are of the merino breed, but there are about a million long-woolled sheep, and between two and three million cross-bred.

There are 68,098 holdings exceeding one acre in extent, and the area occupied is 164,886,804 acres, of which 45,086,209 acres are owned by private persons and 119,800,595 acres by the Crown. About 3 million acres are used for purposes of tillage or are in fallow, and the remainder for grazing and dairying.

Mining.—The mining industry has made great strides. In 1899 there were about 43,000 men engaged in the various mines, besides 3300 employed in smelting. Nearly half this number (19,350) were employed in gold-mining; in coal-mining there were

10,300; silver, 7900; tin, 1500; and copper, 2400. The value of mining machinery may be approximately set down at £2,800,000. The following summary shows the value of the production of the various minerals since their first discovery, as well as the value of minerals won in 1899. It is impossible to separate the values of silver and lead contained in the ore exported from Broken Hill and other fields, but an estimate based upon the best data available gives their approximate values as—silver, £21,559,600, and lead, £6,458,800.

Minerals.	Produced in 1899.	Total Production.
Metallic—		
Gold	£1,751,815	£47,546,013
Silver and lead	2,170,446	28,018,436
Zinc	49,207	112,879
Tin and tin ore	90,482	6,382,538
Copper and regulus	395,451	5,019,480
Iron oxide	846	10,644
Antimony and ore	2,694	190,621
Bismuth	3,355	50,880
Manganese oxide	...	1,331
Chrome iron ore	17,416	70,975
Platinum	1,070	11,425
Non-metallic—		
Coal	1,325,799	35,647,004
Coke (not included with coal)	77,130	371,106
Kerosene shale	40,823	1,908,482
Alunite	2,763	37,958
Cobalt	899	3,380
Diamonds	10,350	49,872
Opals	135,000	376,599
Other	4,970	124,322
Total	£6,080,516	£125,933,945

The value of gold won in 1899 (£1,751,815) was a considerable increase over the production of the previous year and of any year since 1863. As no new fields of importance have been discovered, this increased yield was doubtless due to an improvement in methods. About one-fifth of the gold won is alluvial. The yield of gold from quartz mines was in 1899, 12 dwt. 2 grains per ton, which was somewhat below the average for the previous ten years. The Broken Hill silver lode is the largest as yet discovered; it varies in width from 10 feet to 200 feet, and may be traced for several miles. The Broken Hill Proprietary Company owns the principal mine, and at Port Pirie, in the neighbouring colony of South Australia, has erected a complete smelting plant. From the commencement of mining operations in 1855 to the beginning of June 1900 the company treated 4,594,611 tons of ore, producing 103 million ounces of silver and 419,000 tons of lead, valued at £21,632,000. The production of tin has rapidly declined since 1881, when the value of ore raised was £569,000; in 1899 the production was only £90,000. One cause of this falling-off was the drop in the price of the metal, but the principal cause was the exhaustion of the shallow deposits of stream tin, from which most of the ore was obtained. The high rates ruling in 1899, however, caused an advance in production in 1900, the output being valued at £142,724. The principal deposits of copper are in the central parts between the Macquarie, Bogan, and Darling rivers. The value of the production fell from £473,000 in 1883 to £64,000 eleven years later, but in 1900 had again increased to £425,301. Iron is widely diffused, principally in the form of magnetite, brown hæmatite, limonite, and bog iron. Coal-mining is carried on in three districts. In the northern or Hunter river district there were 57 collieries, employing 8000 men, and the quantity of coal raised was in 1899 about 3,260,000 tons; in the southern district there were 14 collieries, employing 2100 men and raising 1,120,000 tons of coal. The western or mountain collieries were 17 in number, employing 400 men and raising about 218,000 tons. About 70 per cent. of the coal obtained is exported.

Manufacturing Industry.—There are a large number of manufactories, but only 222 employ more than 50 hands. The following is an analysis of the establishments at the close of 1900:—

Establishments with	Number.	Total Hands.
Under 10 hands	1888	10,361
11 to 20 ,,	572	8,449
21 to 50 ,,	395	12,406
51 to 100 ,,	131	8,862
Over 100 ,,	91	20,701
Total	3077	60,779

Of the 60,779 hands employed in 1900, 24,312 may be said to find employment in connexion with industries which come into competition with imported goods, while 36,467 were employed in domestic industries treating perishable produce required for immediate use, or in industries called into existence by the natural resources of the state. About two-thirds of the hands are employed in Sydney and the adjacent district, where the facilities for the establishment of large industries are considerable. The total value of the articles produced in manufactories, and the increased value of materials after undergoing treatment, is approximately £16,300,000, of which about £7,500,000 represents value of material used—£400,000 fuel and £4,750,000 wages. Very fair progress was made in the manufacturing industries up to the year 1892, but in the following year the banking crisis so unsettled affairs that there was a large reduction in the number of hands employed. There was a partial recovery in the following year, and in 1898 the lost ground was fully recovered. Of the hands employed in 1900, 50,516 were males and 10,263 females, making a total of 60,779.

Commerce.—The over-sea trade required in 1900 the services of 3626 vessels; the tonnage entering the ports, excluding the coastal shipping, was 4,094,088 tons. The value of goods imported in 1900 was £27,561,071. Of the imports, £18,270,043 were retained for home consumption and £9,291,028 were re-exported. The average value of imports per inhabitant was, in 1900, £20, 4s. 7d., and of exports, £20, 13s. 5d. Of purely local produce, the value of the exports in 1900 was £18,873,488, or £13, 17s. per inhabitant.

Wool is the staple export, and represents in most years nearly one-half the value of the domestic exports. Gold coin and bullion form one of the principal items in the export list, but only a small portion of the export is of local production, the balance being Queensland and New Zealand gold sent to Sydney for coinage. In 1900 the principal articles of domestic produce, with their value, exported were as follows:—Sheep, £449,633; cattle, £247,663; horses, £366,647; butter, £436,786; coal, £1,273,034; gold coin and bullion, £1,330,249; leather, £420,702; meat, frozen and preserved, £768,245; silver and lead, £2,743,263; skins and hides, £360,713; tallow, £375,855; tin, £171,874; wool, £7,632,213. The total export of coin and bullion was £5,912,710. The course of trade since 1880 has been as follows:—

Year.	Imports.	Exports. Total.	Exports. Domestic Produce.
1880	£14,176,063	£15,682,802	£12,007,931
1885	23,737,461	16,750,107	12,059,280
1890	22,615,004	22,045,937	17,232,725
1895	15,992,415	21,934,785	16,436,210
1900	27,561,071	28,164,516	18,873,488

Railways.—The railways are almost entirely in the hands of the state, for out of 2896 miles open in 1900 the state owned 2812 miles. The capital expended on the state lines open for traffic was £38,477,269, of which sum £5,542,510 was expended on rolling stock and equipment, and £32,934,759 on construction of roads, stations, and permanent ways. The net earnings amounted to £1,394,052, which represents a return of 3·63 per cent. upon the capital invested. The state pays, on an average, 3·62 per cent. for the money borrowed to construct the lines, and there is therefore a slight surplus to the advantage of the revenue.

Postal and Telegraph Service.—The postal business of 1899 was represented by the carriage of 76,742,200 letters and post-cards, 46,807,800 newspapers, and 13,987,000 parcels and books; the telegrams despatched numbered 3,112,000. To transact the postal business of the country, mail conveyances travelled 11,638,000 miles. The income of the postal and telegraph department in 1899 was £789,658, and the expenditure £758,606, but there were some items of expenditure not included in the sum named, such as interest charges, &c.; the total expenditure was approximately £870,000.

Banking.—The banks of issue number thirteen; their paid-up capital amounts to £18,092,428, and the capital and reserves to £22,583,700, but of this sum only about £9,727,000 is used in the state. The coin and bullion in reserve amount to £6,041,444, and the note circulation to £1,241,426. The banks have on deposit £19,679,521 bearing interest, and £12,976,711 not bearing interest, representing a total of £32,656,232. The savings banks had on their books at the close of 1899 about 261,000 depositors, with £10,069,434 to their credit. This represents £7, 8s. 5d. per inhabitant. The total deposits in all banks therefore amounted to £42,725,666. The progress since 1860 has been as follows:—

Year.	Amount on Deposit.	Average per Inhabitant.
1860	£5,721,208	£16 8 3
1870	7,044,464	14 2 6
1880	19,958,880	26 13 8
1890	43,390,141	38 13 6
1899	42,725,666	31 9 11

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II. HISTORY.

New South Wales was discovered by Captain Cook on board the *Endeavour*, on 20th April 1770. After he had observed the transit of Venus at Tahiti, he circumnavigated New Zealand and went in search of the eastern coast of the great continent whose western shores had long been known to the Dutch. He sighted the Australian coast at Gippsland, Victoria, near Cape Everard, which he named Point Hicks, and sailed along the east coast of Australia as far north as Botany Bay, where he landed, and took possession of the continent on behalf of his Majesty King George III. He then continued his voyage along the east coast of Australia, and returned to England by way of Torres Strait and the Indian Ocean. The favourable reports made by Captain Cook of the fertility of the country around Botany Bay induced the British Government, which had lost the North American colonies a few years before, to found a penal settlement on the south-eastern part of what was then known as New Holland. An expedition, consisting of H.M.S. *Sirius* of 20 guns, the armed trader *Supply*, three store-ships, and six transports, left England on 17th May 1787, and after touching at Tenerife, Rio de Janeiro, and the Cape of Good Hope, arrived at Botany Bay on 20th January 1788, under the command of Captain Arthur Phillip, R.N., with Captain John Hunter, R.N., as second. The persons on board the fleet included 564 male and 192 female convicts, and a detachment of marines, consisting of Major Ross, commandant, 16 officers, 24 non-commissioned officers, an adjutant and quartermaster, 160 privates, and 40 women. There were in addition five medical men and a few mechanics. The live stock consisted of one bull and four cows, a stallion and three mares, some sheep, goats, pigs, and a large number of fowls. The expedition was well provided with seeds of all descriptions.

Early history.

The shores of Botany Bay were found to be unsuitable for residence or cultivation, and Captain Phillip transferred the people under his command to Port Jackson, half a dozen miles away, near the site of the present city of Sydney. For some years the history of the infant settlement was that of a large gaol; the attempts made to till the soil at Farm Cove near Sydney and near Parramatta were only partially successful, and upon several occasions the residents of the encampment suffered much privation. But by degrees the difficulties inseparable from the foundation of a remote colony were surmounted, several additional convict-ships landed their living freight on the shores of Port Jackson, and in 1793 an emigrant-ship arrived with free settlers, who were furnished with provisions and presented with free grants of land. By the end of the 18th century the inhabitants of Sydney and its neighbourhood numbered 5000. Immediately after the arrival of the first fleet, surveys of the adjacent coast were made; the existence of a strait between Australia and Tasmania was discovered by Surgeon Bass; and before the retirement of Governor King in 1806 Australia had been circumnavigated and the principal features of its coast-line accurately surveyed by Captain Flinders, R.N. The explorations landward were, however, not so successful, and for many years the Blue Mountains, which rise a few miles back from Sydney, formed an impenetrable barrier to the progress of colonization. Penal establishments were formed at Newcastle in New South Wales, at Hobart and Launceston in Tasmania, and an unsuccessful attempt was made to colonize Port Phillip. The most noteworthy incident in the first decade of the 19th century was the forcible deportation by the officers of the New South Wales Corps, a regiment raised in England for service in the colony, of the governor, Captain Bligh, R.N., the naval officer identified with the mutiny of the *Bounty*. For some time the government was administered by the senior officer of the New South Wales Corps, but in 1809 he was succeeded by Captain Macquarie, who retained the governorship for eleven years.

Penal settlement régime.

During the *régime* of this able administrator New South Wales was transformed from a penal settlement to a colony. Prior to the arrival of Macquarie schools and churches had been erected, a newspaper, the *Sydney Gazette and New South Wales Advertiser*, had been started, and attempts had been made to acclimatize the drama. But he was the first governor to open up the country. He constructed permanent buildings at Sydney and Parramatta, formed roads and built bridges in the districts along the coast, and commenced a track across the Blue Mountains, which had been crossed in 1813 by Wentworth and others, thus opening up the rich interior to the inhabitants of Sydney and the settlements in its immediate neighbourhood. It was during Captain Macquarie's administration that the first banking institution, the Bank of New South Wales, was founded. The final fall of Napoleon in 1815 and the cessation of the war, which had lasted with very little intermission since the first establishment of the colony, gave the people of the United Kingdom leisure to think about their possessions at the Antipodes; and in 1817 free settlers commenced to arrive in considerable numbers, attracted by the success of Captain M'Arthur, an officer in the New South Wales Regiment, who had demonstrated that the soil, grass, and climate were well adapted for the growth of merino wool. But although the free settlers enjoyed a considerable amount of material prosperity, and were enabled to purchase land on very easy terms, they were dissatisfied with the administration of justice, which was in the hands of a judge-advocate assisted by military officers, with the absence of a free press and representative institutions, and they demanded permission to occupy the vast plains of the interior with their flocks and herds, without having to obtain by purchase or by grant the fee-simple of the lands upon which their sheep and cattle grazed. These demands were urged with more or less spirit during the governorships of Sir Thomas Brisbane and General Darling; but they were not finally conceded, together with perfect religious equality, until the *régime* of Sir Richard Bourke, which lasted from 1831 to 1837. At the latter date the population had increased to 76,793, of whom 25,254 males and 2557 females were or had been convicts. Settlement had

Captain Macquarie's governorship.

1831 to 1851.

progressed at a rapid rate. Parramatta, Richmond, and Windsor had indeed been founded within the first decade of the colony's existence; Newcastle, Maitland, and Morpeth, near the coast to the north of Sydney, had been begun during the earlier years of the 19th century; but the towns of the interior, Goulburn, Bathurst, and others, were not commenced till about 1835, in which year the site of Melbourne was first occupied by Batman and Fawkner. The explorations which followed the passage of the Blue Mountains opened up a large portion of south-eastern Australia. Van Diemen's Land was declared a separate colony in 1823, West Australia in 1829, South Australia in 1836, and New Zealand in 1839; so that before 1840 the original area of New South Wales, which at first included the mainland of Australia and the islands in the South Pacific, had been greatly reduced. In the last-named year the press was free in every part of Australia, trial by jury had been introduced, and every colony possessed a legislature, although to none of them except to New South Wales had the principle of representation been introduced, and in that colony only to a very limited extent. The policy of granting land without payment, originally in force in New South Wales, had been abandoned in favour of sales of the public lands by auction at the upset price of twenty shillings per acre; and the system of squatting licences, under which colonists were allowed to occupy the waste lands on payment of a small annual licence, had been conceded. In 1851, when separate autonomy was granted to Victoria, New South Wales had a population of 187,243, the annual imports were £2,078,338, the exports £2,399,580, the revenue was £575,794, and the colony contained 132,437 horses, 1,738,965 cattle, and 13,059,324 sheep.

Gold was discovered at Lewis Pond Creek, near Bathurst, in May 1851, by Edward Hammond Hargreaves; and at the end of June the first shipment, valued at £3500, left Sydney. This discovery made an important change in the position of the colony, and transportation, which had been discontinued during the previous year, was finally abolished. The first mail steamer arrived in August 1852, and in 1853 a branch of the Royal Mint was established at Sydney. The New Constitution Bill, passed during the same year by the local legislature, provided for two deliberative chambers, the Assembly to be elected and the Council nominated, and for the responsibility of the executive to the legislature. The Sydney University, founded in 1850, was enlarged in 1854, and the first railway in New South Wales, from Sydney to Parramatta, commenced in 1850, was opened in 1855. In the same year the Imperial Parliament passed the New Constitution Act; and in June 1856 the first responsible government in Australia was formed, during the governorship of Sir William Denison, by Mr Stuart Alexander Donaldson. The first administration lasted only for a few weeks, and the experiment of transporting to the Antipodes responsible government, modelled upon the British plan, was not immediately successful. Ministry succeeded ministry at short intervals, and it was some years before constitutional government worked smoothly. The powers of the new Parliament were utilized for extending representative institutions. Vote by ballot was introduced; the number of members in the Assembly was increased to 80, and the franchise was granted to every adult male after six months' residence in any electoral area. Meanwhile the material progress of the colony was unchecked. A census taken at the end of 1857 showed that the population of Sydney was, including the suburbs, 81,327. Telegraphic communication was established between Sydney, Melbourne, Adelaide, and Tasmania in 1859; and during the same year the Moreton Bay district was separated from New South Wales and was constituted the colony of Queensland.

Responsible government, 1856.

During the *régime* of Sir John Young, afterwards Lord Lisgar, who succeeded Sir William Denison in 1861, several important events occurred. The land policy of previous Governments was entirely revised, and the Land Bill, framed by Sir John Robertson, introduced the principle of deferred payments for the purchase of Crown lands, and made residence and cultivation, rather than a sufficient price, the object to be sought by the Crown in alienating the public estate. This measure, passed with great difficulty and by bringing considerable pressure to bear upon the nominated Council, was the outcome of a lengthened agitation throughout the Australian colonies, and was followed by similar legislation in all of them. It was during the governorship of Sir John Young that the distinction between the descendants of convicts and the descendants of free settlers, hitherto maintained with great strictness, was finally abandoned. In 1862 the agitation against the Chinese assumed importance, and the attitude of the miners at Lambing Flat was so threatening that a large force, military and police, was despatched to that goldfield in order to protect the Chinamen from ill-treatment by the miners. The railways were gradually extended, and the condition of the country roads was improved. The only drawback to the general progress and prosperity of the country was the recrudescence of bushranging, or robbery under arms, in the country districts. This crime, originally confined to runaway convicts, was now committed by young men born in the colony, familiar with its mountains and forests, who were good horsemen and excellent shots. It was not until a large number of lives had been sacrificed, and many bushrangers brought to the scaffold, that the offence was thoroughly stamped out in New South Wales, only to reappear some years afterwards in Victoria under somewhat similar conditions.

Sir John Young's governorship.

The earl of Belmore became governor in 1868, and it was during his first year of office that H.R.H. the duke of Edinburgh visited the colony in command of the *Galatea*. An attempt made upon his life, during a picnic at Clontarf, caused great excitement throughout Australia, and his assailant, a man named O'Farrell, was hanged. A measure which virtually made primary education free, compulsory, and unsectarian came into operation. A census taken in 1871 showed that the population was 503,981; the revenue, £2,908,155; the expenditure, £3,006,576; the imports, £9,609,508; and the exports, £11,245,032. Sir Hercules Robinson, afterwards Lord Rosmead, was sworn in as governor in 1872. During his rule, which lasted till 1879, the Fiji Islands were annexed; telegraphic communication with England and mail communication with the United States were established; and the long series of political struggles, which prevented any administration from remaining in office long enough to develop its policy, was brought to an end by a coalition between Sir Henry Parkes and Sir John Robertson. Lord Augustus Loftus became governor in 1879, in time to inaugurate the first International Exhibition ever held in Australia. The census taken during the following year gave the population of the colony as 751,468, of whom 411,149 were males and 340,319 females. The railway to Melbourne was completed in 1880; and in 1883 valuable deposits of silver were discovered at Broken Hill, near the western frontier of New South Wales, but much nearer to Adelaide than to Sydney. In 1885 the Hon. W. B. Dalley, who was acting Premier during the absence through ill-health of Sir Alexander Stuart, made to the British Government the offer of a contingent of the armed forces of New South Wales to aid the Imperial troops in the Sudan. The offer was accepted; the contingent left Sydney in March 1885, on board the *Iberia* and *Australasian*, and for the first time a British colony sent its armed forces outside its own boundaries to fight on behalf of the mother-country. In July of the same year Dr Moran, the Roman Catholic archbishop of Sydney, became the first Australasian cardinal. Lord Carrington, who was appointed governor in 1888, opened the railway to Queensland, and during the same year the centenary of the colony was celebrated. The agitation against the Chinese, always more or less existent, became intense, and the Government forcibly prevented the Chinese passengers of four ships from landing, and passed laws which practically prohibit the immigration of Chinese.

Sudan contingent, 1885.

In 1889 the Premier, Sir Henry Parkes, gave in his adhesion to the movement for Australasian federation, and New South Wales was represented at the first conference held at Melbourne in the beginning of 1890. Lord Jersey assumed office 15th January 1891, and a few weeks afterwards the conference to consider the question of federating the Australian colonies was held at Sydney, and the great strike, which at one time had threatened to paralyse the trade of the colony, came to an end. A Board of Arbitration and Conciliation to hear and determine labour questions and disputes was formed, and by later legislation its powers have been strengthened. A census taken on 5th April 1891 showed that the population was 1,134,207, of whom the aborigines numbered 7705 and the Chinese 12,781. In 1893 a financial crisis resulted in the suspension of ten banks; but with two exceptions they were reconstructed, and by the following year the effects of the depression had passed away. Federation was not so popular in New South Wales as in the neighbouring colonies, and no progress was made between 1891 and 1894, although Sir Henry Parkes, who was at that time in Opposition, brought the question before the legislature. The Rt. Hon. Sir William Duff, who followed Lord Jersey as governor, died at Sydney in 1895, and was succeeded by Lord Hampden. In 1896 a conference of Australian Premiers was held at Sydney to consider the question of federation. The then Premier, Mr Reid, was rather lukewarm, as he considered that the free-trade policy of New South Wales would be overridden by its protectionist neighbours and its metropolitan position interfered with. But his hand was to a great extent forced by a People's Federation Convention held at Bathurst, and in the early portion of 1897 delegates from New South Wales met those from all the other colonies, except Queensland, at Adelaide, and drafted the constitution, which with some few modifications eventually became law. The visit of the Australian Premiers to England on the occasion of Queen Victoria's Diamond Jubilee gave an additional impetus to federation, and in September 1897 the convention reassembled in Sydney and discussed the modifications in the constitution which had been suggested in the local parliaments. In January 1898 the Bill was finally agreed to and submitted to a popular referendum of the inhabitants of each colony. Those of Victoria, South Australia, and Tasmania agreed to the measure; but the majority in New South Wales, 5458, was not sufficient to carry the Bill. The local parliament subsequently suggested certain amendments, one of them being that Sydney should be the federal capital. The general election returned a majority pledged to federation, and after some opposition to the federal Bill by the Legislative Council it was again referred to the electors of the colony and agreed to by them, 107,420 votes being recorded in its favour, and 82,741 against it. One of the provisions of the Bill as finally carried was that the federal metropolis, although in New South Wales, should be more than 100 miles from Sydney. The Enabling Bill passed through all its stages in the British Parliament during the summer of 1900, all the Australian colonies assenting to its provisions; and on 1st January 1901 Lord Hopetoun, the governor-general of Australia, and the Federal Ministry, of which the Premier, Mr Barton, and Sir William Lyne, Home Secretary, represented New South Wales, were sworn in at Sydney amidst great rejoicings. In the following May the duke and duchess of York visited Sydney. Large contingents of troops from New South Wales were sent to South Africa during 1899 and 1900.

Attitude towards federation.

(G. C. L.)

NEWSPAPERS.

THE great advances of journalism during the latter half of the 19th century, and the ever-spreading influence of the daily paper, have at last created a general interest in newspapers as a class of literature and a subject for bibliographical and statistical inquiry. As a result of this interest it has become possible to differentiate, roughly at all events, between newspapers and periodicals, and in the following statistics an attempt has been made to take into account only such papers as deal with current events, and appear daily or weekly, or with intermediate periodicity. In this connexion it may be stated that the London General Post Office adopts for registration as newspapers the limit of publication within eight days. For convenience the term "weekly, &c." is used to include papers that appear two or three times in the week.

Great Britain and Ireland.

Taking the newspapers of London as fairly representative of the general movement in the great commercial centres, it may be remarked that the ever-increasing activity of life, especially of commercial life, during the last twenty years of the 19th century was reflected in the history of the newspaper press. Not only are many more papers published now than even ten years ago, but the number of copies of individual papers has increased also, especially in the case of so-called evening papers. In these, rather than in the morning papers, the increased "pace" of the present day is more faithfully represented. Such is now the eagerness to be *au courant* of passing events, that some of the "evening" papers are published before eleven o'clock in the morning, and five or six editions, finishing with an "extra special," are successively issued up to 7 P.M., and on occasions even later. Immense numbers of them are hawked about by newspaper-boys, whose parrot-cry of "All the winners!" whether races have taken place or no, might lead the unwary to think that horse-racing is the only subject that interests Londoners. The figures in the following statistics indicate part only of the progress during the period they cover; for in the interval many papers have been started and after a brief existence have come to a premature termination. Among the older papers there have been very few cessations; the most notable, perhaps, being that of the *Edinburgh Courant*. This was founded in 1705, and

Statistics.

after a prosperous career of a hundred and eighty years was amalgamated with the *Glasgow News* after the 6th February 1886, under the new name of the *Scottish News*, the last number of which was published 11th February 1888. On the other hand, the number of "localized" editions—*i.e.*, editions of one paper published at different places with a certain proportion of local news and a local title—grew from 151 provincial papers in 1890 to 260 in 1900. These localized editions sometimes have the inside pages devoted to general news, but in the greater number of cases that portion of their contents which does not consist of local news is printed from stereotype columns supplied by agencies in London to many journals at a time.

The number of sets of British newspapers received at the British Museum under the Copyright Act was as follows:—

	1890.	1900.
England (Provinces), Wales, and Channel Islands	1420	1664
London	647	1226
Ireland	173	222
Scotland	232	288
Total	2472	3400
Single numbers of papers	170,838	220,369

These, however, include fortnightly and monthly papers, which are not comprised in any of the following statistics.

The total number of daily papers published in 1890 was 193; in 1900, 258, showing an increase of 65; the number of weekly papers—*i.e.*, published less than five times a week, and for the most part only once a week—was in 1890, 2246; in 1900, 2644, showing an increase of 398 papers; the grand totals for 1890 and 1900 respectively being 2439 and 2902, showing an increase of 463.

The following tables will show these figures in detail:—

British Papers.	1890.	1900.
England (Provinces)	1390	1666
London	541	669
Wales (in Welsh, 13 in 1890, and 16 in 1900)	86	114
Ireland	181	198
Scotland	218	232
Isle of Man	7	10
Jersey	8	7
Guernsey	8	6
Total	2439	2902

Showing an increase of 463.

London Papers.	1890.	1900.
Daily	29	40
Weekly	488	611
Twice, or more, a week	24	18
Total	541	669

Showing an increase of 128.

Daily Papers.	1890.	1900.
London (morning, 17 in 1890, and 24 in 1900)	29	40
Provincial—England	120	165
Wales	6	7
Ireland	18	22
Scotland	19	19
British Isles	1	5
Total	193	258

Showing an increase of 65.

Daily Papers of the Three Capitals.

	1890.	1900.
London	29	40
Dublin	9	12
Edinburgh	4	3
Total	42	55

Showing an increase of 13.

It would be extremely interesting to ascertain the average number of copies of the leading morning and evening papers issued daily, but it is not considered prudent by newspaper proprietors to disclose the true facts, and the figures sometimes given are not to be absolutely trusted.

Daily Papers in the Principal Towns.

	1890	1900.
England—		
Birmingham	4	6
Bradford	2	3
Brighton	3	4
Bristol	4	5
Exeter	4	4
Hull	4	3
Leeds	5	4
Liverpool	7	8
London	29	40
Manchester	6	9
Newcastle	4	6
Norwich	3	3
Nottingham	4	5
Oldham	4	3
Plymouth	2	3
Portsmouth	2	2
Sheffield	4	5
Shields	2	3
Wolverhampton	2	2
York	2	2
Total	97	120
		Increase 23
Wales—		
Cardiff	4	4
Swansea	2	3
Total	6	7
		Increase 1
Scotland—		
Aberdeen	4	4
Dundee	3	3
Edinburgh	4	3
Glasgow	5	6
Total	16	16
		Same
Ireland—		
Belfast	5	4
Cork	3	4
Dublin	9	12
Total	17	20
		Increase 3

Amongst "class" papers the greatest increase has been in those relating to finance, 11; shipping, 8; and sporting, 32.

Principal Class Papers.			1890.	1900.
Agriculture and gardening			24	26
Archæology			1	1
Architecture			2	3
Art			1	2
Bakers			3	4
Book Trade			1	4
Boot Trade			2	2
Brewing			2	2
Building			11	13
Coal			3	3
Commercial			21	20
Corn			7	8
Education			7	11
Engineering			7	6
Fashions			8	13
Finance			34	45
Furniture			0	1
Humorous			31	28
Insurance			9	9
Iron			4	4
Juvenile			16	13
Mining			2	3
Music			4	4
Paper			0	3
Photography			4	4
Printing			1	3
Professional—				
Army			5	7
Navy			3	3
Legal			18	14
Medical			6	7
Religious—	1890.	1900.		
Protestant: Church of England	22	20	42	41
Nonconformist	20	21		
Roman Catholic			8	26
Jewish			5	7

	1890.		1900.	
Science	1		2	
Shipping	16		24	
Sporting (general)	43		62	
,, special: Athletics	7		2	
Cricket	1		3	
Cycling	9	66	12	98
Fishing	2		2	
Football	4		14	
Yachting	0		3	
Temperance	9		9	
Theatrical	9		10	

The great increase in Roman Catholic papers is due to the issue of a large number of localized editions, principally of the *Catholic Herald*.

Archæology and History.—In 1893, when the conference of the Institute of Journalists was held in London, the British Museum arranged an exhibition of newspapers, and the following is a selection of the most important items. The exhibition was unique of its kind, but no catalogue of it was printed. The names of a few papers already described in vol. xvii. of the *Encyclopædia Britannica* are for convenience repeated.

The *Mercurius Gallobelgicus*, the probable forerunner of newspapers, the full title of which is "Mercurius Gallobelgicus ab anno 1588 . . . usque ad 1594. *Coloniæ Agrip.* 1594," 8vo; the spurious *English Mercurie*, No. 50, of 23rd July 1588; the *Weekly Newes* of 23rd May 1622; No. 1 of the *Intelligencer*, for 31st August 1663, edited by Sir Roger L'Estrange, just appointed "Surveyor of the Imprimery and Printing presses"; the *Mercurius Politicus* of 2nd September 1658, giving the account of the death of Cromwell; the *Mercurius Publicus* of 30th May 1660, reporting the Proclamation of Charles II. as King on 8th May; the *Mercurius Publicus* of 24th–31st January 1661, describing the hanging of the carcases of Cromwell, Ireton, and Bradshaw; No. 1 of the *Oxford Gazette*, 16th November 1665, and No. 1 of the *London Gazette*, which the former became on 1st February 1665/6; No. 85 of the *London Gazette*, 3rd–10th September 1666, giving an account of the Fire of London; the *Intelligencer* of 24th April 1665, giving notice, with reference to touching for the king's evil, "that his Majesty hath declared his positive resolution not to heal any more after the end of this present April until Michaelmas next"; the *Monthly Recorder* of 1681–82, probably the first monthly paper; the *Flying Post* of 17th December 1695, in which notice is given that half the paper is left blank for gentlemen sending the paper away, to write their own news on; No. 1 of the *Daily Courant*, 11th March 1702/3, probably the first daily paper; Nos. 1–272 of the *Tatler*, 1709–11; Nos. 1–623 of the *Spectator*, 1st March 1711–15th December 1714: the numbers for 2nd August 1712 and onwards bear some fine impressions of the newspaper stamp, imposed under the Stamp Act which came into force on the 1st August; the *London Farthing Post* of 15th December 1718, probably the first farthing paper ever issued; No. 14 of the *Morning Post*, 17th November 1772; the *Public Advertiser* of 21st January 1769, containing the first of the Letters of Junius; No. 1 of *The Times*, 1st January 1788, also a copy of the issue of 29th November 1814, being the first paper printed by steam in England; No. 2 of the *Morning Advertiser*, 10th February 1794; *The Times* of 9th September 1798, in which is a report of a trial of the proprietor of a public newspaper-reading-room who was fined £5 for allowing the use of his rooms and papers to one of the public on payment of one penny; the *London Gazette*, 6th November 1805, reporting the battle of Trafalgar on 21st October (time of transmission, sixteen days); *The Times* of 22nd June 1815, reporting the battle of Waterloo on 18th June (time of transmission, four days); *The Times*, of 11th September 1855, reporting the fall of Sebastopol on 9th September (time of transmission, two days); the *Daily News* of 13th September 1882, reporting the battle of Tel-el-Kebir, 13th September (time of transmission, part of day); the *Jacobite Journal*, No. 1, 5th December 1747. By John Trott-Plaid, Esq. [*i.e.*, Henry Fielding]: illustrated heading attributed to Hogarth; a pigeon-post letter, being *The Times* of 27th January 1871, reduced to 2 by 1⅝ inches for transmission into Paris by pigeons during the Franco-German war; the *Pall Mall Gazette* of 30th January 1873, in miniature, reduced to 2⅞ by 4⅝ inches by Dallastype; the *Western Daily Mercury* (Plymouth) of 1884, the largest English newspaper. Early provincial newspapers:—The *Stamford Mercury*, vol. xi., May 1718; the *Cirencester Post*, No. 18, 16th March 1719; *Northampton Mercury*, vol. iii., No. 127, 1st October 1722; *Norwich Gazette*, vol. xix., No. 969, 24th April 1725; the earliest Irish paper, *Pue's Occurrences* (Dublin), 1704–1706; earliest Scottish paper, *Edinburgh Gazette*, No. 4, March 1699; *Le Mercure Anglois*, June 1644–December 1648, probably the earliest French paper published in England; the *Wady Halfa Gazette*, 13th March 1884, published by the Royal Engineers during the Egyptian campaign in the Sudan, for the amusement of the troops.

(G. F. B.; D. E.)

Recent Developments in London Journalism.

The period from 1882, when the article on Newspapers in the earlier volume of this Encyclopædia (ninth edition) was published, up to 1902, covers many important developments, which are associated either with the immense increase in reading, or with the continuous striving on the part of the increasing crowd of journalistic competitors to attain success by providing the "reading public" of all classes with what suits its taste. Some of the new agencies concerned in the production of newspapers, and other allied subjects, are treated elsewhere in these volumes, in the articles on Paper, Advertisement, Copyright, Type-setting Machines, Printing-Presses, Libel, Process, &c. Here we are concerned rather with the changes in the character of the Press than with the mechanical or legal conditions of newspaper production.

Tendencies of modern journalism.

The principal feature in the development of modern newspapers is the greater importance attached to obtaining and displaying "news" of all sorts, and incidentally there has been a considerable change of view as to what sort of news should be given prominence. Sport and finance are treated at greater length and more popularly; and, partly owing to the largely increased number of papers and consequent greater competition, partly to a desire to appeal to a larger public, there has been a tendency to follow the tastes of the vast number of people who can read at all rather than of those to whom reading means literary and intellectual enjoyment. This has involved a more popular form of presenting news, not only in a less literary style and by the presentation of "tit-bits" of information with an appeal to cruder sentiments, but also in a more liberal use of headlines and of similar devices for catching the eye of the reader. "Personal journalism," *i.e.*, paragraphs about the private life or personal appearance of individuals—either men or women—of note or notoriety in society or public affairs, has become far more marked; and in this respect, as in many others, encouragement has been given to a spirit of inquisitiveness, and also to a widespread inclination either to flatter or be oneself flattered—the latter desire being indeed conspicuously prevalent in these "democratic days" even among the classes which once affected to despise such publicity. The more responsible and more serious organs of public opinion have no doubt, in spite of this prevailing spirit, successfully maintained the dignity of British journalism and kept up its high standard and traditions. The great dailies themselves have exhibited, in various directions, the tendency to extend the interest of their "news" columns, without at the same time adopting the clap-trap devices or introducing the personal flavour which during the 'nineties came to be known as "the New Journalism." But *The Times*, or the *Standard*, or the *Spectator*, and journals of their class, while remaining the true representatives of the best sort of British journalism, had an old reputation and traditions to keep up; it is rather the newer journals which have given the characteristic tone to the period with which we are dealing. The modern impulse came partly from America, and its characteristics may be found discussed in the section devoted to American papers below, but it was also the result of new conditions of life in Great Britain, and of the democratic movement produced by the Education Act of 1870 and the Reform Act of 1885. On the whole, while American methods of journalism have largely influenced the Press in Great Britain in these new developments, it may be said that in so far as they were adopted they were very considerably modified in deference to English ideas. In no British paper has anything ever been found approaching the enormous "scare" headlines or inflated language which are common features in the American Press. The most generally adopted American innovation (for, though not unknown before, it was practically a new thing) has been the "interview," which during the early 'nineties was taken up in varying degrees by almost every paper; it was "cheap copy," and could be made both informing and interesting, and "interviewing" caused a large increase in the journalistic profession, notably among women. In later years the "interview" has declined in vogue, in proportion as people of importance have become less ready to talk for publication—or for nothing. In America the interview is notoriously compounded mainly of the journalist's fertile imagination; but the purely fictitious article is not adapted to British consumption. The English public are still attracted by a reported conversation when it contains a trustworthy account of the real opinions or language of the person interviewed, but they pay little attention to the imaginary article, and English editors, besides themselves objecting to such a practice, know that it is of no use.

Increase of news.

From the highest class of paper downwards, however, real news—and especially early news—has been more and more sought after, and all the force of organization both within individual newspaper offices and outside them in the shape of news agencies[1] has been applied to the purpose of obtaining early news and publishing it as quickly as possible. In this matter the Press has certainly been helped most materially not only by the advance in telegraphic facilities, but by all the other new rapid methods of newspaper production which have been the feature of the period. It is boasted by the Post Office that the acquisition of the telegraphs by the State was a great help to newspaper enterprise. It is, of course, only possible to show results, and it must remain doubtful how far such results would have come about in other circumstances, but it is a fact that in the old days only certain newspapers with special contracts enjoyed a reduction from the ordinary rates, and there were also a good many embarrassing restrictions. The reduction in rates for press telegrams under the new régime, while causing some loss to the Post Office, brought about a great increase in the number of such messages. In 1871 the number of words handed in for transmission was 22,000,000, but in 1900 it had risen to 835,000,000. The extent to which Press facilities are utilized may be gauged by the fact that in 1901, on the occasion of the England *v.* Scotland Association football match at the Crystal Palace, no fewer than 61,193 words of Press matter were handed in to the temporary office in the ground; and the increased scale of telegraphic business at race meetings may be indicated by the fact that at the Epsom spring meeting in that year nearly 18,000 telegrams, including 568 Press messages, containing 51,947 words, were dealt with, whereas in 1871 the total number of all kinds on the corresponding occasion was only 1951. The vastly increased amount of telegraphic work now done has perhaps not been all pure gain to the best sort of journalism. It has to some extent weakened the effect of the considered written article, and led to hasty conclusions and precipitate publication, with results that sometimes cannot be compensated for by any later contradiction or modification. In some cases a reaction is inevitable. Take for instance the case of war correspondence. Nothing finer in journalism was ever done than in Russell's letters to *The Times* from the Crimea, or Forbes's work and others in the Franco-Prussian war; but more recently, although first-rate abilities have been forthcoming in such men as Mr Bennet Burleigh, Mr E. F. Knight, and Mr John Stuart, the special war correspondent has not seemed to compensate the great dailies for their large expenses in connexion with him; the news agencies, often favoured by the Press censor, have generally been ahead of the "specials," and the individual work that might have been done for isolated papers has been much hampered by restrictions on separate accounts. This is due partly to the increased competition, and the number of correspondents who have been sent out, partly to military jealousy and officialism; but the result has been to a considerable extent to reduce the value of the "war correspondent" as compared with what was done in the Press in the days of Russell and Forbes. A letter arriving weeks after the telegraphic account, however meagre, is largely shorn of its interest. Given a brilliant foreign correspondent, the form of letters sent home from abroad on general subjects is still, no doubt, very effective. Mr G. W. Steevens's work for the *Daily Mail*, in various parts of the globe, was a good instance of this, as indeed was that of Mr G. A. Sala among an earlier generation for the *Daily Telegraph;* and the great dailies still do some of their best work, though only exceptionally, in this way: Mr Burdett-Coutts's letters to *The Times* concerning hospital administration in the South African war in 1900 had not been anticipated by telegraphic news. But the telegram is necessarily the backbone of the news service of the daily paper. The principal foreign correspondents supply their papers by this means with long articles commenting on the news of the day. Among the foreign correspondents the name of M. de Blowitz (b. 1832), the famous Paris correspondent of *The Times* from 1871, stands supreme; and among others who have made specially high reputations during the period are Mr G. W. Smalley (b. 1833), *Times* correspondent in the United States; Mr W. H. Beatty-Kingston (1837–1900), the *Daily Telegraph* correspondent in Berlin; Mr A. E. Houghton, the *Standard* correspondent in Spain; and Mrs Emily Crawford, Paris correspondent of the *Daily News.* The Press, be it added, is frequently able to acquaint the public with what is going on while the Government itself is still uninformed: Dr Morrison's messages to *The Times* from China in 1900, for instance, showed how much can be done on the spot by an alert and enterprising correspondent. The work of the official and the statesman is admittedly increased and sometimes embarrassed by the new strain imposed upon them in consequence, but the public are on the whole well served by their emancipation from the obscurity of purely official intelligence and by the obligation of straightforward dealing imposed upon governments, which in their nature are apt to be secretive. It is noteworthy, by the way, that while reports of political platform speeches are given in greater profusion in the Press, parliamentary reporting itself is left to a few of the great dailies, *The Times* and *Standard* being almost the only papers to give full reports; and with the exception of "scenes" in the House, it is considered sufficient in most papers to give a few Parliamentary notes or a "descriptive sketch" or summary.

Posters.

Connected with the increased attention given to news is the greater vogue of the newspaper "poster." This is more evident in London in the evening than in the morning papers. The prevailing habit of newspaper readers is to order the same morning paper regularly beforehand and read it at breakfast, while an evening paper is bought at a railway bookstall or in the street, partly no doubt according to some settled preference for one paper in particular, but also to a large extent

[1] The chief news organizations are Reuter's Telegraph Company (1865), the Exchange Telegraph Company, the Central News (1870), and the Press Association (1868). Foreign news is also supplied by Dalziel's and Laffan's Agencies; and there are a number of minor agencies.

according to the attractiveness of the contents-bill or poster which is exhibited. The desire to secure the pennies or halfpennies of the large afternoon public which buys according to the temptation of the poster has given the latter an increasing importance for indicating the possession of the latest news without revealing its whole nature, and the tendency has been to have fewer lines and fewer words in larger type, in order to catch the eye more impressively. Rotary machines for printing these posters enable them to be turned out with great rapidity; and besides those ordinarily prepared for each edition, it is possible at any time during the afternoon, should important news arrive, to issue a new poster and thus secure a large street sale by the insertion of a few words only in the "stop-press" or "fudge" without the necessity of changes in the plates.

Criticism. Apart from the publication of "news" and reports, and occasional original articles of a descriptive and miscellaneous character, the chief function of a newspaper is criticism, whether of politics[1] or other topics of the moment, or of the drama, art, music, books, sport, or finance. Politics is still the staple subject of the newspapers, and any journalist is expected to write about it. A single dramatic critic, art critic, and musical critic, on the other hand, usually do the bulk of the work in each of these departments for some one paper. The dramatic critic has to be at the opening nights of new pieces, and to write a criticism in time for publication in the next issue of the paper. Considering the conditions of such a task, the dramatic criticism in the daily Press reflects great credit on its authors, and they have frequently exercised considerable personal influence on the stage, owing to the wide public interest which is taken in what is written about theatrical affairs. Mr Clement Scott became famous as the dramatic critic for the *Daily Telegraph*, and among other leading critics have been Mr Joseph Knight, the late Mr Nisbet, Mr Spenser Wilkinson, Mr Archer, Mr Walkley, Mr A. E. T. Watson, Mr E. F. Spence, Mr Davenport-Adams, Mr G. Bernard Shaw, and Mr Malcolm Watson. Art criticism has not been in so flourishing a condition; only a few people really care about art, or want to read about it in the Press; and as a rule the art criticism in the newspapers is amateurish and poor. There have been, however, some conspicuous exceptions, notably Mr Humphry Ward, the late Mr R. A. M. Stevenson, Mr F. Wedmore, Mr Claude Phillips, Sir Walter Armstrong, Mr F. G. Stephens, Mr D. S. MacColl, Mr George Moore, Mr Huish, and Mr C. L. Hind. Musical criticism, notwithstanding the wide public interest in music, offers less opportunities for a readable article, and the notices of concerts are usually meagre and of a somewhat stereotyped pattern; but in critics like Mr Fuller Maitland, Mr Jaques, Mr Joseph Bennett, Mr Lionel Monckton, Mr Sutherland Edwards, Mr. J. S. Shedlock, Mr G. Bernard Shaw, Mr R. Hichens, Mr Streatfield, Mr Hervey, Mr J. F. Runciman, Mr Vernon Blackburn, Mr Charles Graves, Mr Barclay Squire, and Mr Robin Legge the Press has had the advantage of undeniable competence and judgment.

Sport. As regards sport, the comments of the various newspapers are mainly descriptive; but a prominent feature has been the attention paid to "tipping" probable winners on the Turf, and the insertion of betting news. The publication of the "odds" some time before a race, and of starting-prices, has undoubtedly helped to foster the increase of this form of gambling, as was pointed out in the report of the Select Committee on Gambling in 1902, but the efforts to induce the newspapers to keep such matter out of their columns have not had much success, though the *Daily News* in 1902 started on a new proprietorship with a declared policy of not referring to horse-racing or betting. Among the daily papers, the notes of "Hotspur" in the *Daily Telegraph* have had a high reputation. The sporting interest (*i.e.*, the desire to know results of racing and cricket, &c.) largely inflates the circulation of some of the London and most of the provincial halfpenny evening papers; and it has caused a notable increase in purely sporting papers, among which, however, the *Sportsman* (1865) and the *Sporting Life* (which, founded in 1859, became a daily in 1883, and in 1886 absorbed *Bell's Life*) are still the principal dailies.

Reviewing. Books are "reviewed" in the Press partly for literary reasons, partly as a *quid pro quo* for publishers' advertisements. The latter reason does not of course affect the great established journals, which have a large assured circulation, to the same extent as those which are more conscious of the struggle for life, but it is not only very generally potent, but has had a bad effect on serious reviewing. Only a limited number of people are really interested in reviews, and in consequence the work is frequently relegated, except in the very highest class of paper, to writers whose function is considered to be fulfilled if they have provided the publishers with "something to quote." The desire for "something to quote," irrespectively of the responsible nature of the criticism, became in the early 'nineties a mania with publishers, who in general appear to have considered that their sales depended upon their catching a public which would be satisfied by seeing in the advertisement that such and such a book was pronounced by such and such a paper to be "indispensable to any gentleman's library." At all events, such a system must be bad for the quality of reviewing, and unfortunately the enormous output of books made it impossible for editors to have them all reviewed, and equally impossible for them to be certain of discriminating properly between those which were really worth reviewing or not. The result has been that the work of book-reviewing in the newspapers has been hastily and poorly or very spasmodically done. There have been some honourable exceptions. *The Times* has always commanded the best literary talent. The *Daily Chronicle* under Mr A. E. Fletcher's editorship started a "literary page" in 1891, which at first was an excellent feature, and it was imitated in varying degrees by a few other papers. Critics of responsibility and eminence contributed signed reviews to the *Daily Chronicle*, and also to the *Daily News*, *Daily Telegraph*, and *Morning Post*, and among the evening papers the weekly "Literary World" (by W. P. James) in the *St James's Gazette* contained for several years a series of brilliant notes. The "Literary Supplement" to *The Times* is the most ambitious attempt yet made by a daily paper to deal seriously with literature. As a form of journalism, however, the review has during our period taken a lower place, partly owing to the cause named, partly to a tendency among reviewers either to indiscriminate praise or to irresponsible irrelevance, partly to a suspicion of "log-rolling"; and to a large extent it has become the practice merely to treat the appearance of new books as so much news, to be chronicled, with or without extracts, according as the subject makes good "copy," like any other event of the day.

[1] It is important to note how the balance of political feeling in the Press has altered since 1880. That year has been described as the high-water mark of Liberal ascendancy on the Press; out of 71 penny morning papers in London and the provinces, 47 were Liberal. In 1902, however, out of 65 only 28 were Liberal. In 1880 the *Scotsman* and *Glasgow Herald* were both Liberal; in 1902 both were Unionist. The *Birmingham Post* in both years supported Mr Chamberlain, but he had changed from an extreme Radical to a colleague of Lord Salisbury.

While the connexion between journalism and contemporary literature is now closer than ever, it must be said that journalism has become less literary and literature more journalistic. Either as reviewers, leader-writers, or editors, most of the principal "men of letters" have worked for longer or shorter periods as writers for some newspaper or other, and much of the published literature of the time has appeared originally in the columns of the newspapers, in the form of essays, poems, short stories, or novels (in serial form). Publication in this shape has many advantages for an author besides that of additional remuneration; it offers an opportunity for a new writer to try his wings, and it helps to introduce him at once to a large public. Moreover, the newspapers read by the educated classes profit by the superior class of journalist represented by writers of a literary turn, though it has frequently happened that the result of a discerning editor's success in establishing a writer's reputation is that the latter can then command higher terms than the paper can afford, and his work is lost to it just when he has become valuable. But the increased popularity of the newspaper, and the close tie between it and the literary world, have on the whole impressed a journalistic stamp upon much of the literature of the day. However popular at the moment a writer may be, the infection with journalistic methods—while rightly employed by journalists, as such, in dealing with contemporary events and for strictly contemporary purposes—is apt to be responsible for something wanting in his work, the loss of which deprives him of the permanent literary or scientific rank to which he might otherwise aspire. It is unnecessary in this matter to go into detail. The literary and scientific abilities, however, of such a writer as Mr Grant Allen, for instance, were so encumbered by journalistic methods, that in spite of the cleverness of his fiction and the temporary interest of his biological work, both nevertheless missed the character of permanent value which would cause his name to be remembered beyond his generation. And much of the output of more distinguished writers, whose best work will undoubtedly survive, is fatally marred by the same fault.

Journalism and literature.

As regards the less literary character of the journalism of the day, the falling-off is mainly noticeable in the more recently established journals, of which the principal halfpenny papers and the multitude of new popular magazines are the type, and also in the gradual decline of those literary features which formerly so markedly distinguished such journals as the old *Saturday Review*, or the *Pall Mall* and *St James's Gazettes* in their earlier days. The new point of departure for the journalism of the period is really to be found in the publication of Sir George (then Mr) Newnes's *Tit-Bits* in 1881. This penny weekly paper, with its appeal to the masses, who liked to read snippets of information brightly put together, opened the eyes of the newspaper world to the enormous profits which were to be made by this style of enterprise; and the multiplication of journals of this description—notably Mr Harmsworth's *Answers* (1888) and Mr Pearson's *Pearson's Weekly* (1890)—had a further influence on public taste, so that even the classes above that which primarily enjoyed these publications were affected in the same direction. A new note was introduced into daily journalism. Whereas before 1885 the notable feature had been the brilliance of the Saturday reviewers and their evening-paper offshoots, the *Pall Mall* and *St James's*, in the early 'nineties came a craze for "actuality." Mr T. P. O'Connor, with his vivid pen (first in the *Star*, then in the *Sunday Sun* and elsewhere), set the pace for a crowd of imitators; the successful establishment of the *Daily Mail* (see "Halfpenny Papers" below) in 1896 by Mr Alfred Harmsworth, with its system of compressing the news of the day briefly and pointedly into short paragraphs, while at the same time catering for all tastes and employing first-rate correspondents and reporters to supply it with special information, gave a distinct shake-up to the older traditions of daily journalism. Even when an attempt was made to provide for a literary public, success came to be generally sought by popular rather than by literary methods. The literary public in the proper sense of the word is inevitably a small one, and the greater part of the Press deals with literature on lines more suited to a larger and less refined *clientèle*. It may be claimed, no doubt, that the best sort of journalism shows a high, and sometimes the highest, literary standard, but the fact remains that the bulk of modern journalism is of a different sort, and that its conductors realize only too well that their business is to appeal to the masses, and to a standard of education which falls far short of anything that can be called intellectual.

The leading article.

It is often said that leading articles have lost their importance, but this is only a half-truth. A leading article in *The Times* has as much weight as ever it had, on any occasion or on any subject when a decisive attitude is required; and the leading articles in the *Standard*, *Daily Telegraph*, *Morning Post*, and some other papers carry great weight with public opinion. Nor is this statement true only of the great dailies, for the articles in such journals as the *Spectator* or *Economist* must not be excluded. Though in the multitude of papers it is probably true to say that in these later years there has been some falling off in quality (which is really more properly to be described as a conforming with a more popular style of speaking) in the writing of "leaders," on the other hand the actual amount of good writing in this department—well-informed, scholarly, and incisive—has been, just as probably, equal to anything done in what are sometimes considered its palmy days.[1] It sometimes suits a minor Cabinet minister or a disappointed politician to sneer at "what the papers say," but the usual experience of the leader-writer is either to find his phrases or arguments repeated some days afterwards by politicians up to the highest ranks as though they were original observations, or else to find the attitude which for the moment is pooh-poohed substantially confirmed or followed within a very short period; and it may be asserted with confidence that in recent years more real political "leading" has been done in the columns of the great newspapers than by any of the professional statesmen. If it is said that the newspaper writer is "inspired" by the statesman, this no doubt is frequently true, though there is nothing analogous in Great Britain to the "Reptile Press" in Germany; but there have been just as many occasions when the statesman, who gets the credit, has really been inspired by the suggestion of some acute journalist, whose very name is most likely unknown to the public. It would be impossible to mention the names of all the best London leader-writers in recent years; and as regards *The Times* anonymity is rigorously observed. But some prominent names may well be recorded. Mr Frederick Greenwood in the original *Pall Mall*, and later in the *St James's Gazette*; Mr Morley and Mr W. T. Stead in the Liberal *Pall Mall* (the latter, up to the time of his "Maiden Tribute" crusade, showing remarkable ability in focussing public attention suggestively on the topics of the day); Mr E. T. Cook in the *Westminster Gazette* and *Daily News*; Mr J. A. Spender in the *Westminster*; Mr Robert Wilson, Mr William

[1] It must be remembered that the style of speeches in Parliament has also altered. Nobody thinks of quoting the classics nowadays in the House of Commons. A more business-like form of speech is adopted in public life, and the Press reflects this change.

Clarke, Mr H. W. Massingham, and Mr Henry Norman in the *Daily Chronicle;* Mr Alfred Austin and Mr Richardson Evans in the *Standard;* Mr Justin McCarthy, Mr Clayden, Mr Herbert Paul, and Mr Whiteing in the *Daily News;* Mr Sidney Low in the *St James's Gazette* and the *Standard;* Mr G. A. Sala, Sir Edwin Arnold, and Mr H. D. Traill in the *Daily Telegraph;* or Mr Spenser Wilkinson in the *Morning Post*—have written as brilliantly and with as much constructive ability as any in a preceding generation. On the other hand, it is undoubtedly the case that in the newer type of newspaper, which appeals rather on the score of its tit-bits of news and rapid readableness to a more casual and less serious public, the whole *raison d'être* of the old-fashioned leading article has disappeared, and its place is taken by a few brief notes, merely indicating the attitude of the paper, and not seeking to discuss any subject comprehensively at all. And though many provincial papers, like the *Manchester Guardian, Yorkshire Post,* or *Scotsman,* employ the leading article almost as effectively as any London paper, the majority are content with quoting and following the lead of others. The halfpenny papers usually recognize that their influence lies in displaying news rather than in imposing views, but even here there are exceptions, notably in the Radical *Star* and *Morning Leader,* while the *Daily Mail* on occasions of importance uses the "leader" with an effect which is none the less because as a rule it does not rely on this weapon. No doubt there are often days on which the stereotyped "leader" in any of the great dailies only represents a marking of time, and the multitude of such articles in the aggregate gives occasion for doubt as to the influence exercisable by this form of journalism at all. But the doubt is founded on a fallacy: *Neque semper arcum tendit Apollo.* The "leader" is to some extent a form of newspaper routine, but on the whole it is a routine which has proved its value by experience. The continuous high standard of the British Press depends more largely than is sometimes realized on the regular industry and skill of those whose business it is to discuss the latest developments of affairs every day or every week in a manner which gives reasonable men something fresh to think about, or interprets for them the thoughts which are only vaguely floating in their minds; and the stability of British public opinion, and consequently of British institutions, is in no small degree the outcome. The liberty of the Press enables every sort of view, right or wrong, to be discussed in this prominent form, and thus every aspect of a question is brought out in public, to be accepted or rejected according to the weight of evidence and of argument.

Correspondence.

The same end is assisted by the devotion of so much space to "letters to the editor." It is sometimes said that *The Times* owes its position largely to the fact that if any individual grievance is felt, it is generally ventilated by a letter to *The Times.* Whatever may be the organization of the Press for reporting the news of the day, the resources of no newspaper staff are great enough to cover an area of information as large as that represented by its readers; and the value of the outlet for opinion and information afforded by the correspondence columns cannot be overstated. Strange, however, as it may appear to the uninitiated, there is a great deal of diffidence on the part of the public in writing letters to the papers; apart from a certain number of habitual letter-writers, it takes a considerable stimulus to bring an ordinary man to commit himself in this way. An important condition of his doing so is that he should have confidence in its being considered the right thing to do. One of the advantages possessed by *The Times* over other papers is that the tradition in its case has long been fixed, and when any definite subject of importance is before the public, it is always certain that the best opinions will be found expressed in its columns in this shape; but the other great dailies are not far behind. Sometimes it has been considered a good device to attract public attention by provoking a wide correspondence, as in the "Is Marriage a Failure?" series and others in the *Daily Telegraph;* but this is really an expedient for attracting readers, rather than a real symptom of popular feeling, though it often results in some interesting conclusions.

Finance.

The increased public interest taken in money matters, and especially in speculative transactions in the stock markets, is responsible both for the establishment of a financial daily press (notably the *Financial News,* 1884, and the *Financial Times,* 1888), and for the increased attention given in the ordinary press to the publication of stock exchange prices and criticism of financial affairs. Another factor which has largely contributed to this result is the importance of financial advertisements, and the pressure exercised by advertisers to have their operations commented upon and their businesses recommended. The company-promoting boom between 1889 and 1893, which brought so much profit to the Press in the shape of advertisements of prospectuses and so forth, had an effect in this direction which was only increased by the subsequent "slump" and the corresponding efforts of advertisement canvassers, anxious for their commissions, and business-managers anxious for revenue, to keep up the advertising income of the papers to which they were attached. It is a legitimate piece of business to insert financial advertisements, and equally legitimate to comment upon financial matters; and the public interest in such things is so great, and public gullibility so persistent, that well-informed comments, honestly made, are both attractive to readers and a valuable form of journalism. The British Press, so far as the principal newspapers are concerned, has kept its reputation for integrity in these matters satisfactorily clean and sound, and it is under no suspicion of being bribed or having its favour bought; and though it has been shown on more than one occasion that certain promoters and financiers (generally with the vaguest notion of whom they were dealing with) have been quite ready to corrupt the Press if they could, the few cases which have been brought home have been in connexion with papers and journalists of no account or influence. The danger, however, is obvious, and can only be met by having in control of the great newspapers, and in charge of this particular department, men who are beyond suspicion both as to their acumen and their impartiality.

The sources of newspaper influence.

While certain financial papers were found guilty of lax methods in this particular in the course of the investigations into Mr E. T. Hooley's affairs (1898–99), and those of one or two other promoters, the leading journals of the United Kingdom have fortunately been owned and edited by men who were too cautious and too wide-awake to fall a prey to such wiles. The history of these great papers, further details of which are given below, is dominated by a succession of proprietors, managers, or editors whose enterprise, insight, and judgment have kept the reputation of the British Press higher than that of any other in the world. Newspapers, like other businesses, are of course conducted with a view to a profit; and the desire to make a profit out of mere popularity, in its effect on both circulation and advertisements, has sometimes led to the exercise of a proprietor's authority in altering the character of a paper against the best interests of high-class journalism; but the Press in the United Kingdom has in the main been fortunate in having behind it, as owners, men who took a personal interest in journalism and had a full sense of their responsibilities in relation both to the guidance of public opinion and to the position of the journalistic profession. It would be impossible to review the period under discussion as regards the London daily press without paying a tribute on this score to the influence among proprietors of such men as Mr Walter of *The Times*, Lord Glenesk (Sir Algernon Borthwick) of the *Morning Post*, Sir Edward Lawson of the *Daily Telegraph*, or Mr Alfred Harmsworth of the *Daily Mail*. Among editors and managers, those who have exercised most influence are Mr G. E. Buckle and Mr Moberly Bell (*The Times*), Mr Mudford and Mr G. Byron Curtis (*Standard*), Sir Edwin Arnold and Mr Le Sage (*Daily Telegraph*), Sir John Robinson (*Daily News*), Mr Massingham (*Daily Chronicle*), Mr J. N. Dunn (*Morning Post*), Mr F. Greenwood (*Pall Mall* and *St James's Gazette*), Sir George Armstrong and Mr W. T. Madge (*Globe*), Mr Sidney Low (*St James's Gazette*), Mr W. T. Stead, Mr H. Cust, and Sir Douglas Straight (*Pall Mall*), Mr E. T. Cook and Mr J. A. Spender (*Westminster Gazette*), Mr T. P. O'Connor and Mr Ernest Parke (*Star*). Whatever may be said of a certain degeneration in journalism as a whole, the fact remains that, though most people read more papers than is compatible with a healthy mental digestion, the Press, as such, has to-day a greater influence than ever; and this is largely due to the reputation maintained by its higher representatives. The reflected glory is shown in the fact that to be an "editor" involves some prestige even in the case of a comparatively feeble journal; and though "medical student" has been supplanted by "journalist" in the "profession or occupation" formula of the police-court, the old Bohemian days of journalism are gone, and it has become a settled profession with as much self-respect as any other. While, individually, the great papers wield considerable influence, due partly to real sagacity and authority, partly to the psychological effect produced by mere print or by reiterated statement, collectively the Press now represents and expresses the Public, and expresses popular opinion more directly than Parliament itself. Nor can the social results of the multiplication of "Press-cutting agencies," or of such publications as *Who's Who* (started by Mr Douglas Sladen in 1897) and similar biographical reference books—all tending to increase the publicity of modern life—be passed over. With other factors they have contributed materially to the pervading influence of journalism in everyday life and the constant dependence of society in most of its manifestations on the activity of the "Fourth Estate."

Weekly papers.

The serious high-class weeklies have developed no specially important new features of their own. To the *Spectator* and *Saturday Review* have been added the Radical *Speaker* (1890), edited by Mr J. L. Hammond, the *Outlook* (1898), edited by Mr Percy Hurd, and the *Pilot* (1900), edited by Mr Lathbury; and several new weekly papers, *e.g.*, the *Realm* (edited by Mr Earl Hodgson), the *British Review* (edited by Mr Mallock), the *Review of the Week* (edited by Mr Harold Gorst), came and passed away after showing promise of good things. On the whole, the weekly press has declined in proportion as the daily papers and the monthly magazines have grown. The *Spectator* alone, among the serious weekly papers, has kept or increased its vogue. Under Mr Hutton and Mr Meredith Townsend the *Spectator* became an institution, as a thoughtful organ of criticism; and after it passed into the hands of Mr J. St Loe Strachey in 1897 its old characteristics were still maintained. The palmy days of the *Saturday Review*, on the other hand, had already gone when in 1894 Mr W. H. Pollock retired from the editorship and Mr Saintsbury, Mr David Hannay, and the other brilliant members of its old staff ceased to write for it. Under Mr Frank Harris the *Saturday* failed to regain its position. In 1899 it was acquired by Lord Hardwicke, and under the editorship of Mr Harold Hodge it remained the chief Conservative weekly. The most important decease has been that of the *National* (at first the *Scots*) *Observer*, which under Mr W. E. Henley's editorship (1888–93) had a considerable literary success. Mr Henley gathered about him a staff of young literary men who formed to all intents and purposes a school. It had some mannerisms and preciousnesses, but it was essentially clever and often brilliant. In 1894 Mr Henley ceased to be editor, and Mr J. E. Vincent edited the paper with conspicuous ability till in 1897 the *National Observer* came to an end. Among weekly illustrated papers, *Black and White* (1891) and the *Sketch* (1892), for the immediate success of which Mr Clement Shorter (then editor of the *Illustrated London News*) was responsible, *Country Life Illustrated* (1897), edited by Mr J. E. Vincent, and the *Sphere* (1901), started under Mr Shorter when he left the *Illustrated London News*, have prospered without affecting the popularity of the *Graphic* and *Illustrated London News*. The "Society" papers, *Truth* (1877), *Vanity Fair* (1868), and the *World* (1874), have well maintained their interest. Mr Edmund Yates's (*q.v.*) success with the *World* contributed largely to the increase of the personal style which he did so much to introduce. *Truth* made Mr Labouchere, its proprietor, one of the most prominent men of the day, not so much on account of his cynical Radicalism, as for its vigorous exposure of all sorts of public humbug and charlatanry. *Vanity Fair's* leading feature is its cartoon (see CARICATURE), the weekly interest of which has been ably maintained under Mr Oliver Fry's editorship. Sunday papers have not multiplied as much as might have been expected. The *People* (conducted by Mr Madge, of the *Globe*) was started in 1881; the *Sunday* (afterwards *Weekly*) *Sun* (1891) began brilliantly under Mr T. P. O'Connor, but after his connexion ceased it gravitated to a more commonplace type: these, with *Lloyd's* (edited after 1884 by Mr T. Catling), now appeal to an uncritical public. The *Sunday Special* (1897) has been added to the small list of high-class Sunday papers (its competitors being the *Sunday Times* and the *Observer*, the latter of which has reduced its price to twopence); the *Referee* too (1877) has a sporting and theatrical character of its own, and in "Dagonet" (Mr G. R. Sims) has had a paragraphist of original humour. But British feeling is against Sunday journalism, and in 1899, when a *Sunday Daily Mail* and *Sunday Daily Telegraph* simultaneously appeared, the vociferous objections raised by the public—added to the fact that they showed no sign of paying their way—led to their simultaneous withdrawal.

The old "literary weeklies," the *Athenæum* (1828) and *Academy* (1869), still hold the field. The former continued to be ably edited by Mr Norman MacColl till 1901, when he was succeeded by Mr Vernon Rendall. The *Academy*, which was bought in 1894 by Mr Morgan Richards and put under the editorship of Mr Lewis Hind, altered some of its methods and lost a good deal of the academic character it had enjoyed under the editorship of Mr J. S. Cotton; in 1901 its proprietor bought *Literature* from *The Times* (*q.v.*) and amalgamated it with the *Academy*. The *Guardian* (1846) reduced its price to threepence, and maintained its high character; in 1900, for reasons connected with the ritualistic crisis in the Church, Mr Lathbury ceased to be its editor, and was succeeded by the Rev. Walter Hobhouse. In the *Economist* (1843) and *Statist* (1878) the world of political economy and finance continued to find admirable critical articles; and the *Field*

(1853) has encountered no real rival in the world of sport. *Punch* (an excellent *History* of which was published by Mr M. H. Spielmann in 1895) remained easily first among humorous journals, being supported by a number of such talented writers as Sir F. C. Burnand, Mr Anstey Guthrie, Mr E. J. Milliken, Mr Arthur à Beckett (an all-round journalist who, besides editing the *Sunday Times* (1891–95), became president of the Newspaper Society, 1893, and chairman of the Institute of Journalists, 1901), Mr H. W. Lucy ("Toby, M.P."), and Mr Owen Seaman; but though *Fun* (1860) died in 1901, and *Lika Joko* (started by Mr Harry Furniss in 1894) only lived a few months, *Judy* (1867), *Moonshine* (1879), and *Pick-me-up* (1888), served to cater to a wider and rather less discriminating public. Mention must also be made here of the technical and professional journals, which have been produced in increasing numbers; many of them are admirably conducted, and are models of what such publications should be. The Religious Press has developed considerably, and among its most notable representatives besides the *Guardian* may be named the *Record* (1828), edited by the Rev. A. R. Buckland, the *Church Times* (1863), *Tablet* (1868), *Weekly Register* (1849), *Christian World* (1857), *Methodist Times* (1885).

Though Magazines and Reviews are dealt with properly under PERIODICALS, some reference may be made to them here. The place of the two old Quarterlies in public interest has really been taken by the modern half-crown monthly reviews, of which the type is the *Nineteenth Century, and After* (1877), founded and edited by Mr James Knowles. These high-class monthlies enable the best writers to deal more at length with the subjects of the day than is possible in a daily or weekly paper. The *Fortnightly Review* (1865), edited successively by Mr John Morley, Mr T. H. S. Escott, Mr Frank Harris, Mr Oswald Crawfurd, and Mr W. L. Courtney; the Conservative *National Review* (1883), edited successively by Mr Alfred Austin, Mr Earl Hodgson, and Mr Leo Maxse; the Liberal Nonconformist *Contemporary Review* (1866), edited during this period by Mr Percy Bunting; and *Blackwood's Magazine*, which has maintained its old standard, are conducted from slightly different standpoints on somewhat similar lines; and the *Monthly Review* (1900), edited by Mr Henry Newbolt, stands in the same class. These are all serious reviews of an intellectual type; and in *Longman's Magazine* (1882, distinguished by Mr Andrew Lang's *causeries*), *Macmillan's*, and *Cornhill* a diversity of reading matter of good quality is provided at a lower price. In addition to these there have gradually come upon the scene a number of popular sixpenny and still lower-priced magazines, the first of which, Sir G. Newnes's *Strand Magazine* (1891), set the fashion; including miscellaneous articles, copiously illustrated, they appeal to the general public, and are intended solely to entertain. The *English Illustrated* (1883), and, later, the *Pall Mall Magazine* (1893), at a shilling, were attempts to carry out the same idea on a somewhat higher plane. A characteristic development of the period has been the foundation by Mr W. T. Stead, whose personality has been very prominent in the journalism of the time, of the *Review of Reviews* (1890), containing extracts from and comments on all the most interesting articles in the periodicals of the month, together with original features of its own. Among the monthly reviews devoted to special subjects, a high type of journalism is represented by, in sport, the *Badminton Magazine*, and in art, the *Art Journal* (1839), *Magazine of Art* (1878), *Studio* (1893), *Connoisseur* (1901); and the *Bookman* (1886) has managed with some success to combine both popular and literary qualities.

Magazines and Reviews.

The introduction of women into journalism is one of the new departures of our period. It was indeed no new thing for women to write for the Press. Harriet Martineau was one of the principal members of the *Daily News* staff, and Miss Frances Power Cobbe (b. 1822), the advocate of anti-vivisectionism, was an active woman journalist in her day. But these were exceptional cases, in which something in the nature of a personal mission and a peculiar aptitude gave the impulse. It was not till later that journalism as a profession was resorted to by women, in consequence of the immense increase in women readers and the immensely increased publicity given to matters of primarily feminine interest. In 1880 the only "ladies' paper" of any importance was the *Queen*, a weekly which, dating from 1861, remains a valuable property. But since then a considerable number of new weeklies have entered the field and become popular: notably the *Lady's Pictorial* (1880), the *Lady* (1885), *Woman* (1889), the *Gentlewoman* (1890), which owed its success to the ability of Mr J. S. Wood, *Madame* (1895), and the *Ladies' Field* (1898). New monthlies have also appeared, in the *Englishwoman*, the *Ladies' Realm*, and the *Woman at Home*. The sphere of action of the lady journalist has been by no means confined to the "ladies' papers," or to writing columns on dress or cookery for other journals which found it useful to cultivate feminine readers; women have invaded every other field of journalism, especially the large new field of fashionable gossip, and though on the whole their success has been very limited, there have been some striking exceptions. Notably is this the case with Miss Flora Shaw (Lady Lugard), whose able colonial articles in *The Times* made her work for that paper up to 1899 one of its most interesting features. Mrs Crawford, the Paris correspondent of the *Daily News*, Mrs Meynell in articles for the *Pall Mall Gazette*, and Mrs Humphry Ward have shown what first-rate work can be done by women writers in the press. Lady Randolph Churchill, in connexion with the sumptuous *Anglo-Saxon Review*, and Lady Jeune, Mrs Alec Tweedie, Mrs Isabella Bishop, and Miss Betham-Edwards have taken a considerable part in the journalism of the day. The names of Miss H. Friederichs, Mrs Humphry, Miss Drew, Mrs Aria, Mrs Harcourt Williamson, Lady Colin Campbell, Miss Christabel Coleridge, Miss Blackburne, Miss M. F. Billington, Miss E. N. Hepworth Dixon, Mrs Ballin, Miss M. Bateson, Mrs Belloc-Lowndes, Miss Clo Graves, Mrs Howarth, and Annie S. Swan have also been prominent as regular workers on various papers.

Women journalists.

THE LONDON DAILY PRESS.

The Times since 1880 has fully maintained the position it acquired at the beginning of the 19th century as the leading paper not only of the British empire, but of the world. No paper can be said to compete with it, or even to attempt competition with it, either in position or influence. Other papers have a larger circulation, may even be sometimes in advance of it with their news, but no other paper can be said to speak with a tenth part of its authority. If it errs, the greater part of the Press follows it in its error; and the influence of the Press on public opinion is the influence primarily of *The Times*, either directly or through its giving a cue to the other papers. Unattached to any party, it gave a general support to Lord Beaconsfield's cabinet in the crisis of the Eastern Question, while warning them as early as 1876 that their Egyptian policy would inevitably lead the nation into more active intervention in that country. It distrusted Mr Gladstone's Midlothian campaign of 1880, but when that resulted in his return to power, it

The Times.

endeavoured to strengthen his policy in Ireland, and, in particular, it heartily endorsed his denunciation of the leaders of the Home Rule movement. While protesting against the weakness of his Egyptian policy, it supported him in the military occupation which was the inevitable result of it, but commented with just severity on the vacillation of his treatment of General Gordon. On the conversion of Mr Gladstone to Home Rule, *The Times* was instrumental in forming the Liberal-Unionist party, and by its opposition may claim to have largely contributed to the defeat of the two Home Rule Bills. In the course of its vigorous campaign it published as part of its case a series of articles on "Parnellism and Crime," including the celebrated "Parnell letters" which proved to be forgeries of Pigott. With the exception of those letters, *The Times* substantiated almost the whole of its charges; but public opinion had so fastened on that portion of them that the services rendered by *The Times* to the country were in some measure overlooked. The revelations and the judgment of the Parnell Commission, by exposing the conspiracy, gave a death-blow to Home Rule; the nation reaped the benefit, and *The Times* paid the whole cost. After the change produced in English politics by the adoption of Home Rule by the Liberal party, *The Times* gave a decided but discriminating support to Lord Salisbury and his colleagues; but, during the brief periods of office enjoyed by the Liberals, it encouraged Lord Rosebery, as Foreign Minister, in his patriotic and largely successful policy of preserving continuity in regard to foreign affairs. In like manner it encouraged the section of Liberals brought into prominence by the South African war, who desired the vigorous prosecution of hostilities, and were anxious to drop the alliance with the Irish Nationalists. In the Turco-Greek war *The Times* supported Lord Salisbury's Government in its refusal to interfere. It advocated the advance into the Sudan, and the necessity of action in South Africa. During the progress of the Boer war it remained, along with the nation, steadfast in insisting that hostilities should only end in the absolute incorporation of the two Boer States in the British Empire; and, while refraining from much comment on mistakes in the field, expressed itself with severity on the blunders of omission and commission of officials at home. Kept admirably informed by its Peking Correspondent, *The Times* demanded, for some time in vain, more vigour in the China policy of the Government, and it advocated the treaty with Japan. For a long time it was almost alone in giving prominence to news from the outlying portions of the empire, and it was imperialist before Mr Chamberlain became Colonial Secretary. *The Times* bore an honourable part in the efforts which were made from time to time to improve the defences of the country. The great increase of the Navy could hardly have been carried through without its persistent advocacy; and, so far as the nation is awakened to the defects of its Army and War Office and the right methods of amending them, it is largely due to the well-known letters of "Vetus," and the numerous other series of articles in *The Times* on the subject. In other domestic matters *The Times* has recognized that it is no longer organic changes of ancient institutions, but rather modest social reforms that are demanded by the people. It has endeavoured with some success to curb the inordinate pretensions of trade-unions, and to combat the insidious advances of Socialism.

In the earlier volumes of this Encyclopædia the personal history of *The Times* concluded with an incidental mention of the retirement in 1877 of John Thadeus Delane (*q.v.*), for thirty-six years chief editor of the paper. He was succeeded by Thomas Chenery (*q.v.*), sometime Lord Almoner's professor of Arabic at Oxford. Chenery died after a short illness in February 1884, and was succeeded by George Earle Buckle. Mr John Walter (*q.v.*), who since 1847 had been the chief proprietor and manager of the paper, died in 1894, and was succeeded by his eldest son Mr Arthur Fraser Walter. *The Times* has always maintained the principle of anonymity in relation not only to the occasional contributors to its columns, but also to the permanent members of its staff. It is sufficient to say that there are few well-known men who have not in one form or another contributed to its pages.

The bulk and business of the paper greatly increased after 1880. It was stated in the earlier article in vol. xvii. that on one occasion a number of the paper had contained 67 columns of advertisements. This was even then much below the mark. As far back as 1861 a single issue had contained 105 columns of advertisements, and another 98. Prior to 1884 the paper had only on two occasions consisted of 24 pages in a single issue. Between that year and 1902 more than 80 separate issues of this size were published, many of them containing over 80 columns of advertisements. Of the two issues, one containing the news of the death and the other the account of the funeral of Queen Victoria, 140,000 copies were printed.

The increasing circulation of *The Times* between the years 1840 and 1850 made an improvement in the printing-presses necessary, as sometimes the publication could not be completed before the afternoon. To meet this want the Applegath vertical press was introduced in 1848. This press, instead of having a flat printing surface, by which only one sheet could be printed at each movement, had an upright revolving cylinder on which the pages of type were fixed. This cylinder revolved at a speed which enabled eight sheets to be laid on by eight men, and taken off by the same number, thus printing very much faster than the flat press. But it still had the drawback of printing only one side of the paper. To improve upon this machine the American Hoe ten-feeder press was introduced in 1858. This machine required ten "layers-on," but no "takers-off," and also printed at a faster speed than the Applegath. Meanwhile the idea of stereotyping from the movable types had been making steady progress, but it had many drawbacks in consequence of the "plaster" process being continued. About the year 1856, however, a Swiss named Dellagana introduced to *The Times* Kroning's idea of casting from papier-mâché instead of plaster, and was allowed to experiment in the *Times* office. After a time the invention was so much improved that matrices of pages could be taken, and the stereotype plates fixed bodily on the printing machine in place of the movable type. This cleared the way for the introduction of the Walter press. Hitherto only one set of "formes" could be used, as the type was set up once only—one side of the paper being worked on one machine, and the sheets then taken to another machine to be "perfected." Stereotyping enabled the formes to be multiplied to any extent, as several plates could be cast from one matrix. Mr MacDonald of *The Times* had devoted himself for several years to the production of a press which could print papers on both sides in one operation from a large reel of paper, the web of paper being cut into the required size after printing, instead of each sheet being "laid on" by a man, and then printed. After years of experiment the Walter press was introduced into the *Times* machine-room in 1869, and the question of printing great numbers in a short time was solved. Each press turned out 12,000 sheets per hour, and it was therefore only a question of multiplying the stereo plates and presses to obtain any number of printed papers by a certain time. Meanwhile Messrs Hoe and Company had not been idle, but had set about producing something even quicker and better than the Walter press. They succeeded in accomplishing this by multiplying the reels of paper on each press, and also adding folders and stitchers. The result was the production of over 36,000 sheets per hour from each machine, all folded, and, if required, stitched with wire. These presses were adopted by *The Times* in 1895, and were still in use in 1902.

In 1868 the question of composing machines for the quicker setting-up of type was taken up by *The Times.* A German named Kastenbein had an invention which he brought to the notice of *The Times,* and arrangements were made for him to continue his experiments in the *Times* office. In a couple of years a machine was made, which was worked and improved until in 1874 several machines were ready to set up a portion of the paper; but it was not until 1879 that the arrangements were sufficiently advanced to make certain that they could do all that was wanted from them. The introduction of composing machines, and the necessary alterations in the office arrangements which followed, led to some trouble among the compositors, which in 1880 culminated in a partial strike; but a part of the staff remaining loyal, the printer was able by extra effort to produce the paper at the proper time on the morning following the strike. In the course of a few days the places of the strikers were filled, and the business of the paper went on as before. From this time the composing machines took their place as the chief producers of the work. Various improvements were made, until one machine was able to set up as many as 298 lines of *The Times* in one hour, equal to 16,688 separate types, the compositor being dictated to at the *Times* office by telephone directly from the House of Commons. This system of telephone dictation was commenced in 1885, and was continued until the House of Commons decided to rise at midnight, which very much reduced the pressure of work, and enabled the more economical method of composing direct from the "copy" to be resumed. In connexion with the telephoning it may be mentioned that a special helmet was made for each compositor's head, with a receiver at each ear, and as fast as the reader at the House of Commons dictated, the compositor set up the matter at the *Times* office. Ever since the introduction of the composing machines they had been much hampered by the question of "distribution"—that is, the breaking-up and sorting of the types after use. Kastenbein had invented a distributing machine to accompany his composing machine, but it proved to be unsatisfactory. Various systems were tried at the *Times* office, but for many years the work of the composing machines was to some extent crippled by the distribution difficulty. This had been recognized by Mr Wicks, the inventor of the Wicks Rotary Type-casting Machine, who for many years had been working at a machine which would cast new type so quickly and so cheaply as to do away with the old system of distribution and substitute new type every day. In 1899 his machine was practically perfect, and *The Times* entered into a contract with him to supply any quantity of new type every day. Since that time the average weekly delivery to *The Times* has exceeded 5,000,000 types. The difficult question of distribution was thus surmounted, and composition by machines placed on a satisfactory basis. To sum up, we find that during the last half of the 19th century *The Times* continued to take the lead in new inventions relating to the printing of a newspaper, just as it had in the fifty years preceding. The three most important advances during the later period were practically worked out at the *Times* office—namely, fast-printing presses, stereotyping, and machine composing, and without these it is safe to say that the cheap newspaper of the present day could not exist.

The growth of *The Times* is shown in a statement published in the issue of 7th January 1901, from which it appears that the total news, exclusive of advertisements, supplied to the public by *The Times* during the year 1800 amounted to about 2,700,000 words, while during the year 1900 it is estimated to have consisted of over 35,000,000 words. "To pursue the comparison, *The Times* for the year 1900 contained, always exclusive of advertisements, nearly 20 per cent. more reading matter than the *Encyclopædia Britannica,* more than 240 quarterly volumes (60 years) of the *Edinburgh Review,* and more than five times as much as all Macaulay's works, Grote's *History of Greece,* and Gibbon's *Decline and Fall* added together."

In addition to this colossal daily issue, *The Times* is the parent of several other newspapers. *The Mail,* published three times a week at the price of 2d. per number, has 8 pages, and gives a convenient summary of two days' issue of *The Times. The Times Weekly Edition* (begun in 1877) is published every Friday, and for 2d. gives a carefully condensed but necessarily brief epitome of *The Times* for the six days. It includes also a serial story, the character of which is always irreproachable, and a popular chess column. The circulation of *The Times Weekly Edition,* chiefly in the colonies, almost trebled between 1890 and 1900. The *Law Reports* (begun in 1884) are conducted by the large staff of *Times* law reporters, all of them barristers of at least five years' standing, under the direction of Mr William Frederick Barry of the Inner Temple, and they have acquired a recognized position in the legal world. *Commercial Cases,* edited by Mr T. E. Aldous of the Inner Temple, deals with cases of a commercial nature. *Issues* is a useful half-yearly compilation of all the company announcements and demands for new capital, taken from the advertisement columns of *The Times.*

In 1897 the increasing demand of the public for information of a literary character encouraged the conductors of *The Times* to issue a weekly literary organ under the title of *Literature.* This at first was issued entirely independently of *The Times,* under the editorship of the late Dr H. D. Traill, but after his death it was in 1901 deemed advisable to issue in its place a weekly literary supplement to *The Times,* and *Literature* passed into the hands of the proprietor of the *Academy,* with which paper it was incorporated as *The Academy and Literature.* The "Literary Supplement" appears each Friday, is printed in a different form, and separately paged.

Moreover, the publishing department of *The Times* has of late years invaded several new fields of enterprise. *The Times Atlas* was first published in 1895, and successive editions, revised, enlarged, and continuously brought up to date, have been published at frequent intervals, and about 50,000 copies were sold up to 1902. By an arrangement with Messrs Longmans, this publication was supplemented by that of *The Times Gazetteer.* A much larger and more important venture was the issue in 1898 of a reprint of the ninth edition of the *Encyclopædia Britannica.* That work was then out of print. The original publishers, Messrs A. and C. Black, had printed 10,000 copies, and in the fourteen years of its publication, and in the nine years following its completion, had sold little more than 9000. It was recognized by *The Times* that this small sale of an invaluable work was due to the high price at which it was issued. Messrs Black had assumed that as the sale would be small the price must be high. *The Times* recognized that the sale was small *because* the price was high, and by an arrangement with Messrs Black they issued their reprint at less than half the original price, and on a new system of terms that enabled the purchaser to receive the whole work at once and to pay for it by a series of equal monthly payments. In the first year 18,000 copies were sold, the gross proceeds of sales amounting to almost exactly £365,000. Subsequent sales in the United Kingdom alone up to 1902 amounted to nearly another 18,000, apart from considerable sales in India and the colonies. The new method of sale introduced into the United Kingdom by *The Times* found several imitators, and was repeated by that journal itself in the case of the *Century Dictionary* and of a reprint of the first fifty years of *Punch*. The new volumes of the *Encyclopædia Britannica*, supplementing the ninth edition and forming with it the tenth edition, were issued in 1902 on similar terms at brief intervals. Within three weeks of publication of the first volume more than 10,000 complete sets were subscribed for.

In the year 1895 *The Times*, through its Vienna correspondent, purchased from the late Dr Busch the MS. and entire copyright of his journals, containing a very minute record of his intimate relations with Bismarck. It was stipulated in the contract that these were not to be published until after the death of the prince. That event occurred on the 30th July 1898, and on the 12th September of the same year *The Times* published through Messrs Macmillan (in 3 vols.) *Bismarck: Some Secret Pages of his History*, by Dr Moritz Busch. The work created an immense sensation, was translated into many languages, and remains the most authentic record of much of the secret history of the period with which it deals (1870–90).

The Times History of the War in South Africa arose out of a desire to preserve in a more readable form the excellent work done by the numerous *Times* correspondents in South Africa. When originally projected in the early days of 1900 it was hoped that the war would be of short duration, and that the history of it could be rapidly completed. The length of the war naturally upset all these calculations, and the large number of subscribers at the very low price which had originally been deemed sufficient compelled *The Times* to decide between a mere re-editing of its original despatches and a more complete and permanent record of the whole event. The fact that numerous short histories had already been produced decided *The Times* to adopt the latter more costly and more laborious alternative. Mr L. S. Amery, fellow of All Souls, who during the war had not only served for a short time as its special correspondent in the Boer camp, but had ultimately had the direction of the nineteen correspondents representing *The Times*, was selected as the editor. Two volumes had been published by August 1902, and met with general approval. The comments made in the second volume had the result of causing at length the official publication of the much-disputed Buller heliogram.

The Standard. The *Standard* was established as an evening paper in the Tory interest in 1827, its first editor being Stanley Lees Giffard, father of the first earl of Halsbury, who had Alaric Watts and Dr William Maginn, famous as one of the originators of *Fraser's Magazine*, as his chief helpers. In the course of two or three years it became a pecuniary, as it had from the first been a political, success, and gradually ousted the *Courier*, which was for a time conducted by William Mudford, whose son half a century later became the most distinguished editor of the *Standard*. In course of time the latter became the property of Mr Charles Baldwin, whose father was proprietor of the *Morning Herald*, and when the father died the son found himself in possession of both a morning and an evening journal. In his hands neither of them prospered, although the *Standard* retained a large circulation and constantly printed early and accurate political information. At length, midway in the 'fifties, both papers were purchased by Mr James Johnstone, Mr John Maxwell, the publisher, being for a time associated with him in the ownership. Mr Johnstone realized that he had before him a great opportunity, and at once set to work to grasp it. He brought out the *Standard* as a morning paper (29th June 1857), increased its size from four to eight pages, and reduced the price from fourpence to twopence. One of the most curious features of the early numbers was a novel by William Howard Russell. The evening edition was continued. In February 1858 Mr Johnstone again reduced the price, this time to a penny. When that step was taken the *Standard* announced that its politics were "enlightened amelioration and progress," but that it was "bound to no party"; and to those independent lines it in the main adhered. In the course of four or five years it became a financial success, and then began to attract to itself many brilliant pens, one of its contributors in the 'sixties, Lord Robert Cecil, being destined to become illustrious as marquess of Salisbury. Lord Robert was an occasional leader-writer, whose contributions were confined almost entirely to political subjects. It was at this time that the *Standard* laid the foundation of the great reputation for early and detailed foreign news which it has ever since enjoyed. During the American Civil War it obtained the services of a representative signing himself "Manhattan," whose vivid and forcible letters from the battlefield arrested attention from the beginning. As the campaign progressed, these full, picturesque, and accurate accounts of the most terrible struggle of modern times were looked for with eager interest. There were no "special cables" to discount the poignant curiosity of the reader, and the paper reached a circulation far beyond anything hitherto known. The distinction thus acquired was maintained during the Prussian-Austrian war of 1866, and greatly increased by the letters and telegrams describing the triumphs and disasters of the campaign of 1870. In the early 'sixties the staff had been reinforced by the engagement of Mr William Heseltine Mudford. In the midst of his work as a Parliamentary reporter, he was sent as special correspondent to Jamaica in 1865 to report upon the troubles which involved the recall of Governor Eyre; a further period in the gallery of the House of Commons followed, and in 1873 Mr Mudford became business manager. Mr Johnstone's first editor was Captain Hamber, who afterwards seceded to the short-lived *Hour*, with whom had been associated Mr David Morier Evans as manager. He was succeeded by the owner's eldest son, to whom Mr (afterwards Sir) John Gorst was joined in a consultative capacity. In 1876 Mr Mudford became editor, still, however, retaining managerial control. Mr Johnstone, the proprietor to whose energy and perspicacity the paper owed so much, died in 1878, and under his will Mr Mudford was appointed editor and manager for life, or until resignation. Already a great property, the *Standard* in Mr Mudford's hands entered upon a very brilliant period. Sturdy independence was the note of his editorship—mere party factiousness did not enter into his ideas. The relations between the paper and the Conservative party were still intimate, but they were very different from those which obtained in the old days when a *Punch* cartoon had represented Lord Derby and Mr Disraeli as followed in the street by an old woman in a "Gamp" bonnet—since it was as Sairey Gamp that the *Standard* was invariably referred to by its weekly contemporary. "Throw her a penny," says Mr Disraeli, "or people will think she belongs to us." No man, however brilliant, is capable of successfully editing a great daily newspaper, with its heavy weight of labour and responsibility, without an able and trustworthy second in command, and in that respect Mr Mudford was fortunate throughout. He had for his first assistant-editor Mr Gilbert Venables, who was succeeded after a short term by Mr George Byron Curtis, previously one of the leader-writers, who thus held the position through nearly the whole of Mr Mudford's long editorship. The staff at this time comprised many men, and some women, whose names are distinguished in letters as well as in journalism. Mr Alfred Austin, Mr T. H. S. Escott, Miss Frances Power Cobbe, and the late Professor Palmer were all writing for the paper at the same time. To them must be added, among others, Mr E. D. J. Wilson, the brilliant political leader-writer (afterwards of *The Times*), Mr Percy Greg, son of "Cassandra" Greg, Mr T. E. Kebbel, and the late Dr Robert Brown, who wrote copiously upon scientific and miscellaneous subjects. Throughout these years the *Standard* was exceptionally well served by a series of war correspondents who to enterprise and resource added unusual literary ability. Foremost among them were Mr G. A. Henty, who represented the paper on many a stricken field; Mr John A. Cameron, who was killed at Abu Klea; and Mr William Maxwell, who added appreciably to the brilliant tradition he inherited. In January 1900 Mr Mudford retired, and was succeeded in the editorship by Mr Byron Curtis, Mr S. H. Jeyes, the biographer of Lord Salisbury and Mr Chamberlain, whose connexion with the paper had begun in 1891, becoming assistant-editor. Under Mr Curtis's control the *Standard* is said to have increased in circulation, while maintaining its unique position as the exponent of progressive and independent Conservatism. Among the members of his literary staff in 1902 were, in addition to some of those whose names have been mentioned, Mr Sidney Low, Mr Richardson Evans, Mr David Hannay, the Rev. Professor Bonney, and Mr J. Penderel-Brodhurst. Mr A. E. T. Watson and Mr Sutherland Edwards wrote on the theatre, and Mr Frederick Wedmore on art.

Daily Telegraph.

The first number of the *Daily Telegraph* was published on 29th June 1855, as a twopenny newspaper. Its proprietor was Colonel Sleigh. This gentleman soon found himself in pecuniary straits, and in satisfaction of the debt for the printing of the paper it was transferred to Mr Joseph Moses Levy in the following September. On 17th September Mr Levy published it as a four-paged penny journal, the first penny newspaper produced in London. His son, afterwards Sir Edward Lawson (b. 1833), immediately entered the office, and after a short time became editor, a post which he only abandoned in 1885, when he became the managing proprietor and sole director. From the outset Mr Levy gathered round him a staff of high literary skill and reputation. Among the first were Mr Thornton Hunt, who acted in collaboration with Sir Edward Lawson, Mr Geoffrey Prowse, Mr George Hooper, and Sir Edwin Arnold (*q.v.*), as leader-writers. Sir Edwin returned from public service in India immediately after the Mutiny, and became a member of the staff of the *Daily Telegraph* in response to an advertisement. Mr E. L. Blanchard was among the earliest of the dramatic critics, and Mr Alexander Harper the City editor. Later there came Mr George Augustus Sala (*q.v.*), then one of Charles Dickens's young men; Mr Clement Scott (b. 1841), at one time a clerk in the War Office; and Mr Edward Dicey (b. 1832), then fresh from Cambridge. The Hon. Frank Lawley turned to journalism from official life; and among the most remarkable of the early contributors to the paper was Mr J. P. Benjamin, Q.C., the great American lawyer, who wrote a number of articles, principally on financial and legal subjects, when he took refuge in England in 1866. A distinguished man of letters, who was on the staff for well-nigh a quarter of a century, was Dr H. D. Traill (*q.v.*). The active list of the staff in 1902 included Mr J. M. Le Sage, the managing editor, who had been connected with the paper over thirty-five years; Mr W. L. Courtney, editor of the *Fortnightly Review*; Mr E. J. Iwan-Muller, Mr J. B. Firth, and Mr J. L. Garvin; Mr Joseph Bennett and Mr Lionel Monckton being the musical critics, Mr T. M. Rendle dramatic critic, Mr H. W. Lucy principal Parliamentary reporter, and Mr Bennet Burleigh the principal war correspondent. The *Daily Telegraph* is famous for its "special correspondents," Mr John Ellerthorpe and Dr E. J. Dillon having been conspicuous in this capacity; and Lord Dunraven, the late Lord Russell of Killowen, and Mr Winston Churchill, M.P., have also been on special missions for the paper. Among the regular correspondents in foreign capitals have been Mr Felix Whitehurst in Paris, Mr W. H. Beatty-Kingston (1837–1900) in Berlin, Mr Lavino in Vienna, and Sir Campbell Clarke (1835–1902) in Paris. After 1890 Mr Harry Lawson assisted his father in the general control of the paper.

Sir Edward Lawson, with the influence of the paper at his back, took a leading part in the agitation for the abolition of the stamp duties upon newspapers in 1861. On his initiative the *Daily Telegraph* organized many expeditions for scientific and exploring purposes. In June 1873 it despatched Mr George Smith to carry out a series of archæological researches in Nineveh, which resulted in the discovery of the missing fragments of the cuneiform account of the Deluge, and many other inscriptions. In co-operation with the *New York Herald* it equipped Mr (afterwards Sir) Henry Stanley's second great expedition to Central Africa (1875–77), described in his work *Through the Dark Continent*. During this journey Stanley surveyed Lakes Victoria and Tanganyika, and identified the Lualaba with the Congo. Another geographical feat with which the name of the *Daily Telegraph* is associated was the exploration of Kilimanjaro (1884–85) by Mr (afterwards Sir) Harry Johnston, whose account of his work appeared in the *Daily Telegraph* during 1885. And Mr Lionel Decle's march from the Cape to Cairo, in 1899 and 1900, was also undertaken under the auspices of the paper.

The *Daily Telegraph* has raised many large funds, which Sir Edward Lawson has himself organized and managed free of charge. Almost the first was the subscription for the relief of the sufferers by the cotton famine in Lancashire, in the winter of 1862–63; the fund in aid of the starving and impoverished people of Paris at the close of the siege in 1871; the prince of Wales's Hospital Fund in commemoration of the Jubilee of 1897, which was collected in the end of that year and the beginning of 1898; and the *Daily Telegraph* Shilling Fund for the soldiers' widows and orphans in connexion with the Boer war. It is interesting to note that while the cotton famine list resulted in a total subscription of £6300, that in aid of the Hospitals realized £37,840, and the widows and orphans' fund in May 1900 stood at £253,000. An undertaking of a more festive kind was the fête given to 30,000 London school children in Hyde Park on the occasion of Queen Victoria's Jubilee in 1887.

In politics the *Daily Telegraph* was consistently Liberal up to 1878, when it opposed Mr Gladstone's foreign policy as explained in his Midlothian speeches. After 1886 it represented Unionist opinions. Among special feats of which it can boast was the first news brought to England of the conclusion of peace after the Franco-German war.

Prior to 1874 the *Daily Telegraph* was printed by eight- and ten-feeder machines, through which every sheet had to be passed twice to complete the impression. Under these conditions it was necessary to start printing one side of the paper as early as ten or eleven o'clock. The handicap which this imposed on the satisfactory production of a newspaper was removed by the introduction of Hoe's web machines at the end of 1874. No further change took place until 1891, when they were superseded by others built by the same makers capable of printing a 12-page paper at the rate of about 24,000 an hour, cut, folded, delivered, and counted in quires. In 1896 they were modified so as to be suitable for turning out an 8-, 10-, 12-, 14-, or 16-page paper. Up to 1894 the setting of type had been done entirely by hand, but in that year the linotype, after an experimental trial, was introduced on a large scale, the *Daily Telegraph* being the first of the great London dailies to make the change. There are 36 of these machines at work, and with only a few exceptions the whole of the setting is entrusted to them. The difference between the scale of operations in earlier days and present practice may be illustrated by a few figures. The volume which contains the issue of the *Daily Telegraph* for July to December 1856—the beginning of the second year of its existence—consists of 632 pages; the three volumes required for the same period of 1900 are made up of 2080 (for the first half of that year the total is 2192). In the second half of 1856 the issue numbered 3792 columns, while in July to December 1900 the aggregate was 14,560. This, however, does not indicate the whole addition to the size of the paper. The page is now deeper from top to bottom, with the result that it would take 16,640 of the columns of 1856 to represent the output of the latter half of 1900. Another example of the volume of work done by the mechanical departments is afforded in the fact that while in 1860 there were printed 5000 columns of advertisements, the total in 1900 was over 16,000. Here, again, for purposes of comparison the latter figure may be taken as equal to 18,300. Mr Levy acquired the *Daily Telegraph* paper-mills at Dartford Creek in 1867, and the whole of the material used for the daily issue of the paper is manufactured at these mills, which are as fully equipped with machinery as the offices in Peterborough Court.

Morning Post.

During the first three quarters of the 19th century the *Morning Post* fairly held its own against the constantly increasing pressure of competition, but without making any great headway. Amongst its editors were Mr Peter Borthwick, M.P.; his son, Algernon Borthwick (b. 1830), under whom it acquired great political influence as the official organ of Lord Palmerston's Government; and Sir William Hardman, for many years chairman of the Surrey sessions, and recorder of Kingston. For a time the paper passed into the hands of Messrs J. and T. B. Crompton, one of the largest firms of paper manufacturers; but upon the death of Mr Rideout, the principal surviving partner, Mr Algernon Borthwick (who was knighted in 1880, made a baronet in 1887, and raised to the peerage as Lord Glenesk in 1895) acquired the sole proprietorship. One of his first acts (on 27th June 1881) was to reduce the price of the *Morning Post* from threepence, at which it had so long stood, to one penny —an experiment which many experts predicted would be fatal to the existence of a journal which hitherto had been regarded as merely the organ of the fashionable world. The result exceeded his most sanguine anticipations. The circulation increased in the course of a few months more than tenfold, and with expanding circulation came a corresponding increase of advertisements. Under the later editorships of Mr Moore, Mr Algernon Locker (1895–97), and Mr James Nicol Dunn, who became editor in 1897, the *Morning Post* fully maintained its position. It claims to have been the first paper to announce the conclusion of the Anglo-Russian agreement in regard to China in April 1899, to have been the only newspaper in which the text of the award in the Delagoa Bay Railway Arbitration was published on the day after it was made, and the first to announce the duke of Connaught's renunciation of the Saxe-Coburg succession. Its list of contributors includes such well-known names as those of Andrew Lang, W. E. Henley, George Meredith, Thomas Hardy, Spenser Wilkinson, Professor York Powell, E. F. Knight, and Mr Winston Spencer Churchill, M.P.—the last-named as the special correspondent in Lord Kitchener's campaign against the Khalifa and the war in the Transvaal. Mr Spenser Wilkinson's trenchant criticisms of the military operations in South Africa in 1899 and 1900 were a notable feature of the *Morning Post* during that period. Of recent years considerable attention has been devoted to social questions. A short series of articles on the outcasts who frequented the Thames Embankment at night led the readers to provide funds for the *Morning Post* Embankment Homes, where homeless wanderers are provided with temporary shelter and are afterwards assisted to permanent employment. The readers of the paper likewise presented Lord Kitchener with money enough to erect a bronze statue of General Gordon, by Mr Onslow Ford, R.A., in Khartum. Moreover, it is claimed the articles in the *Morning Post* induced the Government to open throughout the United Kingdom convalescent homes for soldiers, and to erect a monument in memory of the many nameless heroes among the Chelsea Pensioners buried in Brompton Cemetery.

Daily News.

The history of the *Daily News* has been told by Mr Justin McCarthy and Sir John R. Robinson in a volume (Sampson Low, Marston and Co.) of "political and social retrospect" published in 1896 on the occasion of its jubilee. It could boast of having continuously been the champion of Liberal ideas and principles—of what (so long as Mr Gladstone lived) might be called official Liberalism at home and of liberty abroad. Its only rival in the history of Liberal journalism in London for many years was the short-lived (1856–70) *Morning Star*, which in 1870 it absorbed. Notably, it led British public opinion in foreign affairs as champion of the North in the American Civil War, of the cause of Italy, of the emancipation of Bulgaria from the Turk, and of Armenia. Its early editors were Charles Dickens (21st January–March 1846), John Forster (March–October 1846), E. E. Crowe (1847–51), F. K. Hunt (1851–54), W. Weir (1854–58), T. Walker (1858–69). In 1868 the paper was reduced in price to a penny, and came under the management of Mr (after Sir) John R. Robinson (b. 1828), who only retired in 1901. Its later editors have included (1868–86) Mr F. H. Hill (the brilliant author of *Political Portraits*), and subsequently Sir John R. Robinson, as managing editor, in conjunction with Mr P. W. Clayden (b. 1827; d. 1902), the author of *Life of Samuel Rogers*, *England under the Coalition*, and other able works, as political and literary editor, down to 1896, and Mr E. T. Cook from 1896 to 1901. Mr Cook, during the negotiations with the Boer Government in 1899, strongly supported Sir Alfred Milner; and under him the *Daily News*, as an exponent of Liberal Imperialism, gave no countenance to the pro-Boer views of some of the more active members of the Liberal party. In 1901, however, the proprietary changed, and Mr E. T. Cook, whose views on the Boer war were not shared by the new proprietors, retired; the journal then becoming an organ of the anti-imperialist section of the Liberal party. After other editorial changes, Mr Gardiner became editor in 1902.

Throughout its career the *Daily News* has been famous for its war correspondents, among whom may be named Archibald Forbes (Franco-German and Russo-Turkish wars), E. H. Vizetelly (Italy), O'Donovan (of Merv), MacGahan (Bulgaria), and A. G. Hales (Boer war). Among its other principal writers have been Harriet Martineau, Professor Minto, William Black, Justin McCarthy, E. F. S. Pigott, Sir R. Giffen (City editor), Professor Elliot Cairnes, Grenville Murray, John Hollingshead, Richard Whiteing, Andrew Lang, Herbert Paul, and (Parliamentary sketch) H. W. Lucy.

Daily Chronicle.

The *Daily Chronicle* arose out of the *Clerkenwell News*, the latter paper having been purchased by the late Mr Edward Lloyd in 1877, and converted into "an Imperial morning paper" on independent Liberal lines. Under the editorship of Mr R. Whelan Boyle the *Daily Chronicle* soon took rank among the other London daily journals, the only traces of its original character being shown in the attention paid to metropolitan affairs and the appearance of numerous small advertisements. The independent tone of the journal was conspicuous in its treatment of the Home Rule question. At first deprecating the system of combined agitation and outrage with which the term was synonymous, the *Daily Chronicle*, under the editorship of Mr A. E. Fletcher (1890–95), ceased to be a Unionist journal, and supported Mr Gladstone's Bill of 1893. Another instance was afforded in the course of the Boer war. During the negotiations and the early stages of the campaign, the *Daily Chronicle*, which was then edited by Mr H. W. Massingham, strove for peace by supporting the Boer side against the diplomacy of Mr Chamberlain. Mr Massingham's policy was, however, not to the liking of the proprietors, and he retired from the editorship towards the end of 1899, Mr W. J. Fisher, whose knowledge of international affairs had singled him out for the post, succeeding him as editor. Mr Massingham during his editorship, ably seconded by Mr Henry Norman, had largely increased the interest of the paper, particularly on its literary side. A new impetus had been given in this direction in 1891, when a "literary page" was started, conducted at first by Mr J. A. Manson, and after 1892 by Mr Massingham, when he became assistant-editor under Mr Fletcher. The journal can claim to have taken a leading part in many public movements since 1877. It was conspicuous in its advocacy of the cause of the men in the London dock strike of 1889; and in the great mining dispute for a "living wage," which was brought to a close by Lord Rosebery in November 1893, raised over £13,000 for the relief committees. Much attention was given to the theosophical discussion of 1891, and to the exposure of the adventurer "De Rougemont" after he had appeared before the British Association at Bristol in 1898. The *Daily Chronicle* took an active part in the negotiations which led to the Venezuelan Arbitration Treaty of 1897, it energetically pleaded the cause of the Armenians and Cretans during the massacres of 1896, and it encouraged the Greeks in the war with Turkey in 1897. Its foreign policy was, however, more distinguished by goodwill than by discretion—and notably in the latter instance. The *Daily Chronicle* also worked strenuously for the Progressive cause in London in regard to the County Council, Borough Councils, and the School Board. Of late years it has devoted a portion of its space daily to "the Churches." Its news successes included the first announcement of the revolution in eastern Rumelia (1885); the first circumstantial account of the death of Prince Rudolph (1889); Nansen's own narrative of his expedition towards the North Pole; and Sir Martin Conway's journey across Spitsbergen in 1896, and the first ascent of Aconcagua in the following year. Among its more frequent contributors—past and present—may be mentioned the late Robert Wilson, B. F. C. Costelloe, Sir Walter Besant, William Clarke, and Lewis Sergeant; Mr William Archer, Mr Edmund Gosse, Mr E. T. Cook (whose association with the paper after 1901 confirmed its adoption of Liberal Imperialistic views), Mr Joseph Pennell, Dr Jessopp, Mr Lionel Johnson, Mr Henry Norman, M.P., Mr L. F. Austin, Mr Edward Clodd, the Hon. R. C. Drummond, Mr Egerton Castle, Sir Martin Conway, Major Martin Hume, Mr Henry Harland, Mr Francis Thompson, Mr Arthur Waugh, and the Rev. Dr R. F. Horton.

Morning Advertiser and Daily Graphic.

The only other important morning papers, other than those of the halfpenny press (see below), are the *Morning Advertiser*, the organ of the licensed victuallers, which is devoted largely to the interests of "the Trade," and was reduced in price from threepence to a penny in 1891 (one of its conspicuous features up to 1902 being an alliterative contents bill); and the *Daily Graphic*, founded in 1890 by Mr W. L. Thomas (1830–1901) as an offshoot from the *Graphic*, and edited by Mr Hammond Hall, assisted by Mr Lucien Wolf. The combination of clear arrangement of news, well-informed comments, and plentiful illustration of the topics of the moment, rapidly made the *Daily Graphic* a popular addition to London journalism. In 1896 Sir G. Newnes started a new type of penny morning daily in the shape of *The Courier*, edited by Mr Earl Hodgson; but it only survived for a short time.

The Pall Mall Gazette.

We pass now to the London penny evening papers. The first number of the *Pall Mall Gazette* issued on 7th February 1865 from Salisbury Street, Strand. Mr George Smith, of the publishing firm of Smith and Elder, was its first proprietor; Mr Frederick Greenwood (b. 1830), its first editor, took the *Anti-Jacobin* for his model; the paper was intended to realize Thackeray's picture of one "written by gentlemen for gentlemen." In spite, however, of brilliant supporters such as Fitzjames Stephen as writer of leading articles (replaced to a certain extent, after 1869, by Sir Henry Maine), R. H. Hutton, Matthew James Higgins ("Jacob Omnium"), James Hannay, and George Henry Lewes, with George Eliot, Anthony Trollope, Charles Reade, and Thomas Hughes as occasional contributors, the paper failed to attract until, in the following year, Mr Greenwood's brother, James, furnished it with three articles on "A Night in a Workhouse: by an Amateur Casual." A morning edition had already been tried and dropped, and so was a distinct morning paper, attempted in 1870. In 1867 new premises were taken in Northumberland Street, Strand. Three years later the *Pall Mall Gazette* was the first to announce the surrender of Napoleon III. at Sedan. Matthew Arnold was represented in it by "Friendship's Garland" in 1871, and Richard Jefferies by "The Gamekeeper at Home" in 1876 and onwards. Mr Greenwood made the paper unflinchingly Conservative and strongly adherent to Lord Beaconsfield's foreign policy. In 1880 Mr Smith handed over the *Pall Mall Gazette* to his son-in-law, Mr Henry Yates Thompson, who turned it into a Liberal journal. Mr Greenwood retired from the editorship shortly afterwards and started the *St James's Gazette*; and Mr John Morley became editor of the *Pall Mall*, with Mr W. T. Stead (b. 1849) as assistant-editor. The price was reduced in 1882 from twopence to one penny. Many of the old contributors remained, and they were reinforced by Robert Louis Stevenson, who wrote some "Letters from Davos," Professor Tyndall, Professor Freeman, James Payn, and Mrs Humphry Ward. Mr Morley exchanged journalism for politics in 1883, and was succeeded by Mr Stead, with Mr Milner, afterwards Lord Milner, as his assistant. Adopting an adventurous policy, Mr Stead imported the "interview" from America, and a report of General Gordon's opinions was believed to have been the cause of his ill-fated mission to Khartum. A series of articles called "The Truth about the Navy" (1884) forced the Admiralty to lay down more ships next year. "The Maiden Tribute of Modern Babylon," purporting to further the Criminal Law Amendment Bill, consigned Mr Stead to three months' imprisonment in Holloway Gaol. Mr Stead made a feature of reprints called "extras"; and, edited by Mr Charles Morley, the *Pall Mall Budget* became an illustrated weekly. Mr Stead was replaced in 1889 by Mr E. T. Cook, who had become assistant-editor in succession to Mr Milner. The *Pall Mall Gazette* was now steadily Liberal and a strong advocate of Home Rule. On its staff were Mr Edmund Garrett, Mr F. C. Gould the caricaturist, and Mr Alfred Spender. Mr Cook resigned in 1892, on the sale of the paper to Mr William Waldorf Astor, the American multi-millionaire, who turned it again into a Conservative organ, and also changed its shape, abandoning the old small pages for a larger sheet. Mr Henry Cust, M.P., was appointed editor, with Mr E. B. Iwan-Muller as assistant-editor, and a staff including Mr H. B. Marriott-Watson, Mr G. W. Steevens, Mr John Stuart, Mr Charles Hands, Mr Nicol Dunn (afterwards editor of the *Morning Post*), Mr Duguid as City editor, the late R. A. M. Stevenson as art critic, and Mr Vernon Blackburn as musical critic. Among the fairly regular contributors may be mentioned Mr H. G. Wells, Mrs Meynell, Miss Violet Hunt, Mr G. S. Street, and Sir Herbert Maxwell. Being unstinted from a financial point of view, Mr Cust, who came fresh to editorship with enthusiasms as to what a newspaper could do acquired from his experiences in Parliament and in Society, made the columns of the *Pall Mall* very lively for the next couple of years. It became well known for its "booms," and its "smartness" generally; also for the punning head-lines which frequently adorned its leading articles. Some papers contributed to it by Sir Charles Dilke and Mr Spenser Wilkinson resulted in the establishment of the Navy League in 1894. The paper had, too, the first news of Mr Gladstone's resignation and the appointment of Lord Rosebery to succeed him. But though the *Pall Mall* under Mr Cust had outshone all its competitors, its independence of those business considerations which ultimately appeal to most proprietors hardly represented a durable state of affairs; and eventually the relations between proprietor and editor became strained. In February 1896 Mr Cust and Mr Iwan-Muller parted company with the *Pall Mall Gazette*, and were succeeded in their appointments by Sir Douglas Straight and Mr Lloyd Sanders, the latter of whom retired in 1902. A more moderate policy was now pursued. The *Pall Mall* was the first London paper to announce the critical character of Mr Gladstone's last illness; while its denunciation of the use of water-tube boilers in the Royal Navy produced a Parliamentary Committee of Inquiry. The *Pall Mall* published its 10,000th number on 14th April 1897.

The St James's Gazette.

Founded in 1880 by Mr H. Hucks Gibbs (afterwards Lord Aldenham), with Mr Frederick Greenwood as editor, the *St James's Gazette* represented the more intellectual and literary side of Tory journalism in opposition to the new Liberalism of the changed *Pall Mall Gazette;* it was in fact meant to carry on the idea of the original *Pall Mall* as Mr Greenwood had conceived it, and was more of a daily review than a chronicle of news. In 1888, the paper having then been sold to Mr E. Steinkopff, Mr Greenwood retired and was succeeded as editor by Mr Sidney Low (1888–97), who had as his chief assistant-editors Mr S. H. Jeyes (till 1891) and Mr Hugh Chisholm (1892–97), the latter succeeding him as editor (1897–1900). The paper was for many years conspicuous for its literary character and for the number of distinguished literary men who wrote for it, some of whom first became known to the public by means of its columns. Among its contributors were Sir J. Fitzjames Stephen, Sir Henry Maine, Mr H. D. Traill, Mr Edmund Gosse, Mr Coventry Patmore, Mr J. M. Barrie, Mr Rudyard Kipling, Mr (afterwards Sir) Gilbert Parker, Mr Anthony Hope, Mr F. S. Pulling, Mr David Hannay, Mr T. E. Kebbel, Sir Walter Armstrong, Mr J. K. Stephen, Mr Sutherland Edwards, Mr Marcus B. Huish, Mr J. R. Fisher, Mr Walter Low, Mr Pett Ridge, Mr Harold Boulton, Mr H. A. Kennedy, Mr W. B. Woodgate, Dr A. Shadwell, Mr Henry Newbolt, and Mr W. P. James. In 1895 *Truth*, not prejudiced in favour of a Conservative journal, described the *St James's* as the best-edited paper in London. It was one of the earliest supporters of the Imperialist movement, and between 1895 and 1899 was the chief advocate in the Press of resistance to the foreign bounties on sugar which were ruining the West Indies. In 1899 the course taken by Sir Michael Hicks-Beach in reducing the fixed charge on the national debt had previously been advocated in its columns alone. In 1898 the sum of £1000 was raised through the medium of the *St James's* for endowing a cot in the Great Ormond Street Children's Hospital in memory of Lewis Carroll. It may be recalled that under Mr Low's editorship a protest was made on behalf of *boni mores* by the omission of any report in the columns of the *St James's* of the Oscar Wilde trial in 1895. This action obtained commendation in responsible circles, and notably from Lord Chancellor Halsbury, but in practice the circulation returns indicated that, while verbally approving the course taken, people bought other papers which contained an account; and the suggestion which was made that judges should in such cases order no report to be published failed to obtain much support. During the years immediately following 1892, when the *Pall Mall Gazette* again became Conservative, and the competition between Conservative evening papers became acute, it was increasingly difficult to carry on the *St James's* on its old lines so as to secure a profit to the proprietor; and by degrees modifications were made in the general character of the paper, with a view to its containing more news and less purely literary matter. But it retained its original shape, with sixteen (after 1897, twenty) small pages, a form which the *Pall Mall* abandoned in 1892. In 1900 Mr Theodore Cook, who had been assistant-editor since 1898, became editor for a brief period, and subsequently Mr Ronald MacNeill acted in this capacity, with Mr W. D. Ross as manager. The *St James's Budget*, which up to 1893 had been a weekly edition of the *Gazette*, was then turned into an independent illustrated weekly, edited from the same office by Mr J. Penderel-Brodhurst, who had been on the editorial staff since 1888; and it continued to be published till 1899, when Mr Brodhurst retired and the *Budget* was converted back into its earlier form.

The Globe.

The *Globe* (printed on pink paper), founded in 1803, is in the later period associated with the name of Mr George Armstrong, who, first joining its staff in 1872, became editor and proprietor, and in 1892 was created a baronet. In 1895 his son, Lieutenant G. E. Armstrong, became editor. No London paper changed its character in later years less than the *Globe*, both in policy and in methods. Aggressively Conservative since 1866 in politics, it maintained its reputation for straightforward criticism and well-digested news. One of its regular features was its "turnover," a miscellaneous article always appearing on the last column of the front page and turning over on the second; another was its "By the way" column, containing smart paragraphs and *bon mots;* and in recent years its articles on naval topics were consistently well informed. Among those connected with the paper, the most prominent has been Mr W. T. Madge, the manager, who also started and edited the *People* (1881), a popular Sunday journal for the masses.

The Westminster Gazette.

When the *Pall Mall Gazette* was sold to Mr Astor in 1892 and converted into a Conservative organ, Mr E. T. Cook, the editor, and most of his staff, resigned, and in 1893 they came together again on the *Westminster Gazette*, newly started for the purpose by Sir G. Newnes as a penny Liberal evening paper. It was printed on green paper, but the novelty of this soon wore off. The paper was conducted on the lines of the old *Pall Mall*, and it had the advantage of a brilliant political cartoonist in Mr F. Carruthers Gould. In 1895 Mr Cook was appointed editor of the *Daily News*, and his place was ably filled by Mr J. Alfred Spender, who had been his assistant-editor. Apart from Mr Gould's cartoons, the *Westminster* became conspicuous in London evening journalism for the admirable tone of its leading articles, and for Mr C. Duguid's excellent City notes. One of its greatest successes was the original publication of Mr Anthony Hope's "Dolly Dialogues."

The *Evening Standard*, founded as we have seen in 1827 as the *Standard*, has long been the evening edition of the morning paper. It is distinguished by the peculiarly full and detailed character of its reports of the day's news. (H. CH.)

The Halfpenny Press.

One of the problems and surprises that have resulted from the cheapening of telegraphy, of mechanical methods of production, and of the desire to read, is the modern halfpenny newspaper. It is, however, by no means so new as may appear. For its origin we must go back to the middle of the 16th century, when the Government of Venice sent out occasional bulletins of information on political and public affairs. These leaflets were called *Fogli di Avvisi*, and were sold at the price of one gazzetta, a coin worth a fraction over a halfpenny. Thus arose the use of the word "gazette" as a common term for a newspaper, and it is noteworthy that it originally meant what we now know as a halfpenny. In England we find the first mention of inexpensive news-sheets towards the close of the 17th century, when a number of halfpenny and farthing *Posts* sprang into existence, and appeared at more or less irregular intervals. These consisted of small leaflets, containing a few items of news—sometimes accompanied by advertisements—and were commonly sold in the streets by hawkers. The increase of these newspapers, and especially the growing practice of inserting advertisements, led the Legislature to contemplate a stamp tax of a penny per sheet on all news publications. As a protest, a curious pamphlet—of which a copy is preserved in the British Museum—was issued in 1701, and sheds an interesting light upon this early phase of cheap journalism. The pamphlet is entitled, "*Reasons humbly offered to the Parliament on behalf of several persons concerned in the paper-making, printing, and publishing of the halfpenny newspapers.*" It states that five master printers were engaged in the trade, which used 20,000 reams of paper per annum. The journals are described in the following terms: "The said newspapers have been always a whole sheet and a half, and sold for one halfpenny to the poorer sort of people, who are purchasers of it by reason of its cheapness, to divert themselves, and also to allure herewith their young children and entice them to reading; and should a duty of three halfpence be laid on these mean newspapers (which, by reason of the coarseness of the paper, the generality of gentlemen are above conversing with), it would utterly extinguish and suppress the same." The pamphlet goes on to say that hundreds of families, including a considerable number of blind people, were supported by selling the halfpenny journals in the streets.

Origins of the halfpenny Press.

In 1712 a tax of a halfpenny per sheet was imposed, and the cheap newspapers at once ceased to exist. This tax on the press was increased from time to time, till in 1815 it stood at fourpence per sheet. The usual price of newspapers was then sevenpence a copy. From these facts it seems highly probable that, had not the stamp tax been imposed, the halfpenny paper would soon have become the normal type, and would have continued so to this day. In 1724 a committee of the House of Commons sat to consider the action of certain printers who were evading the stamp tax by publishing cheap newspapers under the guise of pamphlets. They found that there were then two *Halfpenny Posts* published in London, one by Read of Whitefriars, and the other by Parker of Salisbury Street. There were also three weekly papers issued at a halfpenny a copy. The tax, after several reductions, was finally repealed on 15th June 1855, and a rush of cheap papers immediately followed.

Modern London halfpenny papers.

The first modern English newspaper to be issued at a halfpenny was the *London Evening News*—afterwards known as the *Day*. It was started in 1855, but soon failed to meet expenses, and disappeared from the scene. Between twenty and thirty local papers were at once started in London, of which the following were issued at a halfpenny:—*Clerkenwell News*, *Time o' Day for Hoxton*, *Islington Gazette*, *Islington Times*, *Lambeth Observer*, *North London Record*, *St Luke's News*, *Shoreditch Observer*, *South London Times*, and *Westminster News*. Of these it is interesting to note that the *Clerkenwell News* became the *Daily Chronicle*, while the *Islington Gazette* still survived in 1902, though not as a daily newspaper. The times, however, were not then ripe for fresh ventures in halfpenny journalism. The high price of paper, the slowness of production, the limited income from advertisements, and inadequate means of distribution, were all against these cheap journals, and one by one they had to raise their price or die. Not infrequently they did both. In 1868 appeared the *Echo*, the first of present-day evening papers to be issued at a halfpenny. It was published by Messrs Cassell, Petter, and Galpin, and had for its first editor, until 1875, Mr (afterwards Sir) Arthur Arnold (1833–1902), who afterwards became M.P. for Salford (1880–1886), and chairman of the London County Council (1895–96), and was well known both as a writer and traveller, and as founder of the Free Land League (1885). Baron Albert Grant (1830–1899), the pioneer of modern mammoth company-promoting,[1] afterwards took it in

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[1] Albert Grant, who took that name though his father's was Gottheimer, was given the title of Baron by King Victor Emmanuel of Italy in 1868 for his services in connexion with the Milan picture gallery. He made a large fortune by company-promoting, and in 1865 became M.P. for Kidderminster. He became a prominent public character in London. In 1873 he built Kensington House, a vast mansion close to Kensington Palace, which in 1883 was demolished and the site seized by his creditors. In 1874 he bought up Leicester Square, converted it into a public garden, and presented it to the Metropolitan Board of Works. But soon afterwards he failed, and from 1876 to his death he constantly figured in the law-courts at the suit of his creditors.

hand and wasted a fortune over it. After passing through troublous days, it was finally put upon a sound basis and turned into a commercial success by the shrewd judgment and untiring energy of Mr Passmore Edwards. In the following year appeared at Darlington the *Northern Echo*, which claims to be the first halfpenny morning daily ever issued in any land, though it is on record that the one-cent morning journal is of older origin in the United States. Next came the *Evening News*, which was begun at a halfpenny in 1881 as a Liberal organ, but was shortly afterwards bought by a Conservative syndicate. It saw stormy times, and at the end of thirteen years it had absorbed £298,000 and was heavily in debt. Its shares could then be purchased for threepence or fourpence each. In August 1894 it was purchased by Messrs Harmsworth for £25,000, and entered upon a career of prosperity. On 17th January 1888 the first number of the *Star* appeared, under the editorship of Mr T. P. O'Connor (b. 1848), as a halfpenny evening newspaper in support of Mr Gladstone's policy. When Mr O'Connor left the paper, Mr H. W. Massingham became its editor, and subsequently Mr Ernest Parke. From the first it warmly espoused the cause of the working classes. In 1893 Mr T. P. O'Connor founded the *Sun*, which eventually passed first into the hands of Mr H. H. Marks and then into those of Mr Bottomley.

Two morning papers at the popular price of a halfpenny appeared in the spring of 1892, the *Morning* and the *Morning Leader*. They raced for priority of publication, the former winning by a day. The *Morning Leader*, under the same management as the *Star*, was still flourishing in 1902, but the *Morning* had but a brief career. The *Daily Mail*, which was originated by Mr Alfred Charles Harmsworth (b. 1865) and appeared in 1896, was the first halfpenny morning newspaper to place at the disposal of its readers a news service competing with that of any of the higher-priced newspapers. It claimed by 1902 a regular circulation of about a million copies daily (and had occasionally sold as many as 1,500,000 copies of a single issue), and it was produced simultaneously in London and Manchester, the whole of the contents being telegraphed nightly. The *Daily Express*, founded by Mr Cyril Arthur Pearson (b. 1866), first appeared in 1900, and won a large *clientèle* by its eminently readable qualities.

British provincial halfpenny papers.

The British provincial press, which had its origin in 1690, when the *Worcester Postman*—now known as *Berrow's Worcester Journal*—was started, advanced by leaps and bounds during the latter half of the 19th century (see also below). Increased facilities for the distribution of news resulted in the establishment of daily newspapers in all the principal towns, and a large proportion of them were in 1902 sold at the popular price of one halfpenny, practically all the evening journals being issued at this price. A list compiled at the commencement of 1902 gave the names of eighty-seven halfpenny daily newspapers published in English provincial towns, a considerable number of these being morning journals. Of these, sixty-two had been issued since 1870, those bearing earlier dates of origin being in most cases sheets which formerly were issued at a penny or more, but had subsequently reduced their prices. An example of this may be seen in the *Leeds Mercury*, which was issued in 1718 at three-halfpence. Owing to the imposition of the stamp tax its price gradually increased, until in 1797 it stood at sixpence, when its circulation was only 800 copies. With the removal of the tax its price was reduced and it became one of the most popular of Yorkshire penny newspapers. In 1901 its price was lowered to a halfpenny and at the same time its news service was greatly improved, with the result that its circulation grew rapidly, and it proved more profitable at a halfpenny than it had been at a penny. Of halfpenny morning newspapers existing in 1902, the first to be published at that price was, as has been stated above, the *Northern Echo*, which was issued at Darlington in 1869. It may be interesting to note that of the eighty-seven halfpenny dailies issued in England in 1902, twenty-nine claimed to be Liberal in politics, twenty-three Conservative or Unionist, and nineteen independent, while the rest did not indicate their tendency. Of the sixty-two that were issued since 1870, twenty-seven appeared between 1871 and 1882, nineteen between 1882 and 1892, and sixteen between 1892 and 1902. Scotland at the close of 1901 had eleven halfpenny dailies, three being morning papers; Ireland had seven, and Wales four.

Conditions of production.

The growth of the halfpenny newspaper has been practically a simultaneous one throughout the civilized world. This has been notably the case in the United States, France, and Great Britain. The general tendency in newspaper production, as in all other branches of industry, has been towards the lowering of prices while maintaining excellence of quality, experience having proved the advantage of large sales with a small margin of profit over a limited circulation with a higher rate of profit. The development—and indeed the possibility—of the halfpenny daily paper was due to a number of causes operating together during the latter half of the 19th century. Among these, the first place must undoubtedly be given to the cheapening of paper, through the introduction of wood pulp and the perfecting of the machinery used in the manufacture. From 1875 to 1885 paper cheapened rapidly, and it has been estimated that the introduction of wood pulp trebled the circulation of newspapers in England. Keen competition in the paper trade also did much to lower prices. At the same time the prime cost of newspaper production was increased by the introduction of improved machinery into the printing office. The growth of advertisements must also be taken into account in considering the evolution of the halfpenny journal. The income from this source alone made it possible to embark upon journalistic enterprises which would otherwise have been simply to court disaster. At the same time, a properly managed halfpenny paper should show a substantial profit, altogether apart from the income that it derives from advertisements.

Special characteristics.

The popular journal of the present day does not, however, owe its existence and success merely to questions of diminished cost and improved methods of production. Its favourable reception points to a change that has come over the public mind. The modern reader demands news rather than opinions, and he likes his news in a brief, handy form, so that he can see at a glance the main facts without the task of reading through wordy articles. This is especially the case with the man of business, who desires to master the news of the past twenty-four hours as he travels to his office in the morning. It is to economize time rather than money that the modern reader would often prefer a halfpenny paper; while the man of leisure, who likes to peruse leading articles and full descriptive accounts—often written by most able thinkers and skilled *littérateurs*—finds what he needs in the more highly priced journals. It is not, then, to the people who cannot afford a penny that the halfpenny paper makes its appeal. To say that it is read by "the man in the street" is after all not to disparage it, for it is "the man in the street" who goes to the poll and governs his country. The growth of education must also be borne in mind when endeavouring to account for the halfpenny paper. It is happily a very rare thing now to find a young man or woman who cannot read, and every person who can read wants to know the news. Even the poorest person does not hesitate much over the expenditure of a halfpenny when an interesting line on the contents-bill arrests his attention and awakens his curiosity. The halfpenny paper in England has not had to contend with the opposition that the penny newspaper met from its threepenny contemporaries in the 'fifties and 'sixties. This is largely due to the fact that in most cases the contributors, paper, printing, and general arrangement of the cheaper journal do not leave much room for criticism. Mr G. A. Sala's famous complaint that the reporters of the older sheets objected to work side by side with him when he represented the first penny morning newspaper, through fear of losing caste, does not apply, for in the United Kingdom, France, and the United States the cheap journals, owing to their vast circulation, are able to offer the best rates of remuneration, and can thus command the services of the best men in all the various departments of journalism.

Foreign Press.

Turning now to the growth of the cheap press abroad, the first French newspaper ever published may be fairly called a halfpenny one. The *Gazette de Paris* was established by Theophrastus Renaudot—the founder of the Mont de Piété, or pawnshop—in the year 1631, at the price of one parisis or six centimes. At first the *Gazette* consisted of four small pages, increased in the following year to eight and sometimes to ten. It still existed in 1902 as an organ of the Legitimist party, though its circulation was presumably very small and its price had been advanced. *Le Petit Journal* was founded in 1863, and may be regarded as the modern pioneer of the French halfpenny press. It claims to have attained on occasion a circulation of 1,012,050 copies, and dispenses almost entirely with advertisements. *Le Petit Journal* has a close rival in *Le Petit Parisien* and in *Le Journal.* The sou was in 1902 the recognized price of Parisian newspapers, of which there were about sixty, comparatively few being dearer. French journalism showed a slow but sure change, the feuilleton giving way to news. *Le Matin*, which in 1902 was in its nineteenth year, claimed that it was the only French journal receiving by special wires the latest news of the whole world, and it had an advantage in having arranged to obtain the news service of the London *Times.* In many respects it offered remarkable value for the money. Of a very different type are *L'Intransigéant*, edited by M. Henri Rochefort, and *La Libre Parole*, conducted by M. E. Drumont, both affording reading matter of the most flamboyant type at the popular price.

To enumerate all the other Parisian newspapers at five centimes would be a lengthy task, but the following are a few of the best known:—*L'Écho de Paris*, an excellent newspaper, in its nineteenth year in 1902, and *L'Éclair*, a typical news-sheet. *La Fronde*, in its sixth year in 1902, enjoyed the unique distinction of being managed, edited, and written by women only, the *directrice* being Madame Marguerite Durand. *La République* represented the progressive Republican party since 1872, and *La Petite République* had expounded the views of the Socialists since 1875. *La Lanterne* in 1902 had seen a quarter of a century, and *Le Journal*, which claimed to be the only French journal appearing every day with six pages at least, was eleven years old. It may be mentioned that six pages is a favourite size for a French halfpenny paper. *Le Radical* was in its twenty-second year, and *L'Autorité*, under the political direction of M. Paul de Cassagnac, in its seventeenth.

In *Belgium* the halfpenny paper is decidedly popular and well established. Among others may be noted *La Chronique*, which in 1902 was in its thirty-fifth year; *L'Étoile Belge* (founded 1869), an eight-page paper, one-half of which consists of advertisements; and *La Gazette*, a year younger. *Le Petit Bleu* makes free and effective use of illustrations, and in 1902 was in its ninth year. *Le Soir*, *Le National Bruxellois*, and *La Réforme*, which last is often illustrated, are sold at the remarkably low price of two centimes (one-fifth of a penny) per copy. These claim to be the cheapest journals in the world. Each is a four-page paper, well edited, and possessing a very fair news service. The first was in 1902 sixteen years old, and the last nineteen.

In *Italy* all the papers, with a very few exceptions, were in 1902 sold at five centesimi. Among others may be mentioned *La Tribuna*, which enjoys an excellent news service, and gives very complete accounts of the debates in the Italian Parliament. Published at Rome, it was in its twentieth year. *Il Secolo*, which in 1902 was thirty-seven years old, and the *Corriere della Sera*, which was twenty-seven, are both issued from Milan; while *La Stampa*, a new Piedmontese gazette, has its publishing offices at Turin. Italy has also its halfpenny illustrated press, of which a good example is seen in *Il Secolo Illustrato*, fourteen years old in 1902, which is admirably produced.

The tendency towards extreme cheapness had not yet, in 1902, influenced the *German* press to so great an extent as in some other European countries, though it is decidedly leaning in that direction. *Der Lokal-Anzeiger* was founded at Berlin by August Scherl, who had gained his journalistic experience in America, and was prepared to introduce entirely novel methods into the Fatherland. The new journal was published on Sunday mornings, and delivered free for two and a half pfennigs per copy, a sum about equal to one farthing. It was subsequently converted into a daily paper, and the price was considerably advanced. A typical German halfpenny newspaper is seen in *Das Kleine Journal*, published in Berlin at five pfennigs. It is occupied mainly with finance and trade announcements. An attempt was made at Vienna in 1902 to establish a paper, the *Neue Zeitung*, at one kreuzer (one-fifth of a penny), but it lived only two months.

In *Switzerland*, *La Tribune de Genève*, founded 1878, is published at five centimes, and is a leading paper of its class. *Spain* is represented by *El Correo*, founded 1879, which is published in Madrid at five centimos. It has an ingenious arrangement by which the inevitable feuilleton is so printed that it may be cut off and folded into book form. In *Russia* a cheap paper has not much encouragement, but the *Swet* contrives to flourish at the equivalent of a halfpenny. *Pesti Hirlap* is a *Hungarian* paper, published at Budapest. It contains twenty-four pages—of which six are advertisements—and costs eight pfennigs. Though this is more than a halfpenny, it is less than a penny, and the *Pesti Hirlap* is certainly a low-priced newspaper.

American Press.

Down to the year 1833 there were no cheap newspapers in *America*. The usual price was six cents, and no journal had a sale of over 5000 copies. On 1st January 1833 the *Morning Post* was started in New York at two cents per copy. This was quickly reduced to one cent, but the paper lived only three weeks. On the 3rd September following, the New York *Sun* was founded by Benjamin H. Day. It sold at one cent until the outbreak of the war, when the general rise in prices sent it up to two cents, where it remained. The first issue of the *Morning Herald* of New York, owned by James Gordon Bennett and Company, appeared on 6th May 1853 at the price of one cent. It consisted of four pages, measuring 30 inches by 24, with four columns to the page. Vigorous competition followed, and the rival one-cent papers adopted tactics which were as ingenious as they were novel in the newspaper world. The *Herald*, *Sun*, *Tribune*, *Times*, and *World* of New York all started at one cent. There were in 1902 an immense number of one-cent journals published in various parts of the United States, and fresh ones are continually appearing. As an example of the enterprise with which they are conducted, mention may be made of the *Journal* and *World* of New York, and the *Press* of Philadelphia. These and many others often give fourteen or sixteen big pages in return for the purchaser's cent. (A. C. H*.)

British Provincial Newspapers.

The London newspaper zone extends eastwards to Ipswich and Norwich, northwards to Leicester, and westwards to Bristol. In 1870 its northern limits were Nottingham and Birmingham. Important daily newspapers had then been established in every great centre of intellectual, industrial, and mercantile activity. The abolition of the duty on advertisements in 1853, of the stamp duty in 1855, and of the paper duty in 1861, opened the way for a cheap press, and within ten years of the abolition of the paper duty penny morning newspapers had taken up commanding positions in Edinburgh, Glasgow, Dundee, and Aberdeen; in Liverpool, Manchester, Leeds, Bradford, Newcastle, and Sheffield; in Birmingham and Nottingham; in Bristol, Cardiff, and Plymouth; and across St George's Channel in Dublin, Cork, Belfast, and Waterford. Halfpenny morning newspapers (see above) had also come into existence. In 1859 the *Dundee Courier* was started. At Exeter two old papers published twice a week—the *Daily Gazette* in 1863 and the *Western Times* in 1866—began to issue halfpenny morning editions on four days in the week. At Brighton in 1868 the *Sussex Daily News* was started as a halfpenny morning paper, but has since been advanced to a penny. Evening newspapers, too, had come into existence. The most successful were the *Manchester Evening News* and the *Glasgow Citizen*; but there were also prosperous evening papers at Birmingham, Shields, Exeter, Bolton, Bradford, Leeds, and Brighton. Practically, however, provincial newspapers at the close of the 'sixties consisted of the penny morning newspapers and the old county weeklies, with a few weekly papers of more recent creation in great towns. Since then there has been an enormous increase in the number of evening newspapers, a smaller addition to the number of both penny and halfpenny morning papers, and some increase also in the weekly press; but the great change effected in provincial journalism during the last thirty years of the 19th century is in the character rather than in the number of the newspapers produced.

So far as the increase in the number of morning newspapers is concerned, politics have been a powerful influence. Dissensions amongst Irish Nationalists led in 1891 to the establishment of the *Dublin Daily Independent* and its evening ally the *Evening Herald* as Independent Nationalist newspapers, in opposition to the *Freeman's Journal* and its evening paper the *Evening Telegraph*; and in 1897 the *Nation*, a powerful Irish weekly in the days of "Young Ireland" and while it was owned and edited by the Sullivans, was brought out as a daily newspaper. In Newcastle-on-Tyne the adhesion of the *Newcastle Chronicle* to Unionism opened the way for the *Newcastle Daily Leader* in 1885 as a Liberal paper; and this journal, with evening and weekly paper attached, is amongst the few new morning newspapers that have in recent years been begun with success. Other places in which morning penny newspapers have been successfully started, as a rule to supply a political want, are Aberdeen, York, Huddersfield, Manchester, Ipswich, Norwich, Cardiff, and Swansea. Halfpenny morning newspapers have increased in number to almost as large an extent as their penny contemporaries. At Darlington in 1871 the *Northern Echo* was started; and a few years later, when Mr W. T. Stead became its editor, the very advanced views that it advocated goaded the Conservatives of the district into the production of a rival paper, the *North Star*. Brighton was again given a halfpenny morning paper in 1896; and the close of the century was signalized by an eruption of morning halfpenny newspapers in Middlesbrough, Newcastle, Shields, and Sunderland, all the outcome of a labour dispute in the office of the *Newcastle Leader*, and all issued from Newcastle by the same publisher. A still more recent development, the ultimate results of which remain to be seen, is the creation in provincial centres of halfpenny morning newspapers in connexion with London halfpenny morning journals. This movement has been inaugurated by Messrs Harmsworth and Messrs C. Arthur Pearson and Co., who have invaded Birmingham, Liverpool, Manchester, Leeds, Newcastle, and Glasgow with halfpenny morning papers that reproduce in the provinces the leading characteristics of the *Daily Mail* and the *Daily Express*.

Except in special cases, provincial newspapers began as strictly local journals. Manchester held an exceptional position. Commercially the centre of a trade that extended over the whole of Lancashire and part of Cheshire, and politically the headquarters of advanced views on social and economic reform, the Manchester press from its earliest days regarded current events from a national point of view, and influenced opinion throughout Lancashire, Cheshire, and northwards to Carlisle. The *Leeds Mercury* from its inception was given a character of its own by its founder and first editor, Mr Edward Baines, whose family have left an impress not only upon journalism but upon literature in the north of England. For many years the *Leeds Mercury* admitted neither racing news nor notices of theatres to its columns, but it was a powerful influence both in morals and politics in the northern districts of Lancashire and Yorkshire. In Northumberland and Durham the *Newcastle Chronicle* had some influence outside its strictly local sphere. It was in Scotland, however, that localism was first thoroughly broken down. The *Scotsman*, under the managership of Mr Law and the editorship of Mr Alexander Russel, led the way. It collected news from the whole of Scotland, opened an office in London, made special arrangements for securing home and foreign news, made liberal use of the telegraphs, reviewed books, discussed general as well as local topics, supplied full parliamentary reports, and in fact realized the present ideal of a morning newspaper. On the business side, means were taken to circulate the paper all over Scotland by the early morning trains. Glasgow is a better centre than Edinburgh for distribution in the west of Scotland; a publishing office was therefore opened in Glasgow, and a special train engaged to take the *Scotsman* to it for distribution over the west of Scotland. The same policy was adopted at Perth for the north of Scotland. The *Glasgow Herald* met this action by arranging for simultaneous publication in Edinburgh, and it and the *Dundee Advertiser* were equally active in improving their news supply and perfecting their London arrangements. The Dublin and Belfast newspapers being more distinctly severed from Great Britain and from British influence than the Scottish press, naturally organized themselves on Irish lines, the Dublin becoming national and the Belfast more distinctly Ulster organs of public opinion. But London connexions were indispensable, and the leading Irish newspapers were carried along in the stream of general advance. For a time the English press rather lagged behind. Even

Manchester did not move forward so resolutely as Scotland. A remarkable result of the *Scotsman's* energetic policy and lavish expenditure, under the editorship after 1876 of Mr Charles A. Cooper (b. 1829), has been that it has killed every other morning newspaper in Edinburgh. The *Daily Review*, once the organ of the Free Church, and the *Edinburgh Courant*, the oldest Conservative newspaper in Scotland, have both disappeared. They could not stand the *Scotsman's* pace. A courageous attempt was made by the Liberal party, after the *Scotsman* became Unionist in 1886, to run the *Scottish Leader*. To compete with the *Scotsman*, with its more than princely revenue, its splendid organization for news supply, and its perfect publishing arrangements, required a very long purse. The *Scottish Leader* did not succeed. In Manchester the *Guardian* has shown enterprise on the Scottish lines. It has perfected its news supply, and promotes circulation by chartering special early trains to Crewe for Wales and the south, Leeds for the Yorkshire district, and Wigan for the north of England. The *Manchester Examiner*, once the leading Liberal paper in the north of England, did not show similar enterprise, and when it abandoned its traditional advanced Liberalism for Liberal Unionism it forfeited whatever remained of its old popularity, and died. The tendency is for one great newspaper to dominate a district, and success falls to the most enterprising and most intelligently conducted. In 1871 the *Liverpool Weekly Albion* brought out a *Daily Albion* under the editorship of Mr William Hind, whose experience in daily journalism was gained on the *Scotsman* and the *Dundee Advertiser*. The new daily was edited on the most advanced lines. It presented both local and general news, reviews of books, special articles on both general and local topics, had special London arrangements, was exceptionally strong in commercial news, and discussed general more than local affairs. It failed through defective business management; but through its three or four years of existence it had given an immense stimulus to the other Liverpool dailies; and when it was converted into an evening paper in 1874, preliminary to its decease in 1887, its disappearance chiefly benefited the *Liverpool Daily Post*, which most closely resembled it in character, and through Sir Edward Russell (b. 1834), who became editor in 1869, enjoyed political and social connexions and influence, and a reputation for cultured criticism in art, music, the drama, and literature, that placed it above its local contemporaries and in the front rank of provincial journalism.

General causes were now beginning to influence the whole provincial press. While the leading journals were content with a merely local circulation, and did not strive very vigorously to push into new and distant ground, the personality and influence of the editor was a factor of first importance. How profoundly the guiding mind of the editor might influence the public usefulness of a newspaper had been shown by Mr (afterwards Sir William) Leng, when in 1867 and 1868, at the peril of his life, he denounced in the *Sheffield Telegraph* the iniquities of "rattening" and the trade-union terrorism of the saw-grinder Broadhead. How powerful the personality of the editor still is, and ever must be, was shown by the strongly "pro-Boer" attitude maintained by the *Manchester Guardian*, under the guidance of Mr C. P. Scott, M.P., from 1899 onwards. But even in 1870 it was beginning to be universally perceived that though the influence of a newspaper depends upon the sagacity, sound judgment, and courage of the editor, its success as a business enterprise rests mainly with the business manager. Managers demanded less localism, a wider range of news, prompter and fuller reports of all important events, longer Parliamentary reports, Parliamentary sketches, verbatim reports of speeches by statesmen of the first rank. In the early 'seventies such a thing as a full telegraphic report in a provincial morning newspaper of Parliamentary proceedings, or of a speech by a leading statesman, was almost unheard of. The Press Association had been in existence a short time, but had not then covered the country with its organization. Reuter's foreign news service very briefly reported important events. Leading articles were written during the day. Between 1870 and 1880 a complete revolution was effected, as the result of social and educational changes that have already been traced. Leader-writers began to discuss the latest topics. Newspapers that had been content to fill their columns with local news and clippings from London and distant provincial papers put such matter aside. Telegraphic news crushed it out. In February 1870 the Government took over the telegraph system. The advantage of the change was immediately felt by newspapers and their readers. Leading English and Irish newspapers, following Scotland's lead, began to open offices in London. Soon Fleet Street began to be an open directory to the provincial press—English, Scottish, and Irish. The Scottish and the leading Irish newspapers of necessity, the wealthiest and most enterprising English papers for convenience and advantage, engaged special wires. Others that were near enough to London to do so secured London news and advertisements by railway, and completed their news supply by a liberal use of the telegraph. Commercial news, both home and foreign, especially American, was expanded. The Press Association spread its news-collecting organization over the whole country, and was stimulated to activity by the rising opposition of the Central News. All this energy had its counterpart in the business side of the press. Rapid "perfecting" printing machines were introduced, and newspaper managers found themselves in possession of newspapers full of the latest news, and procurable in practically unlimited quantities. By the use of special trains and other organizations, circulation increased apace. The development of news agencies, and their universal employment, tended to produce sameness in the provincial press. From this fate the more enterprising journals saved themselves by special London letters, Parliamentary sketches, and other special contributions. In 1881 the reporters' gallery in the House of Commons was opened to some provincial newspapers, and these accordingly enjoyed new facilities for special effort and distinction. A more important matter, however, was the bombardment of Alexandria and the subsequent Egyptian war. The leading provincial newspapers had already emancipated themselves from localism, and in general news and criticism had risen almost, if not quite, to the average level of the first-class London journals. Now they were to step abroad into the field of war. Singly or in syndicates, or by arrangement with London journals, the leading provincial newspapers sent out war correspondents, and were able to record the history of events as promptly and fully as the metropolitan press. The first syndicate to send out war correspondents was formed by the *Glasgow News*, the *Liverpool Daily Post*, *Manchester Courier*, *Birmingham Gazette*, and *Western Morning News*. By this combination two very able correspondents were sent to Egypt, and the new departure was attended with complete success. The Central News also sent out war correspondents to Egypt and the Sudan. During the South African war the Press Association, in conjunction with Reuter's Agency, employed correspondents, as well as the Central News. The leading provincial newspapers, however, all formed syndicates amongst themselves to secure war telegrams, and in many cases made arrangements for the simultaneous publication of the letters and telegrams of leading London journals. The result was that in these provincial journals during the early and most exciting period of the war there was a fuller and better supply of war news than in the London press. This system of securing simultaneous publication, in provincial newspapers, of special contributions to London morning newspapers was afterwards still further extended, and articles of exceptional interest that have been specially prepared for London journals may now be found on the same day in some of the leading provincial newspapers.

By the beginning of 1880 the country had fallen upon a period of low prices, and extra expenditure upon war telegrams and on an improved supply of general news was to a considerable extent balanced by the reduced cost of paper. Under the stimulus of cheapness the news-sheet was enlarged. More advertisements, more news, more varied contributions, filled up the additional space. The cost of composition increased, and, though circulation and revenue increased also, there was some danger to the margin of profit. Again invention came to the rescue. Type-setting machines had been invented even before web-printing machines came into use, but had not been turned to practical service. The experimental was now to pass into the practical stage. In the 'eighties some of the leading provincial newspapers began to use type-setting machines. In this forward step the provinces were far ahead of the London papers excepting *The Times*. The *Southport Daily News*—since dead—led the way by introducing six Hattersley machines. These instruments subsequently passed into the hands of two northern newspapers, and shortly afterwards the *Liverpool Courier* and the *Liverpool Daily Post* adopted the Hattersley machines on a large scale. The Linotype, however, was destined to supersede this invention, and now all the leading provincial journals are supplied with type-setting instruments of this pattern. The immediate results of composition by machinery were important. Fewer compositors were required, the earnings of those employed upon machines were greatly increased, and the employers' wages bill was reduced. But the public were given most of the benefit, for with the enlargement of newspapers and an increase in their number, the composing staffs soon rose to their former numbers, or even beyond them, and increased circulation had to meet the increased cost of production. Another development of newspaper enterprise was the introduction of illustrations into the daily press. So long ago as the first Egyptian war the *Liverpool Daily Post*, under the energetic management of Mr A. G. Jeans, introduced maps and diagrams to illustrate the progress of events. Some other English provincial newspapers have advanced in this direction, but not to any great extent. The displayed advertisements which are now so much in evidence, and have found their way into all English and into some Scottish newspapers, are of American origin. The leading Scottish newspapers, more conservative in their habits and stronger financially than the majority of their English contemporaries, still resist very large type and unusual display. The English newspapers, however, find whole-page and double-column and other display advertisements remunerative, and relax their general rules "for a consideration."

In the general amplification of news in morning newspapers, the enlargement of ideas on sport has been an especially remarkable feature. In 1870 sporting meant horse-racing and little more. Now it embraces athleticism in all its branches, and progressive newspapers are looked to for information on football, hockey, golf, cricket, lawn-tennis, yachting, boating, cycling, wrestling, coursing, hunting, polo, running, bowls, billiards, chess, &c., quite as much as for notices of musical and dramatic performances, and of other forms of recreation and amusement. No newspaper objects on principle to the publication of athletic news, but some have striven against the publication of betting and other gambling accompaniments of horse-racing. Amongst these the *Leeds Mercury* was the most conspicuous; but Yorkshire is a great sporting county, and though the *Yorkshire Post*, under Mr Pebody's management, catered well for all classes, the Leeds Daily News Company found it possible in 1895 to start the *Yorkshire Sporting Pink*. In Manchester so long ago as 1871 a *Sporting Chronicle* was successfully started, the proprietors of which in 1885 began also a *Sunday Chronicle*, and in 1897 an *Evening Chronicle*. Liverpool has a *Football Echo* and a *Football Express*, published on Saturdays; Sheffield a *Football World*, published on Mondays; the *Potteries Sporting News* is published daily at Hanley; the *Midland Sporting Gazette* at Nottingham; and Newcastle-on-Tyne, Bristol, and Newmarket each has a *Sporting News*.

Some provincial towns with special characteristics present journalistic opportunities of their own. Liverpool with its large shipping interest supports a *Journal of Commerce*, issued daily, which Mr Charles Birchall, its proprietor and manager, afterwards published also in Manchester. Since 1877 the *Swansea Gazette*, issued daily, has catered for the shipping trade of South Wales. Liverpool has an exceptionally large Roman Catholic population, which is provided with a weekly *Catholic Times*. Leeds, with an exceptionally large Jewish quarter, supports a weekly *Jewish Express*, established in 1894.

Neither in connexion with sport nor other matters has there been any addition to the number of newspapers in Scotland comparable to English experience, probably because the remarkable completeness of the Scottish morning papers leaves no opening for competitors. Ireland has exhibited more variety, and new journalistic adventures in Dublin speak of increased Irish prosperity. The Freeman's Journal Company in 1881 issued *Sport* as a weekly, and in 1890 added a daily *Sporting News*; in 1885 the *Irish Cyclist* appeared as a weekly, and in 1888 the *Farming World* and the *Social Review*.

Despite the many changes in provincial journalism resulting from the phenomenal energy that has been brought to bear upon morning newspapers, the most conspicuous feature in newspaper evolution during the period under review was the development of the evening newspaper. For a long time proprietors of morning newspapers held aloof. They feared that the evening paper would damage the circulation of the morning journal and give them only a halfpenny for a penny. The idea, as has been discovered by experience, was utterly fallacious, but it was strongly held. Even in Scotland, where every morning newspaper now publishes an evening paper, the proprietors of the morning newspapers were almost forced into the new enterprise. In Glasgow, under a new proprietary, the *Glasgow Evening News* was brought out in 1870, in opposition to the *Citizen*. The *Edinburgh Evening News* was started in 1873, and in Paisley an evening *Daily Express* was issued in 1874. The *Glasgow Herald* brought out its *Evening Times* in 1876. In the following year the *Dundee Advertiser* issued its *Evening Telegraph*. Two years later the *Aberdeen Journal*, and again after a two years' interval the *Aberdeen Free Press*, joined in the movement. Not till 1885 did the *Scotsman* publish an evening paper. In this matter Ireland moved more quickly than Scotland, for the *Freeman's Journal* brought out its *Evening Telegraph* in 1870. In Belfast a new proprietary was left to introduce in the same year an *Evening Telegraph*, and a few years later the *Ulster Echo* was started under independent auspices. But beyond the duplication of evening papers in Dublin through Nationalist dissensions, and the establishment of an evening paper at Waterford, little success has attended evening journalism in Ireland.

It is in England that the evening press has flourished most, though, as in Scotland, the morning newspapers were slow to move. The *Liverpool Courier* and the *Birmingham Daily Post* were first in the field, and in 1870 issued respectively the *Liverpool Evening Express* and the *Birmingham Daily Mail.* The latter paper soon became a great success, and within three or four years of its commencement had a circulation of from 50,000 to 70,000. Other morning papers that during the 'seventies brought out evening newspapers were the *Manchester Courier* and the *Leicester Post* in 1874, the *Western Daily Press* in 1877, the *Nottingham Daily Guardian* in 1878, and the *Liverpool Daily Post* in 1879. This was not striking evidence of appreciation of the value of evening newspapers, during a period in which morning papers were entirely transformed by a widened news supply, and printing power was multiplied by the introduction of web-printing machines. Nor did the Egyptian war, and cheaper paper, and type-setting machines greatly stimulate the issue of evening papers by old dailies.

Between 1880 and 1890 evening newspapers were started by the *Sussex Daily News*, the *York Herald*, the *Eastern Daily Press*, the *South Wales Daily News*, the *Nottingham Daily Express*, the *Newcastle Chronicle*, the *Western Mail*, and the *Sheffield Daily Telegraph.* Since then the *Yorkshire Post*, *Western Daily Mercury*, *Manchester Chronicle*, *Newcastle Daily Leader*, *Bristol Mercury*, and *Western Morning News* have done so. But there are still a few prominent morning newspapers that have not entered into evening journalism. Amongst these are the *Liverpool Mercury*, *Leeds Mercury*, *Sheffield Independent*, *Birmingham Daily Gazette*, and *Bristol Times*.

Comparatively few additions have been made to weekly newspapers since 1870. The most notable new weeklies have been the *Liverpool Weekly Post*, the *Birmingham Weekly Mercury* (issued from the *Birmingham Gazette* office), the *Newcastle Weekly Leader*, the *Western Weekly Mercury* (published at Plymouth), and the *Manchester Sunday Chronicle* and the late Sir W. Leng's Sunday paper, the *Sunday Telegraph.* The old county papers have held their ground, and in many county towns new weeklies have been started; but the prompt publication of news of all kinds by morning and evening newspapers and their circulation throughout the whole country have compelled weekly newspapers to modify their character and to give attractiveness to their columns by publishing serial stories, notes on gardening, agriculture, &c., notes and queries, and other special contributions.

Taking a general survey of the progress that has been made, evidence is found on every hand of remarkable energy, resourcefulness, and prosperity. The progress of education, the greater use of telegraphs, the organization of news agencies, the introduction of the telephone, and the growth of industry, commerce, and population have been the main influences that have led to a revolution in the supply of news. The improved printing machines, type-setting machines, and cheapness of paper have resulted in cheapening the production of newspapers, and have encouraged their owners to increase their size. At the same time, the multiplication and enlargement of newspapers, notwithstanding the temporary reduction of staffs through the improvement of machinery, have provided employment for a greatly increased number of compositors at higher wages, and the rapid distribution of evening newspapers has utilized the services of an immense army of men and boys and horses. The low price of paper has enabled many new journals to come into existence and prosper on a comparatively slender income. But the keenness of competition has carried expenditure upwards. It is only the great newspapers that are indisputably in the front that can feel secure of their position, and those only by a combination of prudence and enterprise and energy in management that do not always coexist. In the financial prosperity and strength of newspapers the public have a very direct interest. Wealthy and flourishing newspapers can resist with impunity all temptations to venality, and perform their functions as vigilant critics and watchful guardians of public interests with fearless independence. The provincial press has gained and maintained a high reputation for integrity of purpose and superiority to all corrupt influences. It ranges itself on the side of public morality and decency and sobriety, and upholds purity in political and social life and in the administration of both local and national affairs. (W. WE*.)

ILLUSTRATED JOURNALISM.

Illustrated journalism is the name given to that form of newspaper enterprise which treats of illustration of current news and the events of the passing hour. The great development in this direction in recent years makes it desirable to trace its origins more in detail than was attempted in the earlier volumes of this work. The earliest attempts at popular illustration of news events took the form of broadsides. One broadside dated 1587 recounted the *Valiant Exploits of Sir Francis Drake;* another dated 1607 gave an account of *A wonderful flood in Somersetshire and Norfolk.* The series of murder broadsides which lasted almost to our own time commenced in 1613 with one that gave an account of the murder of Mr William Storre, a clergyman of Market Rasen, in Lincolnshire, by Francis Cartwright. Early in the reign of Charles I. there appeared a broadside which described a fall of meteors in Berkshire. A little later—in 1683—the *Weekly News* came out with the picture of an island which was supposed to have risen from the sea on the French coast. The execution of Strafford in 1641 was made the subject of a picture pamphlet that is to be seen in the British Museum, and in 1642 the first attempt to portray the House of Commons appeared in *A Perfect Diurnall of the Passages in Parliament.* In 1643 a pamphlet was published, called *The Bloody Prince; or a Declaration of the Most Cruel Practices of Prince Rupert and the rest of the Cavaliers in fighting against God and the True Ministers of His Church.* This contains a woodcut representation of Prince Rupert on his charger, one of the first attempts at providing the public with a portrait of a contemporary celebrity.

Soon after this there appeared a journal, entitled *Mercurius Civicus*, which frequently gave illustrations, and, allowing for the *Weekly News* with its one attempt at an illustration above mentioned, must be counted the first illustrated paper. *Mercurius Civicus*, however, only gave portraits; it published Charles I. and his queen, Prince Rupert, Sir Thomas Fairfax, and all the leading men on both sides in the Civil War. Perhaps the most interesting illustration of the next four years was that contained in a tract intended to evoke sympathy for the conquered and captured king. It represented Charles in Carisbrooke Castle in 1648. There were many later attempts to depict the tragedy of Charles I.'s execution, and several woodcuts present to us also the execution of the regicides after Charles II. came to the throne. A broadside of the reign of the second Charles shows the Frost Fair on the Thames in 1683, and with a broadside describing *Great Britain's Lamentations, or the Funeral Obsequies of that most incomparable Protestant Princess*—Queen Mary, the wife of William III., in 1695—we close the illustrated journalism of the 17th century.

Curiously enough, the 18th century, so rich in journalistic enterprise and initiation so far as the printed page was concerned, did less than the previous century to illustrate news. In 1731, however, in the *Grub Street Journal*, there appeared the first illustration of the Lord Mayor's procession. In 1740 another journal, the *Daily Post*, gave an illustration of Admiral Vernon's attack on Portobello. The narrative was introduced by the editor with the information that the letter that he is printing is from a friend who witnessed the conflict between the English and the Spaniards. The writer of the letter, who must be put on record as the father of war correspondents, signed himself "William Richardson."

There were some interesting efforts to illustrate magazines about this time. In the *Gentleman's Magazine* for 1746 there was a lengthy account of the famous rising of 1745, and a map was given of the country round Carlisle, showing the route of the Scottish rebels; and in the same volume there was a portrait of the duke of Cumberland. In 1747 the *Gentleman's* gave a bird's-eye view of the city of Genoa, illustrating the account of the insurrection there, and so on year by year there were further pictures. In 1751 an obituary notice was illustrated by a portrait of a certain Edward Bright of Malden, Essex. Mr Bright died at the age of thirty, and his interest to the public was that he weighed 42½ stones. There were a number of other magazines besides the *Gentleman's* that came out about this time and continued well into the next century. In the *Thespian Magazine* for 1793, for example, there is an illustration of a new theatre at Birmingham. Then there were the *English Magazine*, the *Macaroni Magazine*, the *Monstrous Magazine*. Every one of these contained illustrations on copper, more or less topical.

William Clement, the proprietor of the *Observer*, the first number of which was published in 1791, was the first real pioneer of illustrated journalism, although his ideals fell short in this particular, that he was never prepared to face the illustration of news systematically; he only attempted to illustrate events when there was a great crisis in public affairs. In 1818 Abraham Thornton, who was tried for murder, appealed to the wager of battle, which after long arguments before judges was proved to be still in accordance with statute law, and he escaped hanging in consequence. Thornton's portrait appeared in the *Observer*. Clement owned for some time *Bell's Life* and the *Morning Chronicle*. All his journals contained occasional topical illustrations. The *Observer's* illustration of the house where the Cato Street conspirators met is really sufficiently elaborate for a journal of to-day, and in 1820 it gave its readers "A Faithful Reproduction of the Interior of the House of Lords as prepared for the Trial of Her Most Gracious Majesty Queen Caroline." In 1821 it published an interior of the House of Commons with the members in their places. The *Observer* of 22nd July 1821—the Coronation number—contained four engravings. Of the George IV. Coronation number Mr Clement sold 60,000 copies, but even that was nothing to the popularity that this journal secured by its illustrations of the once famous murder of Mr Weare and the trial of the murderer Thurtell. The *Observer* in 1838 gave a picture of the Coronation of Queen Victoria. In 1841 there was a fire at the Tower of London, when the armoury was destroyed. The *Observer* published three illustrations of the fire; it further published an emblematic engraving on the birth of the prince of Wales, and issued a large page engraving of the christening ceremony in the following January. Thus it had in it all the elements of pictorial journalism as we know it to-day.

The *Illustrated London News* was, however, the first illustrated newspaper by virtue of its regularity. It was the first illustrated paper, because all the illustrations to which we have referred as appearing in the *Observer* and other publications were irregular. They came at intervals; they were quite subordinate to the letterpress of the paper; they were given only occasionally in times of excitement, with a view to promoting some little extra sale. That they did not really achieve the result hoped for to any great extent may be gauged by the fact that from 1842 to 1847 the *Observer* published scarcely any illustrations at all, and in the meantime the *Illustrated London News* had taken an assured place as a journal devoted mainly to the illustration of news week by week. That is why its first publication marked an epoch in journalism. The casual illustration of other journals still went on: the *Weekly Chronicle*, for example, still published a number of pictures; the *Sunday Times*, also a very old paper, illustrated in these early days many topical subjects. In 1834, indeed, it pictured the ruins of the House of Commons, when that building was burned down. A paper started in 1837 called the *Magnet* gave illustrations, one of them of the removal from St Helena and delivery of the remains of the Emperor Napoleon to the prince de Joinville in 1840.

The first number of the *Illustrated London News* appeared on 14th May 1842. Its founder was Herbert Ingram (1811–1860), who was born in Boston, Lincolnshire, and started life amid the most humble surroundings, what education he ever received having been secured at the free school of his native town. Apprenticed at fourteen to a printer in Hull, he later settled in Nottingham as a printer and newsagent in a small way. It was during his career as a newsvendor at Nottingham that he was seized with the belief that it was possible to produce a paper entirely devoted to illustration of news. In the first number of the *Illustrated London News*, however, there was not a single picture that was drawn from actual sight, the factor which is the most essential element of the illustrated journalism of to-day. Sir John Gilbert (1817–1897), the artist, has stated that not one of the events depicted by him—a State ball at which the Queen and the Prince Consort appeared, the Queen with the young prince of Wales in her arms, and other incidental illustrations—was taken from life.

The *Illustrated London News* had not been long in existence before there were many imitators, in America *Harper's Weekly*, in France *L'Illustration*, and in Germany *Über Land und Meer*, and from that day there has been constant development, although in 1902 in the United Kingdom only three other newspapers existed on lines akin to the *Illustrated London News*, namely the *Graphic*, *Black and White*, and the *Sphere*. Development has taken place, however, in many directions. The photograph has in some measure dethroned the artist; colour-printing has been taken up vigorously, more particularly in France; wood-engraving has given way to mechanical processes that are much more expeditious; daily journalism has largely taken up with illustration, and the *Daily Graphic* has systematically illustrated news. Recent illustrated journalism has also expressed itself in a division of subject. Women's interests are catered for in the *Queen*, the *Gentlewoman*, and many similar journals, the interests of the stage in the *Sketch* and the *Tatler*, while all kinds of interests—golf, motoring, field-sports, for example—have each a separate illustrated organ. Further developments of illustrated journalism will probably be in the direction of more complex machinery and quicker production.

See also *Pictorial Journalism*, by Mason Jackson; *A Treatise on Wood Engraving*, by W. A. Chatto and John Jackson.

(C. K. S.)

THE UNITED STATES.

The changes in the newspaper press of the United States in the last fifteen years of the 19th century were little short of revolutionary. It was noted in the ninth edition of the *Encyclopædia Britannica* that "only one daily illustrated paper is published in America." Now it would be easier to enumerate those not illustrated. It was noted then that most of the new papers were of the four-page class, springing from a reaction against large sheets; that they "aimed at great condensation of routine news," but with "special prominence for sensations," and were coming to be sold for two cents. Now the papers are far larger than ever before, extending in the great cities not infrequently, on special occasions or on Sundays, to sixty pages, and from that to 100, and often ranging from twelve to twenty-four for ordinary week-day issues. Routine news is no longer so rigidly condensed, and far more of it is collected, while sensational news is apt to be expanded beyond all precedent. There has been a great increase in the number of large one-cent papers and in their circulation, while simultaneously different reading habits have appeared among the people, and there has been a distinct diminution in the authority of the press. Several circumstances have combined to promote such changes in the condition and character of American newspapers:—(1) Paper has been enormously cheapened. Before and during the Civil War it cost large New York newspapers at times 22 cents per ℔ for even a poor quality. In 1864 it cost 16 cents in February, and ran up a cent every month till in midsummer it touched 21 and 22 cents. As late as 1873 it was still sold at from 12 to 13 cents. As new materials were found and machinery was improved, the price slowly declined. When the manufacture from wood-pulp was made commercially successful, the profits tempted great investments of new capital; bigger mills were built, competition became keen, and new inventions cheapened the various processes. Thus in New York in 1875 the average price for the year for fair "news" paper was 8·53 cents per ℔; in 1880, 6·92; in 1885, 5·16; and in 1890, 3·38. At last, about 1897, large contracts for a good average quality, delivered at the press-room, were made in New York at as low a figure as 1·5 cents per ℔. Since then advances in raw materials, one or two dry seasons which curtailed the water-power, and combinations resulting from over-competition, have caused some reaction. Yet it could still be said in 1900 that prudent publishers could buy for $1 as much paper as would have cost them $3 twenty years earlier, or $10 about 1875. (2) Printing machinery for great newspaper offices has been transformed. Instead of the old cylinder presses fed by hand, with the product then folded and counted by hand, machines now in common use print, fold, cut, paste, and count and deliver in bundles, ready either for the carrier or the mail, at rates of speed formerly not dreamed of. The size of the paper may be increased or diminished at will, as late news may require, within an hour of the time when it must be in the hands of its readers. Instead of cutting down other news to make room for something late and important, more pages are added, and this steadily increases the tendency to larger papers. Devices have also been found for printing the same sheet in different colours at the same rate of speed; and in this way startling headlines are made more startling in red ink, or a piece of news for which special attention is desired is made so glaring that no one can help seeing it. (3) Hand-setting (for great newspapers) has been practically abolished. Instead of the slow gathering of single types by hand which prevailed since Gutenberg's invention, separate lines are now produced and cast by machines, capable when pushed to their utmost capacity of doing each the work of five average compositors. Various circumstances generally prevent anything like this speed in ordinary use; but in spite of opposition these machines now reduce the cost of composition in well-organized offices at least to one-half the former figure, while helping to advance wages.

Thus between 1880 and 1900 there were reductions in the cost—(1) of the raw material for the manufacture of newspapers from two-thirds to three-fourths; (2) of printing, at least as much; and (3) of composition one-half, while the facilities in each department for a greater product within a given time were enormously increased. The obvious business tendency of these changes was either a reduction in price or an increase of size, or both.

Electricity became the only news-carrier. New ocean cables broke down the high rates charged at the outset. The American news appetite, growing by what it fed on, soon demanded far fuller cablegrams of European news; and the wars in which Great Britain and the United States were involved accelerated the movement. The establishment of a strong telegraph company, capable of efficient competition with the one which practically controlled the inland service in 1880, likewise cheapened domestic news by telegraph and increased its volume. The companies presently recognized their interest in encouraging rival news associations, and so getting double work for the wires, while promoting the establishment of new papers. Wild competition between news agencies was thus encouraged (even in the cases of some already known to be bankrupt) to the extent of credits of a quarter or half a million dollars on telegraphic tolls. The rapid spread of long-distance telephone lines further contributed to this tendency to make the whole continent a whispering gallery for the press. Every great paper now has both telegraph and telephone wires run directly into its newsroom.

Photography and etching were added to the office equipment. Various "process" methods were found, by which the popular desire for a picture to make the news clearer could be gratified. Drawings were reproduced successfully in stereotype plates for the fastest rotary presses. The field of political caricature had heretofore belonged exclusively to the weekly papers, but the great dailies now seized upon it, and commanded the service of the cleverest caricaturists. Newspapers found a way to put the "half-tone" etching of a photograph, such as had heretofore been printed only on slow flat presses, bodily into the stereotype plate for the great quadruple and octuple presses; and thereafter portraits and photographs of important groups on notable occasions began to appear, embodied in the text describing the occurrences, a few hours after the camera had been turned on them, in papers printed at the rate of thirty and forty thousand an hour.

News agencies multiplied and gave cheaper service. The New York Associated Press had been the chief agency for the whole country. It admitted new customers with great caution, and its refusal to admit was almost prohibitory, while its withdrawal of news from established papers was practically fatal. It was owned by the leading New York journals. Their disagreements led to the success of a rival, the United Press. The New York Associated Press finally dissolved, most of the New York members became connected with the United Press, and many of their Western and Southern clients organized the Associated Press of Illinois, more nearly on a mutual plan. The United Press finally failed, and most of its New York members went into the Associated Press of Illinois, which in turn was forced into plans for reorganization by decisions of Illinois courts against its rules for confining its services to its own members. One result of these successive changes has been to encourage new papers by making it easy for them to secure a comprehensive news service, and thus to threaten the value of the old papers. Another has been the struggle to increase the volume of the service, leading to reports of multitudes of occurrences formerly left without notice in the great news centres, an extension of agencies into the remotest hamlets, and less scrupulous care in the consideration and preparation of the reports filed at many points for transmission. News syndicates for special purposes also developed, as well as small news associations, sometimes with a service sufficient for the wants of many papers. The species of almost official authenticity which the public formerly attached to an Associated Press despatch is measurably dissipated; and the dailies have at once more difficulty in sifting and deciding upon the news that comes to them, and more individual responsibility for what they print.

The great accumulation of private fortunes has also changed the newspapers. Millionaires have occasionally come to think it advantageous to own newspapers, openly or secretly, which can be conducted without reference to direct profits, for the sake primarily of political, social, or business considerations. To secure large circulations for such enterprises they have been willing to sell the paper for long periods at much below the cost of manufacture, and to spend money for news and writers more lavishly than the legitimate business of established journals would allow. Great business corporations seeking for favourable or fearing adverse legislation sometimes make secret newspaper investments for the same purpose. Ambitious politicians, men who want newspaper favour to get into politics, or speculators who want it for private schemes, men with suddenly increased incomes who can readily spare a few thousand dollars to promote some end without much certainty of direct return on the investment, are often found ready subscribers for the scheme of any plausible young person with some newspaper experience to start a new paper or buy up and revolutionize an old one, and are not much deterred by occasionally seeing newspaper capital thus raised disappear entirely in a receivership or a bankruptcy.

These various new conditions, affecting the newspaper press of the United States with ever-increasing force since 1885, are changing the average character of the papers and their effect upon their readers. A craze for great circulation obtains—circulation among intelligent and moral classes, if convenient, but at any rate a great circulation, no matter among what classes—as the only evidence of success and the only way to make the sale of a newspaper below cost ultimately a source of profit. A disposition to lower the character in order to catch the largest audience naturally follows. Criminal news is reported more fully than formerly, with more piquant details. Competitors outdo each other in the effort to treat all news with unprecedented sensationalism. The lowest possible price is regarded as essential to the largest possible circulation, and so a favourite price even for large newspapers is one cent to the public, and consequently only half a cent to the publishers, whose business is practically all at wholesale with dealers and news companies. The feeling that the most must be given for the money prompts also the great increase in size, only made possible by the reductions in paper, composition, presswork, &c., already noted. Yet mere quantity and mere sensation after a time palled on the jaded appetite, and the spice of intense personality became necessary. As most people like to see their names in print, and can bear criticism of their neighbours with composure, these two chords of human nature were played upon incessantly. The appetite thus created soon craved yet greater supplies, so that the average American publisher is now right when he pleads that in practically taking the roof off the house of everybody of any note, and filling his paper with inane "social" or other mention of people of no note, he does not even yet satisfy the interest in personalities which possesses large classes of the community.

The habits of readers have also undergone great changes. In the villages and smaller towns few took more than one daily paper a generation ago, and many were content with weeklies. Even in large cities the average well-to-do householder was apt to be satisfied with one daily, or at the most one morning and one evening paper. Now few content themselves with less than one of each at the home, and another (preferably of different politics) on the street car or at the office. Orders from prosperous New Yorkers to serve six or seven dailies are so common as to attract no notice; even the children and the servants have their favourite journals provided. It would not be exact to say that the influence of the press at large has declined in proportion as its circulation has increased and people have acquired the habit of reading both sides. When the papers show reasonable agreement on any new question, they still carry the community with them almost unanimously. The most corrupt and most powerful combination cannot long stand, even yet, against a united press. But when papers differ on any great question, people give less serious thought to what any of them say, and often less to the question itself. In the multitude of contradictory voices one neutralizes another, and the reader thinks of something else. Meanwhile the influence of the press, as measured by the outward appearance of actual subservience to it, has been enhanced, though this is accompanied by a latent distrust, which is becoming general, and by a dislike, often more openly expressed than formerly. The libel laws, unhappily, are resorted to less by people who have character to protect than by those who are tempted by lawyers to speculate on inadvertent errors. The possibility of repressive measures, social or legal, for false news and unwarranted personality is sometimes discussed, but not often seriously approached. It would not be just to omit saying that, while these changes have been increasingly manifest in American newspapers, there has been marked improvement in other directions. Though their flippancy

TABLE I.—*Newspapers and Periodicals in the United States—Census of 1900, with per cent. of Increase.*

Periods of Issue.	Number of Publications.			Per cent. of Increase.	
	1880.	1890.	1900.	1880–1890.	1890–1900.
Daily	971	1,610	2,226	65·8	38·3
Weekly	8,633	10,814	12,979	25·3	20·0
Semi-weekly	133	194	637	45·9	228·3
Tri-weekly	73	34	62	53·4 [1]	82·4
Monthly	1,167	1,734	1,817	48·6	4·8
Quarterly	116	225	237	94·0	5·3
All other	221	290	268	31·2	7·6
Total	11,314	14,901	18,226	31·7	22·3

TABLE II.—*Average reported Circulation per Issue, 1880–1900.*

Periods of Issue.	Average Circulation per Issue.		
	1880.	1890.	1900.
All classes	3,122	4,640	6,271
Daily	4,137	5,209	6,784
Weekly	2,113	2,678	3,071
Semi-weekly	2,136	2,896	4,447
Tri-weekly	1,001	1,473	3,687
Monthly	7,834	11,317	21,750
Quarterly	16,505	36,109	47,331
All other classes	6,474	11,851	20,695

[1] Decrease.

and deplorable addiction to the use and invention of slang continue, they are more generally well written and often more attractively arranged. They enlist large numbers of young college-bred men, who thus find immediate income and no delay for special training, as in law or medicine. They glean news with amazing thoroughness; cover the

TABLE III.—*Daily Papers in Chief American Cities, 1880–1900.*

Cities.	Year.	Number of Daily Papers published.			Aggregate Circulation per Issue.	Population of Cities.	Number of Inhabitants to each Copy per Issue.	Rank of Cities according to Increasing Number of Inhabitants to each Copy per Issue.
		Total.	Morning.	Evening.				
Greater New York	1900	58	29	29	2,732,089	3,437,202	1·26	...
New York, N.Y.	1880	29	20	9	765,843	1,206,209	1·58	2
	1890	50	34	16	1,698,553	1,515,301	0·89	1
	1900	47	28	19	2,632,213	2,050,600	0·78	5
Chicago, Ill.	1880	18	10	8	220,577	503,185	2·28	9
	1890	27	14	13	644,000	1,099,850	1·71	11
	1900	37	16	21	1,099,555	1,698,575	1·54	15
Philadelphia, Pa.	1880	24	13	11	375,274	847,170	2·26	8
	1890	24	13	11	804,008	1,046,964	1·30	6
	1900	21	10	11	1,008,752	1,293,697	1·28	9
Brooklyn, N.Y.	1880	4	...	4	48,537	566,663	11·67	22
	1890	5	...	5	82,448	806,343	9·78	27
	1900	6	1	5	95,476	1,166,582	12·22	25
St Louis, Mo.	1880	9	8	1	99,364	350,518	3·52	14
	1890	15	9	6	238,525	451,770	1·89	13
	1900	13	7	6	373,030	575,238	1·54	15
Boston, Mass.	1880	11	6	5	221,315	362,839	1·64	4
	1890	12	5	7	466,471	448,477	0·96	2
	1900	16	8	8	761,039	560,892	0·74	3
Baltimore, Md.	1880	9	6	3	128,643	332,313	2·58	10
	1890	7	6	1	133,510	434,439	3·25	22
	1900	9	6	3	232,252	508,957	2·19	19
San Franciso, Cal.	1880	21	11	10	143,232	233,959	1·63	3
	1890	21	14	7	286,912	298,997	1·04	5
	1900	23	15	8	304,185	342,782	1·13	6
Cleveland, Ohio	1880	8	2	6	48,730	160,146	3·29	12
	1890	13	4	9	133,800	261,353	1·95	14
	1900	11	3	8	258,473	381,768	1·48	13
Buffalo, N.Y.	1880	7	2	5	26,100	155,134	5·94	19
	1890	10	3	7	120,800	255,664	2·12	17
	1900	12	3	9	217,989	352,387	1·62	16
Cincinnati, Ohio	1880	12	8	4	117,549	255,139	2·17	7
	1890	14	10	4	213,500	296,908	1·39	7
	1900	13	7	6	516,708	325,902	0·63	1
Pittsburg, Pa.	1880	9	6	3	111,001	156,389	1·41	1
	1890	10	7	3	232,462	238,617	1·03	4
	1900	11	7	4	421,741	321,616	0·76	4
New Orleans, La.	1880	10	6	4	37,565	216,090	5·76	18
	1890	9	4	5	73,900	242,039	3·28	23
	1900	9	5	4	96,360	287,104	2·98	22
Detroit, Mich.	1880	6	3	3	41,533	116,340	2·80	11
	1890	8	2	6	134,388	205,876	1·53	8
	1900	8	3	5	207,110	285,704	1·38	10
Milwaukee, Wis.	1880	7	4	3	24,300	115,587	4·76	16
	1890	10	5	5	63,200	204,468	3·24	21
	1900	11	4	7	132,805	285,315	2·15	18
Washington, D.C.	1880	5	3	2	34,500	147,293	4·27	15
	1890	4	2	2	62,651	230,392	3·68	25
	1900	8	3	5	100,848	278,718	2·76	21
Newark, N.J.	1880	6	4	2	18,300	136,508	7·46	20
	1890	6	3	3	50,600	181,830	3·59	24
	1900	3	1	2	71,832	246,070	3·43	23
Jersey City, N.J.	1880	2	...	2	11,176	120,722	10·80	21
	1890	4	1	3	28,300	166,003	5·76	26
	1900	2	...	2	19,580	206,433	10·54	24
Louisville, Ky.	1880	5	4	1	22,215	123,758	5·57	17
	1890	5	3	2	95,100	161,129	1·69	10
	1900	8	5	3	136,950	204,731	1·49	14
Minneapolis, Minn.	1880	...	...	...	...	...	...	...
	1890	9	4	5	92,323	164,738	1·78	12
	1900	9	6	3	137,906	202,718	1·47	12
Providence, R.I.	1880	5	2	3	29,900	104,857	3·51	13
	1890	3	1	2	52,000	132,146	2·54	20
	1900	3	1	2	76,000	175,597	2·31	20
Indianapolis, Ind.	1880	4	3	1	35,587	75,056	2·11	6
	1890	7	3	4	64,213	105,436	1·64	9
	1900	9	4	5	135,698	169,164	1·25	7

world with their correspondents; cultivate the fields of art, literature, and science; and present accounts of discoveries, letters of adventure, details of political, business, educational, reformatory, charitable, and religious movements, especially in the Sunday issues, in a profusion, variety, and popular attractiveness never before approached. There has been an extraordinary increase in the attention given to the interests of women, and also in the space surrendered, even in the soberest of journals, to sport. All kinds of special interests find constant and copious notice: cycling, chess, bridge, motoring, spelling reform, amateur photography, &c. In fact, the great American daily has become a good deal like the great "department store"—a sort of universal provider.

TABLE IV.—*Languages of Newspapers and Periodicals—Censuses of 1880 and 1900.*

	No. of Papers published in Each Year. 1880.	1900.
English	10,515	17,194
German	641	613
German and English	0	20
German and Hebrew	0	3
Hebrew	0	13
Scandinavian	49	115
Spanish	26	39
French	41	27
French and English	0	4
Lithuanian	0	9
Dutch	9	12
Bohemian	13	28
Polish	2	33
Italian	4	35
Welsh	5	0

In 1880 the number of newspapers and periodicals printed in foreign languages in the United States was 799, and in 1900, 1032. Newspapers and periodicals were printed in the United States in fifteen different languages in 1880, in thirty in 1890, and in twenty-five in 1900. In 1900 the newspapers and periodicals reported 122,183 employés receiving $77,348,842 in wages. The total cost of material used in publication of newspapers and periodicals was reported at $50,214,904. The amounts received from advertising and subscriptions and sales were reported at $175,789,610, of which the advertising was a larger part than the subscriptions and sales.

The statistics of circulation, capital invested, profit, and the like are notoriously untrustworthy. The Government adhered to its effort to collect them in 1890, and such results of that census as seem valuable are given together with those of the census of 1900. In spite of the universal newspaper-reading habit in America, none of its papers yet attains regularly the vast circulations attributed to two or three papers in London and Paris. The reasons are obvious. Each of these is a national capital, situated in the midst of a dense population of between thirty and forty millions, of whom from one-half to three-fourths can be readily reached by the London or Paris paper during daylight on the day of publication. In the greatest American cities the population to be reached within the same time is smaller; the papers lack the authority of the capital, and are often met, two or three hours after issue, by the papers from other large cities with the same general news service. Thus a New York paper meets the papers of Philadelphia in an hour and a half, and those of Boston in two and a half, while Chicago and St Louis eat into each other's field in the same way. But it is probably true that two or three morning and evening papers in New York pass ordinarily above 200,000 and at times above 300,000 with the combined circulation of their two editions; and that the best of the high-priced papers range from 20,000 to 80,000. It is not believed that in the case of the larger morning papers the publication at one cent has proved generally and permanently profitable. Those in Chicago, after trying it for several years, finally agreed among themselves and doubled the price. One-cent evening newspapers are produced more cheaply and fare better.

The total number of newspapers and periodicals published in the United States in 1900 was, according to the census returns, 21,272. Of these, however, 3046, or 14 per cent., made no report to the Census Bureau, and as these were the least important, they have been omitted from the tables given (I. to IV.). (W. R.)

FRANCE.

The number of newspapers, as distinguished from periodicals, published in France during 1900 was in round numbers 2400. Of these, about 240 appeared in Paris and 2160 in 540 provincial towns. The increase in the Paris newspapers from 160 in 1890 to 240 in 1900 may be taken to fairly represent the general increase throughout the country for the same period; and as there were about 120 in 1880, it appears that the newspapers of Paris, and similarly of France, have doubled their number between 1880 and 1900.

Of the 146 dailies published in 1900, 81 were political. But in order to have an accurate idea of the balance of parties as represented by the Parisian political press, to the 81 dailies must be added 83 periodicals, and it is then found that, of the 146 political organs, 68 are Moderate Republican, 30 Radical and Socialist, 16 Conservative, 8 Nationalist or anti-Semitic, and 42 independent or nondescript. In the provinces the proportion of Radical to Moderate papers is smaller by one-half, for whereas the numbers in Paris are respectively 30 and 68, in the provinces they stand in the proportion of 223 to 880.

Journalism in France.

In the following table is shown the proportion of dailies to weeklies in Paris and four of the largest provincial towns:—

	1890. Population.	Dailies.	Weeklies, &c.	1900. Population.	Dailies.	Weeklies, &c.
Paris	2,250,000	92	68	2,500,000	146	94
Bordeaux	221,000	6	4	257,000	6	8
Lyons	377,000	7	4	466,000	10	5
Marseilles	360,000	5	3	442,000	7	7
Toulouse	140,000	4	1	150,000	5	2

The history of the French press during the last twenty years of the 19th century follows very closely that of the country itself, Boulangist and anti-Boulangist, Dreyfusist or anti-Dreyfusist, Republican or Nationalist; finally it became either Moderate Republican or Radical-Socialist with a sprinkling of Nationalist organs and a small minority of Royalist and Bonapartist sheets.

At the head of the Moderate Republican organs are *Le Temps* and *Le Journal des Débats* among the evening papers, and *Le Figaro*, *Le Journal*, *Le Siècle*, *Le Petit Parisien*, and *Le Petit Journal* among the morning dailies. *Le Temps* and *Le Journal des Débats* have been edited respectively by M. Adrien Hébrard and M. E. de Nalèche. *Le Figaro* was until 1901 under the editorship of M. F. de Rodays, and the brilliant articles of M. J. Cornély were one of the features of the paper; but a dispute among the proprietors in 1901 resulted in the dismissal of M. Cornély and the retirement of M. de Rodays. M. Jean Dupuy (a member of the Waldeck-Rousseau Government) is the proprietor and editor of *Le Petit Parisien*, a popular organ rivalling *Le Petit Journal*; the circulation of the latter, however, has now reached over one million and a quarter copies daily.

Le Matin and *L'Éclair*, among the Moderate Republican organs, give less attention to the discussion of political questions from the party point of view than to the collection of news, and they have been followed by the *Écho de Paris*. *Le Matin*, which dates from 1884, has from its origin been essentially what is called in France a *journal d'informations*, and publishes every morning a mass of telegraphic news from all countries. By an arrangement with the London *Times*, it is in a position to give every day a translation of most of the telegrams published in the latter newspaper. But *Le Matin* contains also very able articles on current topics signed by M. Harduin and

M. Henri des Houx and a number of distinguished contributors.

In April 1901 the proprietorship of *Le Siècle* was changed, in consequence of the lack of support given by Parisian readers to that journal as edited by M. Yves Guyot (formerly Minister of Public Works). The latter was a staunch free-trader, a courageous defender of Captain Dreyfus, and an eloquent advocate of a good understanding between France and England; he emphatically endorsed the British policy in South Africa, and tried to explain it to his countrymen. The paper was, however, bought in by a number of friends of M. Yves Guyot, who remained as editor.

The greatest opponent of M. Yves Guyot from the economic point of view has been M. Jules Méline, also a former minister, whose paper, *La République*, is the recognized organ of Protectionism.

The Radical and Socialist ideas which in latter years have made such progress in France are very ably advocated by several newspapers whose influence has been steadily growing. Such are *L'Aurore*, edited by M. Vaughan, *La Lanterne*, to which have contributed, besides M. Viviani, who is the editor, men like M. Millerand and M. Baudin (both members of the Waldeck-Rousseau Cabinet), M. Camille Pelletan and M. Rouanet.

It is difficult to assign a proper place to *L'Intransigéant*, which really belongs neither to a well-defined party nor even to a group. It may be said to be simply the organ of M. Henri Rochefort, whose personal influence over a large number of readers is still great. Equally difficult is it to speak of M. Clémenceau's organ, *Le Bloc*, as a newspaper, and yet on account of the writer's ability and political influence, *Le Bloc*, which belongs to that class of one-man political periodical sheets of which M. Rochefort's *La Lanterne* is the best-known type, cannot be ignored. In this periodical M. Clémenceau advocates the practical application of all of the revolutionary republican principles, pure and unadulterated, which form a whole (*bloc*), no part of which can or ought to be sacrificed to temporary political necessities.

As an intermediate link between the Republican organs of all shades and the various Monarchist newspapers, comes the so-called Nationalist press, an offshoot of or successor to the Boulangist press of the preceding decade. As were the Boulangists, so are the Nationalists, a sort of *syndicat des mécontents*. Their chief organs are *La Patrie*, edited by M. Millevoye, and *La Cocarde*, and these papers represent the views of those who have vague hankerings after a different *régime* and a decided hostility towards the republican form of government.

There has been a considerable diminution of influence in the Monarchist press. *Le Soleil*, however, has a large circle of readers among the Conservative *bourgeoisie* with Orleanist leanings, and still keeps up the tradition left to it by the late M. Édouard Hervé. *Le Gaulois* remains a Royalist paper of somewhat doubtful tendencies, since the editor, M. Arthur Meyer, seems to have incurred the displeasure of the Pretender whose cause he defended. Of the old Legitimist press there remains the old *Gazette de France*, which was founded in 1631 and has still a diminishing band of faithful readers whose fidelity to their principles compels respect.

It is impossible to close this rapid review of the existing French newspapers without mentioning the organ of the religious (Roman Catholic) associations in France, namely, *La Croix*, founded in 1880. The name of the editor (now M. Feron-Vrau) matters little; what is important is the fact that *La Croix* represents the views of the French religious associations, and discusses all questions from the point of view of Catholic interests. *La Croix* is published in Paris, but there are in the provinces one hundred and four local weekly supplements to the Paris edition, each one taking its name from the parent journal and adding to it the name of the department or locality in which it is printed, such as *La Croix de l'Allier*, *La Croix de Lyon*. The circulation of *La Croix* is supposed to be about 200,000 copies daily. It is needless to add that the tendencies of this journal are anti-Republican.

To whatever parties the French papers belong, most of them have in recent years taken greater interest in foreign matters, and have much improved their organization for collecting news. Some of them, in fact, were almost exclusively news-sheets as distinguished from ordinary newspapers, and the *journal d'informations*—*Le Matin* or *L'Éclair*, for instance—took its place beside the *journal* properly so called more perhaps as a rival than as a complement. The natural result followed, and the ordinary newspapers took steps to provide their readers with news as well as with leading articles, current and literary topics, society gossip, dramatic criticism, and law reports. The most remarkable as well as perhaps the earliest attempt to enlarge the scope of Parisian newspapers was made in 1893 by the late M. Georges Patinot, one of the ablest French editors, who was editing the *Journal des Débats*. Instead of one edition, that newspaper published two entirely distinct editions, a morning one and an evening one. After some time the plucky attempt had to be given up, and the *Journal des Débats* became an evening paper. Before that an interesting event had taken place in 1889, when that renowned organ celebrated its hundredth anniversary by the publication of a most valuable record of its distinguished career in the shape of a splendid volume, *Le Livre du Centenaire du Journal des Débats*. The bold experiment made by the *Journal des Débats* led the other newspapers to find a happy mean between a four-page paper published twice a day and an eight-page paper on the pattern of English newspapers, and the result was that now most great daily papers in Paris have six pages: the *Figaro* gave the lead, and the others followed suit.

Another fact to be noted is that as French newspapers increased in size they reduced their price, and the time is fast approaching when all daily political papers will be sold at 5 centimes ($\frac{1}{2}$d.). Already most six-page newspapers, with the exception of *Le Figaro*, are sold at 5 centimes, and the price of 15 centimes, which used to be the rule, is now the exception. At the present time 60 Paris papers (daily and weekly) are sold at 5 centimes, and 51 at 10 centimes, whilst only 11 cost 15 centimes. In 1880 only 23 were 5-centime papers and 24 were 10-centime papers.

At one time the American style of journalism was in vogue in Paris, and "interviews" were frequent; they are much more scarce now, and the general tendency of Parisian editors is towards the English rather than the American or sensational methods of journalism. Most of the important Parisian newspapers now have special correspondents in the great capitals of Europe, London, Berlin, St Petersburg, Vienna, and Rome, and print every day telegraphic reports from their representatives; and if they do not make use of the telegraph to the same extent as their English and American *confrères*, at least their use of it has become regular and of everyday occurrence. This in itself is a great and remarkable change, and nothing perhaps has been so striking since 1890 as the demand of the French public for foreign and colonial news, or the readiness of the papers to supply it by means of special representatives who make them independent of the news agencies.

In home matters the French press has made greater progress still in the rapid and accurate collection of news, and in this respect the provincial press has shown more enterprise and more ability than that of Paris. Its development has been remarkable, for whereas in 1880 the inhabitants of the departments had to await the arrival of the Parisian papers for their news, they now have the advantage of being supplied every morning with local newspapers inferior to none of the best organs of Paris. The provincial press is extremely well-informed, its news is accurate, and its leading articles are well thought out and well written. Among the best provincial papers may be mentioned *La Gironde* and *La Petite Gironde* of Bordeaux, *La Dépêche* of Toulouse (215,000), *Le Lyon Républicain*, *L'Écho du Nord* of Lille, *Le Journal de Rouen*, all of which have a staff in Paris engaged in collecting news, reporting parliamentary proceedings and law cases, the whole of which is telegraphed or telephoned during the night and published early the next morning in their respective localities. Although, in addition to their regular contributors, these papers frequently engage leading Parisian journalists or literary men to give them special articles, they are nevertheless perfectly independent of purely Parisian opinion or even bias, and the decentralization of the French provincial press may be said to be complete.

The influence of the press of the departments is great, for the newspapers of the large towns circulate not only in the city in which they are printed but throughout the region of which it is the centre. Thus the *Dépêche* of Toulouse, with its twelve editions daily, is read in the whole of the departments extending from the Lot to the Pyrenees, whilst the *Petite Gironde* is found in all south-western France.

It may be said here, however, that in the provinces, as in Paris, there prevails an idea that the press is becoming too powerful, and there is a growing feeling against its omnipotence, as M. Avenel says in his book on the French press.[1] The power of the newspaper in France differs from that of the English newspaper, in that it seems to act more on the Government and the Parliament than on public opinion; and it is needless to insist on the danger of such a state of things, which gives undue power and prominence to individuals and groups of individuals, and may enable them to prevail against a real current of opinion. It is against this system that there exists the feeling to which M. Avenel refers. The French newspapers have taken upon themselves, in many cases, functions which belong more properly to the legislative or to the judicial power than to the press, and the result has not always been successful. The cause of this is that too many men of talent with political ambition look upon journalism as "leading to everything, provided one gets out of it," and use it alternately as an antechamber of Parliament or of the Cabinet, and a lounge during their parliamentary or ministerial eclipses. The remedy will be found ultimately in making the press in France what it once was—a profession which men will be proud to enter, and in which it will be their ambition to remain and to make their mark.

Since 1880 the French press has undergone marked changes which can be summed up in a few words. It has become less exclusive, and has given greater and more intelligent, if at times prejudiced, attention to what goes on beyond the frontiers of France; it has developed its organization for the collection of information, and, without in any way renouncing its literary traditions, it has given to political and current topics of general interest, and to "news" properly so called, a more conspicuous and important place in its columns than before. As a consequence it has been found necessary to increase the size of newspapers and to reduce their price. All these changes are in the right direction, and will probably lead to more important ones in the near future, the tendencies of the French press being now more progressive than at any time during the 19th century. (P. V*.)

[1] *La Presse française au vingtième siècle*, par Henri Avenel. Paris, 1901.

Germany.

In their main characteristics German newspapers are similar to those of Great Britain, but do not approach them in vastness of circulation. There are 3278 newspapers altogether in the empire. Berlin in 1890, with a population of 1,300,000, had 18 dailies and 36 weeklies, &c., while in 1900, with 1,660,000 inhabitants, it was credited with 45 dailies and 48 weeklies, &c. Among its leading papers are the *Vossische Zeitung*, which still retains its position and character; the *National Zeitung*, the organ of the Liberal party; the *Deutsche Allgemeine Zeitung*, the official organ, chiefly inspired by the Foreign Office; the *Berliner Tageblatt*, progressist; and *Germania*, the organ of the Catholic centre.

For the provinces the following table will show the movement during the last decade of the 19th century:—

	1890.			1900.		
	Population.	Dailies.	Weeklies, &c.	Population.	Dailies.	Weeklies, &c.
Leipzig .	170,000	3	10	220,000	8	9
Munich .	200,000	9	4	292,000	12	11
Hamburg .	470,000	6	4	519,000	11	11
Stuttgart .	126,000	3	8	126,000	8	10
Strasburg .	110,000	3	12	124,000	6	6

At the beginning of the 20th century the position and influence of the German press may be described as passing through a period of change. There can be no doubt that the Germans have become a newspaper-reading people. Indeed, with the remarkable growth of the commercial spirit in Germany there has simultaneously been a change in the intellectual attitude and habits of the mass of the nation. The German of what is commonly called "the great period" of recent German history, which had its high-water marks in the years 1866 and 1870, derived his knowledge of his own and other countries to a very great extent from the more or less intelligent study of books, pamphlets, and magazines. The busy German of the opening years of the 20th century is almost as much the slave of his newspaper as the average American. He takes the information which it daily places before him as authoritative, not because he has any general faith in the accuracy of German journalism, but because he has no time to investigate the truth of what he reads. In the domains both of home and of foreign politics the result is often a chaos of crude opinions and impulses, the strata of which are only differentiated by certain permanent tendencies of German political thought based upon tradition, class feeling, material interests, or distinctions of religious creed. In these circumstances it is still possible for the Government, as in the days of Prince Bismarck and Dr Moritz Busch, to bring its superior knowledge to bear upon the anarchy of public sentiment through the medium of the inspired press. It is true that this operation must now be performed with greater delicacy and skill. The press has begun to feel its power, though it is still to some extent incapable of wielding it. It is at least able to drive a bargain with those who would officially control it, and it is conscious in its relations with the authorities that the advantage is no longer exclusively on the side of the latter. It would be instructive to compare, with the aid of Dr Busch's "Secret Pages" of the history of Prince Bismarck, the methods by which the first Chancellor used to create and control a movement of public opinion with the devices by which, for instance, count von

Bülow and his subordinates have endeavoured to manage the press of a later day. The journalists who placed themselves at the disposal of Prince Bismarck were mostly treated as his menials; as he himself said, "Decent people do not write for me." Count von Bülow's methods, and to a certain extent those of his predecessor, Prince Hohenlohe, might be said to move on somewhat different lines. These methods might be characterized as the psychological treatment of the individual journalist, the endeavour to appeal to his personal vanity or to his legitimate ambition, and only in a minor degree to his fear of the *dossier*, the public prosecutor, and the official boycott. There has also been a further development of Prince Bismarck's system of acknowledging the existence of political and social movements the origin of which is wholly or partially independent. As in Bismarck's time, the tendencies of these movements are carefully observed, and they are turned to account where they seem capable of subserving the main objects of State policy. Thus the pro-Boer and agrarian movements were both employed in support of German foreign and colonial policy, and of an elaborate scheme of naval construction; while the growth of the commercial spirit on the one hand and the awakening of the lower middle classes on the other have been pressed into the service of *Welt-politik* and of its auxiliary—a system of protective tariffs. It must have required no small skill to bring into line and to hold together the various classes and interests which are from time to time arrayed in the press in support of German foreign policy. The organs of the Government in the press are the sheep-dogs which hold the flock together.

The German journals of which English newspapers hear most belong with few exceptions to the daily press of Berlin. There are, however, one or two provincial or non-Prussian newspapers which from time to time enjoy more careful inspiration from the Government offices than any of their Berlin contemporaries. There is, for example, the *Cologne Gazette* (*Kölnische Zeitung*), of which Prince Bismarck once said that it was "worth an army corps on the Rhine." It is difficult to trace all the channels by which information is conveyed to an organ of this kind, but there have undoubtedly been times when leading articles and *entre-filets* in the Rhenish organ were virtually or actually written in the German Foreign Office. It does not by any means follow that, because an article or a semi-official announcement is inspired or dictated from official quarters, it precisely represents the views of the Government or the facts of the situation. It is often in the interest of German policy that a hypothetical case should be stated or an alternative course of action suggested, in order that public opinion and even the governments of the different German states should be prepared for all eventualities, or should be influenced in favour of the ultimate decisions of the central authority by being led to contrast them with other possible courses of action. Indeed, the methods of the institution which has been called the "Press Bureau," but which in the realm of foreign policy at least represents no concrete organization, are so numerous and varied that it is hopeless for any one except the most practised observer to trace their manifestations. The advantage of a semi-official press, if it could be manipulated with unvarying success, is that it can easily be disavowed when the suggestions, overtures, or menaces of which it has been the exponent have served their turn or have become inexpedient. Thus during the blockade of Manila the *Cologne Gazette* gave all the prominence of its first column and of leaded type to an article taken from the *Marine Politische Korrespondenz*, which practically warned the United States of the intention of Germany to have a share in the Pacific possessions of Spain if these should eventually change hands. Some ten days later the authority of this menace was explicitly disavowed by the *North German Gazette*, which announced that the *Marine Politische Korrespondenz* had never possessed a semi-official character. The *Cologne Gazette* continues in the west of Germany to serve the German Government much as it did in the time of Prince Bismarck, although for prudential reasons its inspiration is on the whole more intermittent than it was in the days of the first Chancellor. The *Hamburgischer Correspondent*, now the leading Hamburg journal, plays a minor rôle of the same nature in the chief Hanseatic port, while the *Hamburger Nachrichten*, celebrated especially during the exile of Prince Bismarck and the closing years of his life at Friedrichsruh as the receptacle of indiscreet revelations and violent attacks upon his successors, has almost lost all significance except as a local organ of violent Anglophobia. The *Allgemeine Zeitung* of Munich, once famous throughout Europe as the *Augsburger Allgemeine Zeitung* before its transference to the Bavarian capital, has become in the hands of new proprietors practically an organ of the imperial Chancellor. In Prince Bismarck's days the press bureau of the Prussian Ministry of the Interior, and a similar organization in the Imperial Home Office, used to furnish hundreds of petty local newspapers known as *Kreis-blätter* with whole articles gratis, so that the policy of the Government might be advocated in every nook and corner of the country. The numerous journals in which these communications used to appear simultaneously and in an identical form were the Government organs to which the Radical and Socialist opposition more particularly applied the term "Reptile Press." Latterly this practice of wholesale inspiration appears to have been abandoned, but there are still many channels, public and private, through which almost every department of the Government can communicate information and guidance to newspapers in all parts of Germany. The Prussian Ministry of the Interior distributes to all and sundry a news-letter known as the *Berliner Korrespondenz*, which professes only to give statistics and information and to correct erroneous statements; but it also frequently contains articles which advocate some proposal of the Government or combat the arguments of its opponents. The *Sud-Deutsche Reichs-Korrespondenz* is an institution of a similar character, and in 1902 served as an exponent of the policy and tactics of the imperial Chancellor, count von Bülow.

The number of "news-letters"—which seems the only English term by which the German word *Korrespondenz* can be approximately rendered—is very great. Almost every one of the political parties has its *Korrespondenz*, which, it ought to be noted, supplies views rather than news. These circular letters deal, in fact, with the policy of the party with which they are associated, although they occasionally also embody information which the party leaders in the Reichstag or in the Prussian Diet have received from representatives of the Government for their own guidance. They form the means of holding the parties together, and of inspiring them with common aims, as they are reproduced throughout the country by all the party organs.

It is in the press of Berlin that the greatest changes have taken place in recent years. During the régime of Prince Bismarck the *North German Gazette*, and occasionally the *Post*, used to keep Europe in a state of nervous tension by fulminant *communiqués* which the great Chancellor himself often dictated, or by what he used to call "jets of cold water" (*Kaltwasserstrahl*), which were mostly directed against France or Russia.

So far as France and Russia are concerned, a much more pacific tone prevailed in Berlin after the conclusion of the Dual Alliance, and it was upon England that the press mainly concentrated its attacks. The *North German Gazette*, which was originally established by a private individual, in order "to place a blank sheet of paper at the disposal of Prince Bismarck," has become, on the whole, a mere record of home news and a summary of foreign intelligence bearing the semi-official stamp of Wolff's Telegraph Agency. It had doubtless been found that the constant employment of an organ so distinctly official as the *Norddeutsche Allgemeine* as a medium of expression for the views of the Government was apt to lead to indiscretions which committed the authorities too deeply. Indeed, immediately before Prince Bismarck's fall he had actually employed this journal in order to attack the labour policy of the Emperor. At the present day *communiqués* dealing with foreign affairs still appear at rare intervals in the columns of the *North German Gazette*, but they are mostly characterized by a vagueness and awkwardness of style which is in striking contrast to the force and point of Prince Bismarck's polemics. The *Imperial Gazette* (*Reichsanzeiger*), corresponding to the *London Gazette*, is purely a record of official intelligence, though on rare occasions it publishes in the section marked *Nicht Amtlich* (non-official), some *démenti*, some statement of policy, or some official document—a proceeding which always requires the express sanction of the Emperor.

The journals which in 1880 were most widely read in Berlin, and which were best known abroad as the exponents of Berlin opinion, were the Liberal or Radical *Vossische Zeitung* and *Berliner Tageblatt*, and the National Liberal *National Zeitung*. These journals still survived in 1902 in a more or less flourishing condition, and the *Vossische Zeitung*, the oldest of all the Berlin newspapers, was still written with a degree of literary ability which justified its real title, *Königlich priviligierte Berlinische Zeitung für Staats- und Gelehrten Sachen*. The *National Zeitung* is also ably written, and represents those vestiges of old German Liberalism which still survive in the National Liberal party. The *Kreuz Zeitung* continues to represent the "small but mighty party" of the reactionary Conservatives and Agrarians in the State, and of the orthodox (Lutheran) Protestants in the Church. In its surveys of foreign affairs it occasionally contains an important reflection of the views of foreign policy which have been acquired by leading Conservatives in their intercourse with members of the Government. It is the favourite journal of officers in the army, of the Conservative gentry (*Junker*), as well as the medium through which people of social standing prefer to announce births, marriages, and deaths. The *Post* continues to be subsidized by a small number of industrial and rural magnates in the interests of the *Reichspartei*, or Free Conservative party, which for the most part subordinates its views to those of the Government. In matters of foreign policy this journal reflects the views entertained in official quarters. The *Berliner Neueste Nachrichten*, like the *Post*, is a consistent advocate of the development of the German navy and of a vigorous *Welt-politik*. It enjoys an intermittent official inspiration. The *Boersen Zeitung* and the *Börsen-Courier* are organs of the Berlin Stock Exchange; the one is of a National Liberal colour, and the other expresses the views of the Moderate Radicals (*Freisinnige Vereingung*) and of opponents of extreme protection. The *Vörwarts* is the central organ of the German Social-Democrats, who have established a considerable number of other journals throughout Germany. The clericals or Centre party are represented by the *Germania*, the importance of which is not, however, so great as that of the other leading organ of the Roman Catholic "governing party," the *Kölnische Volks-zeitung*. The *Deutsche Tageszeitung* has recently made itself a name by its advocacy of the agrarian movement, while the *Freisinnige Zeitung* (founded, and to a great extent edited by the Radical leader Herr Eugen Richter) gives a very full yet concise summary of the news of the day, upon which it comments in luminous editorial articles and notes, written from the Radical point of view. Among the provincial papers the *Frankfurter Zeitung* (Radical) is distinguished by the excellence of its news, especially on commercial subjects. The *Schlesische Zeitung*, a leading Conservative organ, has continued to appear in Breslau since the days of Frederick the Great. The *Magdeburger Zeitung* and the *Hannoversche Courier* give an independent or National Liberal support to the Government. The *Weser Zeitung*, published at Bremen, is an exponent of the Liberalism of the commercial classes, while the *Strasburger Post* is one of the journals which enjoy Government inspiration, and helps to maintain *die Wacht am Rhein*. A considerable number of journals, published in the Polish language, advocate the Polish cause in the eastern provinces of Prussia.

Great success has attended a new departure in German journalism, represented by newspapers like the Berlin *Lokal-Anzeiger*, which describe themselves as non-political. Their political philosophy is that of Dr Pangloss, for they generally find that all is done for the best by the best of governments. The *Lokal-Anzeiger* has a circulation in Germany which is comparable with that of the *Petit Journal* in France, while its news is superior in quantity and in freshness to that of any of its German contemporaries. It has become a power with which the Government has to reckon, since it is read "in the palace and in the hovel." It is often asserted that journals of this kind are read for their news, and have no political influence. It has already been pointed out, however, that the average modern German is too busy to correct by study and reflection the impressions which he derives from the hurried perusal of his newspaper. The *Lokal-Anzeiger* undoubtedly exercises a very marked influence upon public opinion in Berlin, and there is plenty of evidence that both in Government and in Court circles it has frequently been used in order to shape the views of its readers.

The external form and arrangement of German newspapers is often puzzling at first sight to an English reader. There is an absence of the striking headlines, which in English journals direct attention to news of importance, and which in America almost swamp the text. The outside page generally contains the editorial articles and the news of most importance, while the intelligence received immediately before going to press is placed in the last column of the last sheet. The bulk of the paper can apparently be increased indefinitely in accordance with the supply of news or literary matter, or with the number of advertisements. The *Vossische Zeitung* on a Sunday morning assumes, with its numerous supplementary sheets, the dimensions of a thick Blue-book. The quantity of extraneous matter, such as articles on literary, social, and technical subjects, is enormous, and even the most serious political journals invariably publish a novel in serial form, as well as numerous novelettes and sketches. The local news in Berlin and other large cities is written with the minuteness and the familiarity of style of a village chronicle, and gives the impression that every one is occupied in observing the doings of his neighbour. The signed article is very much in vogue, and most writers and salaried correspondents have at least a cypher or initial by which they are distinguished. The greatest licence prevails in reporting and discussing the affairs of other countries, combined with the keenest sensitiveness to foreign criticism of anything that concerns Germany. The example of the Government is followed in advertising the products of German industry, while those of foreigners are studiously depreciated. (X.)

Austria.

In the period from 1880 to 1888 the only notable paper founded in Austria was the *Wiener Allgemeine Zeitung* (1880). It appeared three times daily, and attempted to compete with the large dailies already established, but in spite of the impetus communicated to its start by the well-known "Freilands" Apostle Theodor Hertzka, it soon fell away, and now only appears as a late evening paper; it is known as the *6 Uhr Abendblatt*, and enjoys a large local circulation. It was with the rise of the anti-Semitic and Socialistic movements of 1888 onwards that the Vienna daily press first began a fresh increase. The *Deutsche Volksblatt* (anti-Semitic) was founded in 1888, the *Ostdeutsch Rundschau* (Radical) in 1893, and the *Reichspost* (the organ of the Catholic section of the Christian Socialist party) in 1894. The Labour movement led to the development of the *Arbeiterzeitung* from a weekly, when it succeeded the *Gleichheit* in 1889, to a daily in 1895. It is therefore the first Social Democratic daily of Austria. In 1893 the *Neues Wiener Journal* was founded as a political neutral, and the old *Presse* at last disappeared in 1894, its place being filled by the weekly *Reichswehr* (military), established in 1888. Since May 1899 the French in Vienna have once more a daily paper in their language, *Le Petit Journal de Vienne*. There are now nineteen political dailies published in Vienna, but owing to the various nations included in the Austrian empire, the political press of the provinces has more than usual importance. Of the German provincial press the most highly developed is in the German towns of Bohemia and in Prague, and the foundation of the *Deutsche Volkszeitung* at Reichenberg in 1885 marks the date of separation of the *Deutschfortschrittliche* and *Deutschvolkliche* parties, while the Radical party, which has so greatly increased in Bohemia of late years, was first represented by the weekly *Deutscher Volksbote* at Prague, and also in 1897 by the *Unverfälschte deutsche Worte*, now edited by Iro at Eger. A peculiar feature is the existence of German organs of the Czech national movement, of which the representative is the Prague daily *Politik*, which has appeared since 1862. In Silesia the anti-Semitic *Freie Schlesische Presse* was founded in 1881 at Troppau, and when it changed sides in 1889 it was speedily replaced, 1891, by the *Deutsche Wehr*. In Moravia the representative papers of the Czech Conservatives and Radicals are the *Mir* and the *Pozar* respectively. The newspapers in Galicia, which have been growing steadily since 1870, are both numerous and important. The leading ones are the *Slovo Polskie* in Lemberg and the *Glos Naroda* in Cracow. There are 161 newspapers in Polish, as against 10 in 1848 and 50 in 1873.

Of the lesser Slavic nations, the Slovenians have advanced the most, and their latest political newspaper is the *Slovenski List*, commenced at the end of 1896.

In Illyrian journalism the chief newspapers founded since 1880 are the *Crvena Hrvatska*, 1891, and the *Hrvatska Kruna*, 1893. An attempt at unity amongst the Ruthenian factions in 1885 to 1887 produced the *Mir*, while the *Ruslan*, published daily at Lemberg since 1896, advocates joint action by Poles and Ruthenians. The *Bukowyna*, established in 1885, has developed into the organ of "Young Ruthenia," and the *Bukowinska Widomosty*, established in 1895, represents the Old Ruthenians.

The Italian press in Austria is now represented chiefly by the very popular daily *Piccolo*, published at Trieste; it had a formidable rival in the *Mattino*, which commenced in 1885, but only lasted to the end of 1898. The *Fede e Lavoro*, published at Roveredo, is the organ of the Catholic Labour party, and *L'Avvenire del Lavoro*, at Bozen, that of the Socialists. In Dalmatia the *Corriere Nazionale*, founded in 1896 at Zara and now published at Trieste, is the organ of the autonomist Italians, while *Il Dalmata* continues to represent the National Liberals.

The Rumanian press is limited to a few papers in Czernowitz. The oldest is the anti-Semitic *Dutepazza*, founded in 1883; but the real representative of the autonomist Rumanians is the *Patria*, founded in 1897. Economics and social science, in which subject journalism in Austria is of very recent growth, is chiefly represented by the *Zeitschrift für Volkswirtschaft, Socialpolitik und Verwaltung*, a paper which deals exclusively with its own subject.

The technical journals of Austria are very numerous and most highly developed, consisting of 154 agricultural, 263 trade, 25 military and marine, 92 medical and scientific, 50 legal, 88 religious, 130 educational, 52 geographical, statistical, and historical, 189 theatrical, musical, sporting, &c., 169 humorous and literary, 289 economic, and 16 for women. Most of these, however, are not newspapers, but magazines.

In 1890 Vienna, with a population of 1,100,000, had 8 dailies and 44 papers published less frequently but at least weekly. In 1900, with a population of 1,526,000, it had 14 dailies and 36 weeklies, &c. Prague, notwithstanding a large increase in population, had about the same number of papers in 1900 as in 1890, namely, 11 dailies and 2 weeklies, while Trieste, which in 1890, with a population of 144,000, had 5 dailies, had 9 in 1900, with an increase of only 16,000 inhabitants. In the smaller provincial towns there were in 1900, 321 newspapers of various periodicity, but not exceeding a week, which are published in 168 towns.

ZENKER. *Geschichte der Journalistik in Osterreich.* Vienna, 1900.—HAASENSTEIN and VOGLER. *Notizkalendar*, 1901, &c.

Hungary.

Budapest in 1890, with a population of 360,000, had 14 dailies and 10 weeklies, &c. In 1900, with 470,000 inhabitants, it had 21 dailies and 3 weeklies, &c., and 147 papers, mostly weeklies, were published in eighty-nine other towns. The leading papers are the official *Budapesti Közlöny*, the Liberal *Pester Lloyd*, and the *Budapesti Hirlap*. From the Hungarian returns of 1899 (*A Magyar Hirlapirodalom Id. Szinnyei J.*) it would appear that 764 newspapers were published in that year, but those returns include a large number of official bulletins and journals that are more correctly described as periodicals. It may be noted here that seven papers in Hungarian are published in America and one in Vienna.

Belgium.

In 1890 Brussels published 34 papers of various periodicity, among which the *Moniteur Belge* held the lead with a circulation of 90,000, while *Le National* (founded in 1885) and *L'Étoile* circulated 21,000 and 5000 respectively. In 1900 there were 18 dailies and 14 weeklies, &c. The other large towns compare as follows:—

	1890.			1900.		
	Population.	Dailies.	Weeklies, &c.	Population.	Dailies.	Weeklies, &c.
Antwerp .	191,000	7	2	186,780	7	4
Ghent .	140,000	7	3	140,000	6	3
Liége .	133,000	6	5	140,300	5	3

In 1890 there were 112 papers published in 90 other towns, and in 1900, 230 papers in 124 other towns. These were mostly weekly, but the towns with upwards of 20,000 inhabitants have usually one or more daily papers. *Le Soir*, a Brussels paper, is distributed gratis, and subsists entirely upon its advertisements. Totals:—

	1890.	1900.
Brussels	34	32
Provinces	142	258
Belgium	176	290

Holland.

Amsterdam in 1890 had 10 dailies and 15 weeklies, &c.; and in 1900 the number had increased to 12 dailies (*Algemeen Handelsblad*, *Nieuws van den Dag*, &c.), and 26 weeklies, &c. In 1900 The Hague had 6 dailies (*Dagblad*, *Vaderland*, &c.) and 5 weeklies, &c.; and Rotterdam had 5 dailies (*Nieuwe Rotterdammer Courant*, &c.) and 8 weeklies. In addition to these, about 250 papers, mostly weeklies, were published in 128 other towns. The *Haarlemsche Courant*, founded in 1656, still appears. The totals for Holland are:—Amsterdam, 38; provinces, 274; kingdom, 312.

Luxemburg.

In the Grand Duchy there were 12 newspapers in 1900—3 dailies (*Luxemburger Zeitung*, &c.), and 9 that appear twice or thrice a week. All the dailies and three others are published in the capital.

Sweden.

In 1890 Stockholm, with a population of 205,000, had 5 dailies and 12 weeklies, &c.; in 1900, with an increase of 50,000 inhabitants, it had 11 dailies and 4 weeklies, &c., while 93 provincial towns published 197 papers, mostly weeklies, &c. In the period 1890–94 a large number of newspapers appeared at Stockholm, but their duration was in general very short, often only a few months (Lundstadt, *Sveriges Periodiska Literatur*, ii. 1896). A newspaper in Finnish is published at Haparanda.

Denmark.

In 1890 Copenhagen, with 286,000 inhabitants, produced 8 dailies and 6 weeklies, &c. In 1900, with a population of 410,000, it had 12 dailies and 2 weeklies, while 121 papers appeared in sixty-eight provincial towns.

Iceland.

Reykjavik published two weekly papers in 1890, and the same number in 1900 (*Thiódólfr* and *Isafold*).

Faroe Islands.

A weekly paper called the *Dimmalaeting* was published at Thorshavn in 1890, and continued to appear in 1900.

Norway.

In 1890 Christiania, with a population of 128,000, published 12 papers, of which only three appeared daily; in 1900, although the population increased to 151,000, only 10 papers were produced, but 8 of them were dailies. The *Morgenbladet* still holds its rank, and the *Aftenposten* has a large circulation. In the provinces in 1900 there were 122 papers published in fifty-two towns.

Russia.

In 1890 St Petersburg had 6 dailies and 14 weeklies, &c.; and in 1900 there were 16 dailies and 22 weeklies, &c. (the *St Petersburgskaya Viedomosti*, notably anti-British since 1895, the *Novoya Vremja*, the *Journal de St Pétersbourg*, &c.). Moscow increased its papers from 5 dailies and 6 weeklies, &c., to 8 dailies and 11 weeklies, &c. (the *Moskowskaya Viedomosti*, &c.). The rest of Russia proper produced about 100 newspapers, of which one-third were dailies. In Russian Poland about 11 papers, one-half being dailies, were published at Warsaw in 1900 (*Kurier Warsawski*, *Gazeta Polska*, &c.), and about 18 in the other towns. The Baltic provinces produced 11 dailies and 9 weeklies, &c.; Siberia, 1 daily and 23 weeklies, &c.; the Caucasus, 5 dailies and 4 weeklies, &c.; and Finland, 12 dailies and 29 weeklies. Seven weekly newspapers in Esthonian were published at Reval, Dorpat, and Pernau in 1900. The totals for Russia are therefore—St Petersburg and Moscow, 57; provinces, 230; the Russian empire, 287.

Throughout the empire, but especially in Russia proper, Siberia, and the Caucasus, a number both of daily and weekly papers are so intermittent in their publication that they have not been included in the above statistics.

A large number of newspapers in the Russian language are published, chiefly for political reasons, outside Russia, and most of the papers of the non-Russian nations living under Muscovite rule are similarly published outside the empire.

In all the large provincial towns there is a Government newspaper published daily, or at least twice a week, but apart from this but few of the periodicals can justly be considered as newspapers. The provincial press labours under great difficulties, for whereas in St Petersburg or Moscow the editors may publish at their own risk, subject to warnings, every paper that appears in the provinces must duly pass the censor. The more important section of the Russian press tends to develop on the lines of British newspapers, *i.e.*, large papers well filled with advertisements, but no new papers of importance were founded during the period under review. The popular press in the French fashion has largely developed, and there is a system of giving bonuses to subscribers in the form of books published as supplements.

Italy.

In 1890 Rome, with a population of 278,000, published 13 dailies and 1 tri-weekly, and in 1900, with 376,000, 10 dailies and 5 weeklies, &c. The leading Roman papers are—the *Fanfulla*, representing the Court and Government; the *Tribuna*, a Liberal paper founded in 1883, which has the largest circulation (150,000); the organ of the Vatican, *L'Osservatore Romano*; and the popular *Messagero*. The number of papers published in the chief towns between 1880 and 1900 was as follows:—

	Population.	Dailies.	Weeklies, &c.
Florence . . .	170,000	4	...
Milan . . .	375,900	6	5
Naples . . .	463,000	9	...
Turin . . .	253,000	5	3
Venice . . .	130,000	4	...

In addition to these, about 200 papers, one-third being dailies, were published in 123 of the smaller towns, making the totals—Rome, 15; provinces, 236; Italy, 251.

Malta in 1890 had 3 dailies and 3 weeklies, and in 1900, 8 dailies (*Malta Chronicle*, *Il Risorgimento*, &c.) and 5 weeklies. Two were in English, one in Maltese, and the rest in Italian.

Spain.

In 1890 Madrid published 38 papers, of which 15 were dailies; but by 1900 they declined to 28, of which 19 were dailies. Barcelona published only 4 dailies in 1890, the remaining 17 being weekly, &c.; in 1900 the dailies increased to 15, while the weeklies, &c., decreased to 4, a state of things very consonant with the increased commercial activity of the town. The leading Spanish papers are—*El Correo*, Monarchico-Liberal; *La Epoca*, Conservative; *El Imparcial*, Independent Liberal; *La Justicia*, an evening Republican paper; *El Liberal*, which numbers among its contributors the best writers without distinction of party; and *El Pais*, the organ of the Progressives. The provincial press is very active, but extremely short-lived. In Badajoz, a typical ordinary provincial town, about 30 newspapers sprang into existence during the twenty years 1881–1900, besides a still larger number of periodicals (Gomez Villafranca, *Historia y Bibliografia de la Prensa de Badajoz*, 1901). In 1900 there were 287 papers published in 118 provincial towns, thus making the totals—Madrid, 28; provinces, 306; Spain, 334.

Majorca.—In 1900 there were 4 daily papers published at Palma de Mallorca.

Portugal.

In 1890 Lisbon, with 246,000 inhabitants, published 18 papers, of which 11 were dailies; and in 1900, with a population of 261,000, 21 papers, of which 19 were dailies. The other towns show very little movement since 1880, about 58 papers being published in 30 provincial towns. The totals may be roughly taken as—Lisbon, 21; provinces, 58; Portugal, 79.

Switzerland.

This is one of the countries remarkable for the number of its newspapers in proportion to its size. Among the more important may be mentioned the *Journal de Genève* and the *Gazette de Lausanne*, both Moderate Liberal, and the Catholic *Courrier de Genève*. The following table shows the increase in the three largest towns:—

	1890.		1900.	
	Dailies.	Weeklies.	Dailies.	Weeklies.
Geneva . .	3	...	5	4
Basel . .	2	1	5	1
Zurich . .	2	3	4	15

In 1895, 587 papers were published in 192 towns, about 270 being weeklies and about 100 dailies. Nearly two-thirds are in German, the remainder being chiefly French, with a few in Italian, in Romansch, and in English. The number of papers founded in the decade ending 1890 showed an increase of 30 per cent. on the previous one. In 1872 only 3 papers were credited with a circulation exceeding 20,000, but there were in 1896 at least 16. The Swiss continue to preserve with jealous care the freedom of the press, and in 1895 they rejected an alteration in their criminal code which appeared likely to interfere with it.

Greece.

Athens, with 85,000 inhabitants in 1890, published 9 dailies and 4 weeklies, &c., and in 1900, with 114,000 inhabitants, 10 dailies and 2 weeklies. The chief papers, the *Asty* and the *Acropolis*, are mainly political and on the Liberal side, as indeed are nearly all the Athenian papers. In the smaller towns the number increased from 20 in 1890 to 35 in 1900, most of them being published weekly.

Rumania.

Bucharest, with a population of about half a million, had 7 dailies and 1 weekly in 1890, and 14 dailies (the *Romanul*, &c.) and 3 weeklies in 1900, when about 30 papers, mostly dailies, were published in the provinces.

Servia.

Belgrade has a large number of papers in proportion to its population of 36,000, but shows no movement in recent years. It had 6 dailies and 8 weeklies, &c., in 1900. The official paper is the *Serbske Noviny*, and the leading Liberal organ the *Videlo*. Five smaller towns published one or two papers apiece, appearing twice or thrice in the week.

Bulgaria.

In 1890 only 3 newspapers were published in Bulgaria, namely, 2 at Sofia and 1 at Rustchuk. In 1900 Sofia, with a population of 48,000, had 1 daily, the *Swoboda*, and 3 on alternate days; while Philippopolis and five smaller towns produced 11 papers, mostly weeklies.

Montenegro.

Cettigne, with 1500 inhabitants, published 2 weeklies (the *Glas Crnagorca* and the *Political*) in 1900.

Turkey.

In 1890, with a population of 873,000, there were 19 papers, in various languages, published at Constantinople, most of them dailies; and in 1900, with a decrease in population estimated at 1000, the number of papers decreased to 18. They appeared in the following languages: the *Stamboul* and 4 others in French, 3 in

Turkish, 1 in Turkish and Greek, 3 in Greek, 2 in Armenian, 1 in English and French, and 1 each in Arabic, English, Italian, and Persian. Smyrna, with 200,000 inhabitants, published 8 papers, mostly weeklies, in 1890, and the same number in 1900. Owing to the number of fasts and feasts observed by the Mahommedans, during which Turkish newspapers are not published, they are somewhat irregular in their appearance. Two papers are published at Adrianople and 2 at Salonica (1 being in Hebrew). Cyprus had 6 weeklies in 1900, the chief being the *Owl* at Nicosia and the *Times of Cyprus* at Larnaca.

Persia.

Tehran, with 200,000 inhabitants, published 2 newspapers in 1890 and 3 in 1900. The *Irán* is the leading paper, but the papers of Persia, like those of Turkey, appear somewhat irregularly.

Syria.

At Beyrout were published in 1900, 1 daily (the French *Journal*), and 5 weeklies (1 in Turkish and 4 in Arabic).

China.

With the exception of the *Peking Gazette*, which is the official organ of the Chinese Government, it may be said that all the newspapers published in China, including those in the vernacular, are due to foreign influence, and are under European management. The leading papers of the British colony are the *North China Daily News* and *Shanghai Mercury* at Shanghai, and the *Hong Kong Daily Press* and *China Mail* at Hong Kong. In addition to these may be mentioned the *Journal* at Peking, the *Gazette* at Amoy, the *Herald* and *Daily Echo* at Foochow, the *Chinese Times* at Tientsin, the *Deutsch-Asiatische Warte* at Tsintau, and a few Portuguese papers at Macao. Of the few papers in Chinese, the *Shun-pao* and *Hu-pao* of Shanghai have a very large circulation, and there are four Chinese dailies at Hong Kong and two at Canton. Several newspapers are published by the missionaries in various parts, but they are more of the nature of religious or scientific journals with a few items of news thrown in (J. D. Ball, *Things Chinese*, 1893). The total number of newspapers published in China in 1900 may be reckoned at 40, about two-thirds being dailies.

Siam.

Bangkok, with 255,000 inhabitants in 1890, had 3 dailies and 1 weekly, while in 1900, with a population of 400,000, it had an additional weekly. The leading papers are the *Times* and the *Siam Free Press*.

Straits Settlements.

There are about a dozen papers, half of them dailies, published in the Straits Settlements. The chief are the *Straits Times* and the *Government Gazette* at Singapore, the *Penang Gazette*, &c.

Cochin China.

Two papers, the *Courrier* and the *Mekong*, are published at Saigon. Tongking has the *Courrier* published at Haiphong, and *L'Avenir* at Hanoï.

Japan.

Rapid growth of journalism has been one of the marked features of Japan's modern career. As early as the beginning of the 17th century, a sheet called the *Reading for Sale* (*Yomi-uri*) was hawked about the streets of Yedo by a vendor who cried his wares in the familiar European style of later times. This embryo journal was in manuscript. It contained accounts of natural calamities, conflagrations, fights, vendettas, and other striking events. Another more aristocratic sheet, called the *Official Intelligence* (*Go-sata-gaki*), was compiled by the chief of the tea-cult in the shogun's palace and sold privately. Its contents were taken chiefly from the archives of the Government secretariat, and consisted of appointments and dismissals of officials, copies of administrative ordinances, and notes on current events. Neither of these publications attained permanent vogue or suggested any expansion of the enterprise. Not until 1863 did a real newspaper make its appearance. Its publisher, Fukuda Meiga, was inspired by the hope that if fuller knowledge of foreign countries were disseminated among the people, the policy of national exclusion might become distasteful. He therefore made translations of the *Batavia News*, and published them in the form of a journal printed from wood blocks. The following year (1864) Joseph Hiko—a Japanese who had just returned from the United States, where he had lived since boyhood, having been rescued from a sinking junk and carried to San Francisco by an American ship—combined with two of his countrymen to publish a periodical which they called *Shimbunshi* (newspaper), a term destined to become permanent in the language. As yet movable types were not employed. But that innovation followed quickly on the establishment of English journals for the foreign community in Yokohama, and during the stirring times of the fall of feudalism a demand for news became so keen that one journal after another made its appearance. At first the tone of these sheets reflected the anti-foreign, anti-progressive spirit of the conservative section of the nation, and their influence seemed so pernicious that the Government prohibited their publication and treated the editors as malefactors. But the incongruity of such a policy being quickly perceived, the veto was revoked in 1869, and journalistic enterprise received official sanction within certain limitations. All discussion of religious questions, of politics, and of legal problems was interdicted; a general injunction forbade the publication of matter prejudicial to public peace or good morals; official permission had to be obtained before issuing a journal, and the power of fining or imprisoning editors, publishers, and printers, as well as that of suspending or suppressing a newspaper, was vested in administrative officials without any recourse to courts of law. It might have been foreseen that the young journalists of Japan, whose ideas of press liberty were derived from European theories, would not readily submit to these restrictions. A bitter struggle commenced between, on the one hand, irresponsible editors who were influenced partly by honest faith in the value of free speech, but partly by a desire to embarrass the Government, and, on the other, responsible officials who either believed that Japanese society was not yet ripe for the full enfranchisement of newspapers, or were unwilling to place in the hands of their political opponents a weapon which threatened to prove inconveniently effective against themselves. The public, of course, sympathized with the editors, and each sentence of imprisonment or fine pronounced against them brought a fresh access of popular support. Devices, often unscrupulous and sometimes ingenious, were employed by the editors to gain popularity or to bring the Government into ridicule. On one occasion they organized imposing funeral rites in honour of journals that had been suppressed by ministerial order. The defunct sheets, placed in a coffin, were borne in solemn procession to the temple of the Goddess of Mercy, where Buddhist priests chanted litanies for the dead, journalists and political agitators read threnodies or burned incense, and all the pomp, parade, and ceremony proper to aristocratic obsequies were observed. The story of this struggle for liberty reads strangely in the context of such a history as that of Japan under the Tokugawa shogunate. Although scarcely a month passed that did not see an editor fined or imprisoned, a newspaper suspended or suppressed, the representatives of the press grew constantly more defiant, the demand for journals more urgent. The first daily paper, the *Mainichi*

Shimbun (*Daily News*), was published in 1871, and in 1879, despite the severity of the law, there were 192 journals and periodicals, with a total annual circulation of over 11,000,000. In 1897 a law, passed by both Houses and confirmed by the emperor, removed all restrictions on freedom of speech, except in cases of *lèse-majesté*. In 1900 there were 829 journals and periodicals, with an annual circulation of 463 million copies. (See also JAPAN.)

The more important newspapers appearing in the capital are the official *Kwampo*, the Conservative *Nihon*, the Progressive *Yomiuri* and *Mainichi*, and the *Kokumin Shimbun* (established in 1890), one of the best specimens of Japanese journalism, and remarkable for its liberal spirit, and for having an article in English to facilitate the exchange of views between Japanese and foreigners.

East Indies.

Philippines.—In the Philippines, where the periodical press has now been established for upwards of three-quarters of a century, the first newspaper printed outside Manila was *El Eco de Vigan*, 1884, which lasted for about a year. In Manila itself a considerable number of newspapers have been started since 1880, but few have lasted long; many, indeed, only a few months. The *Diario*, *Occania Español*, and *Comercio* are the dailies (Retana, *El Periodismo Filipino*, Madrid, 1895).

Java.—The newspapers of Java show but little movement. In 1900 there were 6 dailies and 1 weekly published in Batavia, and about 20 papers, half of them dailies, in other parts of the island.

Sumatra.—In 1890, 3 papers were published in Sumatra, and double that number in 1900; they appear, at most, three times in the week.

Celebes.—The number of papers published at Macassar in 1900 was 3, published once or twice in the week.

West Africa.

In Gambia in 1900 the *Gambia Intelligencer* was published weekly at Bathurst.

At Accra, in the Gold Coast Colony, there were 2 weekly papers, the *Gold Coast Chronicle* and the *Gold Coast Independent*.

In Sierra Leone, Freetown, with a population of 39,000, had 3 weekly papers (the *Weekly News*, *Weekly Times*, and *West African Reporter*).

Lagos, with 32,500 inhabitants, published the *Lagos Times* daily and 3 weekly papers.

East Africa.

Mauritius.—In 1900 the *Merchant and Planter's Gazette* and the *Vrai Mauricien* were published daily at St Louis, the only other paper being the *Weekly News*.

Congo Free State.

St Paul de Loanda published *O Mercantil* daily and 2 weekly papers.

Liberia Republic.

At Monrovia the *Observer* and the *Liberia Gazette* were published weekly.

Morocco.

In this territory were published in 1900 the *Times of Morocco*, a newspaper in Arabic, one in French, and one in Spanish; their periodicity varies.

German East Africa.

The *Deutsch-Östafrikanische Zeitung* was published weekly at Dar-es-Salam.

Algeria.

In 1890 there were 11 newspapers published in Algeria. In 1900 Algiers, with a population of 154,000, published 6 dailies (*L'Akhbar*, *La Dépêche Algérienne*, &c.) and 4 weeklies, and seventeen smaller towns had 25 papers, in most cases weeklies or semi-weeklies.

Tunis.

Two daily papers, the *Journal Officiel* and the *Petit Tunisien*, and 4 weeklies were published at the capital in 1900, while *Le Courrier* appeared weekly at Bizerta, *La Dépêche Sfaxienne* daily at Sfax, and *L'Avenir* weekly at Sonese.

Senegal.

In 1900 the *Moniteur* was published weekly at St Louis.

Réunion.

The *Journal Officiel* was published twice a week, the *Nouveau Salazien* weekly at St Denis.

Madagascar.

Le Progrès, *Le Madagascar*, and *La Cloche*, nominally weeklies, appeared at irregular intervals.

Angra Pequeña.

The *Deutsche Colonial Zeitung* was published weekly.

Canary Islands.

In 1900 the *Diario* was published at Las Palmas, and the *Diario* and the *Liberal* at Santa Cruz and Tenerife, but at very irregular intervals.

Madeira.

The *Diario de Noticias* was published daily, and *O Direito* twice weekly at Funchal.

St Helena.

In 1900 the *Guardian* was published weekly.

Egypt.

In 1900 Alexandria, with 230,000 inhabitants, published 10 dailies (*Le Phare d'Alexandria*, the *Egyptian Gazette*, &c.) and 1 weekly; Cairo, with 380,000, had 8 dailies (*Journal Egyptien*, *Le Progrès*, &c.) and 3 weeklies; and Port Said 2 dailies, the *Phare* and the *Telegrafo*. These are exclusive of Arab newspapers.

Portuguese East Africa.

In 1900 *O Futuro* was published at Delagoa Bay, the *Boletim Oficial* and *Africa Oriental* at Mozambique, and *O Africano* at Quilimane. These are all weeklies.

Azores.

There were two papers apiece published weekly in Terceira, Fayal, and San Miguel in 1900.

Central America.

In the republics of Central America there has been little or no variation in the number of newspapers, save in Nicaragua, which in 1900 had 4 dailies (*El Diario*) &c., and 5 weeklies, against 4 weeklies in 1890. The *Diaro del Centro de America* is the chief paper of the 3 published in Guatemala; the *Diario Oficial* and *El Siglo XX.* were published at San Salvador; the *Correo Español*, *La Republica*, and *El Heraldo* at Costa Rica; and *La Paz* and *La Regeneración* at Honduras.

British Honduras in 1900 had 1 daily paper, *El Sol*, published at Belize.

West Indies.

Cuba.—In 1890, 6 dailies and 1 weekly appeared in Cuba. In 1900 there were 9 dailies and 2 weeklies, the *Diario de la Marina* and 4 other dailies being published at Havana. Seven papers were published in other towns of the island.

Porto Rico.—Three newspapers, 1 daily (*La Avispa*) and 2 tri-weeklies, have appeared in Porto Rico since 1890, to which is now added the *Democracia*, published daily.

Hayti in 1900 had 5 dailies and 3 weeklies, being an increase of 2 papers since 1890.

Jamaica in 1900 maintained its number, 5 dailies and 4 weeklies; the leading papers are the *Jamaica Daily Telegraph*, *Evening Express*, *Gleaner*, and *Government Gazette*.

Barbados published 6 papers, mostly bi-weekly (*West Indian*, *Barbados Herald*, &c.), at Bridgetown in 1900.

Trinidad, with 5 weeklies in 1890, had 2 dailies (*Daily News* and *Times*) and 4 weeklies (*Royal Gazette*, &c.) in 1900.

Dominica had 2 weeklies, the *Dominican* and the *Guardian*, in 1900.

Grenada, which had only 1 paper in 1890, had 3 (*St George's Chronicle*, &c.) in 1900.

St Vincent had 2 weekly papers (*Sentinel*, &c.), and St Lucia the same number (*The Voice*, &c.), in 1900.

Antigua had 3 weeklies (*Leeward Isles Budget*, &c.).

Bahamas.—In 1900 the *Guardian* was published twice weekly at Nassau.

Bermudas.—In 1900 the *Royal Gazette* was published at Hamilton, and the *Colonist* at St George, both weekly.

St Christopher (St Kitts), which had only 1 paper in 1890, had the *Daily Express* and 2 weeklies in 1900.

Tobago had the *Gazette* and *News*, both weekly.

Turks Island.—The *Royal Standard*, weekly.

St Thomas.—The *St Thomæ Tidende* appeared twice weekly in 1900.

Martinique.—Three papers, *Les Antilles*, *Les Colonies*, and *El Porvenir*, were published at St Pierre in 1900, and were still being published up to 8th May 1902, when the town was destroyed (see MARTINIQUE).

Guadeloupe.—The *Courrier* was published twice weekly.

Mexico.

In 1890, 5 dailies and 2 weeklies were published in the capital, with 316,000 inhabitants, and 2 dailies and 1 weekly in other parts of the territory. In 1900 there were 10 dailies (*El Diario Oficial*, *El Nacional*, &c.) published in the capital, which has increased its population by 16,000; and 20 papers, about half being dailies, appeared in fifteen smaller towns.

Colombia.

Panama, with 35,000 inhabitants, had 3 dailies in 1890, and 3 dailies (*La Estrella*, &c.) and 1 weekly in 1900. Bogotá, with a population of 100,000, had 3 dailies and 3 weeklies in 1890, and 9 dailies and 23 weeklies in 1900. In the other towns of the republic there were only 3 weeklies in 1890, while there were 17 newspapers, mostly weekly, published in seven towns in 1900.

Venezuela.

Caracas, with a population of 70,500, published only 2 dailies in 1890, but in 1900, with 80,000 inhabitants, it had 5 dailies (*El Correo*, &c.) and 6 weeklies. The returns from smaller towns were 1 daily and 6 weeklies in 1890, while in seven towns in 1900 there were 10 papers, about half of them appearing daily.

British Guiana.

There has been very little movement in the number of papers. In 1900 the *Daily Chronicle* and 5 weeklies appeared at Georgetown, and the *Berbice Gazette*, a bi-weekly, at New Amsterdam.

Dutch Guiana.

In 1900, 5 weeklies (the *Suriname*, *West Indier*, &c.) were published at Paramaribo, 1 daily and 6 weeklies at Curaçoa, and 1 weekly at Nickerie.

French Guiana.

Two weeklies, the *Moniteur* and the *Reveil*, were published at Cayenne in 1900.

Ecuador.

In 1890 there were only 3 papers, all weeklies, published in Ecuador. In 1900 Quito, with 80,000 inhabitants, had 1 daily (*El Comercio*) and 2 weeklies; Guayaquil had 3 dailies and 1 bi-weekly; and Cuenca 1 weekly.

Brazil.

In 1890 Rio, with 350,000 inhabitants, had 4 dailies and 1 weekly, while 7 dailies and 2 weeklies were published in other towns. In 1900 Rio had 10 dailies (*Diario de Noticias*, *Diario Oficial*, &c.) and 1 weekly, while 33 papers, nearly all dailies, were published in eighteen other towns.

Peru.

In 1890 there were only 2 dailies published at Lima, with 101,400 inhabitants. In 1900, however, with a population of 135,000, it had 8 dailies (*El Comercio*, *El Nacional*, &c.) and 11 weeklies, while 18 newspapers, mostly weeklies, were published in seven other towns.

Bolivia.

In 1900, 6 dailies (*El Comercio*, *El Nacional*, &c.) were published at La Paz, 3 dailies (*El Dia*, &c.) and 3 weeklies at Sucre, and 10 papers in six smaller towns.

Chile.

In 1890 Santiago, with 200,000 inhabitants, published 2 dailies and 1 weekly; Valparaiso, with 95,000, had the same number, and 1 daily paper appeared in Iquique. In 1900 Santiago published 10 dailies (*El Chileno*, *El Constitucional*, &c.); Valparaiso, with 110,000 inhabitants, had 5 dailies (*El Imparcial*, *La Union*, &c.) and 1 bi-weekly; while twelve smaller towns had 13 papers, mostly dailies.

Argentine Republic.

Buenos Aires in 1890, with 398,500 inhabitants, published 18 dailies and 1 weekly, of which 3 were in French and 3 in English; Rosario, with 80,000, had 7 dailies and 2 weeklies, of which 2 were in English; and 8 dailies and 1 weekly appeared in the smaller towns. In 1900 Buenos Aires, with its population increased by 150,000, had 18 dailies (*La Nacion*, *Buenos Aires Herald*, &c.) and 8 weeklies, which appear in the following languages: 11 in Spanish, 4 in English, 3 in Italian, 3 in German, and 2 in French; Rosario, with 90,000 inhabitants, had 6 dailies (*El Mensagero*, &c.) and 2 weeklies; and ten smaller towns produced 14 papers, nearly all dailies.

Paraguay.

In 1900, 5 dailies (*Diario Oficial*, *La Republica*, &c.) and 1 weekly were published at Asunción, with a population of 30,000; and a weekly paper, the *Eco de la Campaña*, appeared at Villa Concepcion.

Uruguay.

The press has made great strides in this republic during 1880–1900, and especially during the second decade. Montevideo, which in 1890 had 7 dailies, all in Spanish, in 1900 had 10 in Spanish, mostly political, 2 in French, and 1 apiece in English and Italian. The chief are *El Telegrafo Marítimo*, founded in 1880, *El Siglo*, *La Razón*, and *El Día*. The reduction of the price of *El Día* to one-half (2 centesimos) in 1890 was a reform which gave the notable recent impulse to the popular press. Among the more important papers in the departments may be mentioned *El Pueblo* and *La Paz* of San José, *El Día* of Paysandú, and *La Prensa* of El Salto. The only available statistics for the newspapers of the entire republic include periodicals: it appears that, in addition to the above-mentioned daily papers, 42 reviews and periodicals were published in Montevideo in 1900, and about 80 newspapers and periodicals in the provinces, giving a total for the republic of about 136. (Fernández y Medina, *La Imprenta y la Prensa en el Uruguay*, Montevideo, 1900.)

India.

It appears from the official tables that there are about 600 newspapers, so called, published in the Indian empire, of which about one-third, mostly dailies, are in the Indian vernaculars. The numbers, however, are very fluctuating, and in the following statistics of 1900 only the chief and more permanent papers are included:—

	Population.	Dailies.	Weeklies.
Calcutta .	843,487	15 (*Calcutta Englishman*, &c.)	40
Bombay .	821,704	2 (*Bombay Gazette*, &c.)	14
Madras .	452,518	4 (*Madras Mail*, &c.)	9
Rangoon .	180,000	3 (*Rangoon Times*, &c.)	3
Allahabad	175,240	2 (*Pioneer*, &c.)	3
Lahore .	176,800	2 (*Civil and Military Gazette*, &c.)	3

Chandernagore has a weekly paper, *Le Petit Bengali*, and Pondichéry *Le Progrès* and the *Journal Officiel*.

Goa has the *Boletin Official* and *A Voz do Povo*, which appear at irregular intervals.

Ceylon.

In 1900 Colombo, with a population of 125,000, published four dailies (*Ceylon Independent*, *Times*, &c.), and six weeklies. These are all in English, and there are several in the native dialects. Also three weeklies were published at Jaffna.

Canada.

Ontario.—In 1890 Toronto, with 181,220 inhabitants, had 6 dailies and 26 weeklies; Ottawa, with 30,000 inhabitants, had 2 dailies and 2 bi-weeklies; while five smaller towns published 12 dailies and 17 weeklies. In 1900 Toronto had 6 dailies (*Evening News*, *Globe*, *Mail*, *Merchant*, &c.) and 70 weeklies; Ottawa had 4 dailies (*Citizen*, *Free Press*, *Le Canada*, &c.) and 11 weeklies; while 203 smaller towns issued 341 papers, mostly weeklies. The *Citizen*, a Conservative daily paper, is the *doyen* of Ottawa journals; it was founded as the *Packet* in 1844, and changed its title in February 1851. (Audet, *Historique des Journaux d'Ottawa*.)

Quebec.—Quebec, with 65,000 inhabitants, had 7 dailies and 5 weeklies in 1890; Montreal, with 250,000, had 9 dailies and 18 weeklies. In 1900 Quebec had 6 dailies and 8 weeklies, 6 of the papers being in English and 8 in

French (*Mercury*, *Telegraph*, *Le Courrier du Canada*, &c.); Montreal had 8 dailies and 48 weeklies, 29 papers being in English and 27 in French (*Gazette*, *Herald*, *La Minerve*, &c.); while in twenty-seven smaller towns 44 papers were published, mostly weeklies.

New Brunswick.—In the whole of this territory only 4 dailies and 9 weeklies were published in 1890, whereas in 1900 Fredericton had 1 daily and 5 weeklies, St John 5 dailies (*Gazette*, *Globe*, &c.) and 4 weeklies; and 20 other papers, mostly weeklies, appeared in thirteen smaller towns.

Nova Scotia.—In 1890, 5 dailies and 8 weeklies were published in Halifax. In 1900 the same number appeared in Halifax, while 47 other papers appeared in thirty of the smaller towns.

Prince Edward Island.—In 1890 the 120,000 inhabitants of this territory had 2 dailies and 6 weeklies. In 1900 there were 3 dailies and 10 weeklies, most of which were published at Charlottetown.

Manitoba.—In 1890 only 2 dailies and 2 weeklies were published at Winnipeg, which in 1900 had 3 dailies (*Manitoba Morning Free Press*, &c.) and 17 weeklies; while 26 other papers, mostly weeklies, appeared in nineteen smaller towns.

North-West Territories.—These territories had only 3 newspapers in 1890. In 1900 there were 2 weeklies (*Leader* and *Standard*) published at Regina; and 16 other papers, mostly weeklies, appeared in thirteen smaller towns.

British Columbia.—In 1890 there appear to have been 6 papers published in this territory. In 1900 there were 20, mostly weeklies; 2 dailies (*Colonist* and *Times*) and 2 weeklies were published at Victoria, and 2 dailies (*News Advertiser*, &c.) and 3 weeklies at Vancouver.

Newfoundland.

In 1890, 3 daily papers were published at St John's, which in 1900 had 2 dailies (*Evening Herald*, &c.), while Harbor and Twillingate had a weekly paper apiece.

South Africa.

Cape Colony.—In 1890 Cape Town, with 45,000 inhabitants, published 13 newspapers of various periodicity. In 1900, with the same population, there were 16 newspapers, of which 3 were dailies and 5 were in Dutch. The leading papers were the *Cape Argus*, *Cape Times*, *South African Review*, *Ons Land*, &c. Port Elizabeth, which published 6 newspapers of various periodicity in 1890, published only 3 in 1900; but Kimberley increased from 2 to 3 in the decade. The number published in other towns of the colony remained stationary at about 32.

Natal.—In 1890 Durban and Pietermaritzburg published 3 newspapers each, of various periodicity, but in 1900 the former, with 16,600 inhabitants, published 2 dailies, the *Natal Advertiser* and *Natal Mercury*, and the latter, with a population of 14,400, published 2 dailies and 2 weeklies, the *Natal Witness*, &c.; the *Herald*, a weekly paper, is published at Newcastle.

Rhodesia.—In 1900 Bulawayo published 2 dailies (*Chronicle*, &c.) and 1 weekly, while 5 other newspapers, mostly weeklies, were published in three smaller towns.

Orange River Colony.—In 1890 only 2 newspapers were published at Bloemfontein, but in 1900 these had increased to 5—2 dailies (*Daily Express*, *Government Gazette*) and 3 weeklies.

Transvaal Colony.—In 1890, 6 newspapers of various periodicity were published at Pretoria, 7 at Johannesburg, 3 at Barberton, and 1 apiece at Lydenburg and Potchefstroom. In 1900 Pretoria published 2 dailies, the *Advertiser* in English, and the *Press* in Dutch and English; and 1 daily, the *Volksstem*, and 2 weeklies, the *Staatscourant* and *Land en Volk*, in Dutch. At Johannesburg 8 appeared—4 daily (the *Standard and Digger's News*, *Daily News*, *Eastern Star*, and *Times*), and 4 weekly (the *Mining Journal*, &c.) Barberton published only the *Gold Fields News*, weekly, but Lydenburg issued the *Transvaal* and the *Lydenburger* weekly; Potchefstroom the *Budget*, *Potchefstroomer*, *Vryheid*, and *Nieuwe Republieken* weekly; while Klerksdorp published the *Mining Record* twice a week; Krugersdorp, the *Times* and *Ons Volk* weekly; and Middelburg the *Courant* and the *District Advertiser* also weekly.

Australasia.

The first newspaper established in Australasia was the *Sydney Gazette and New South Wales Advertiser.* It began 5th March 1803, and continued to 23rd December 1843. The *Derwent Star*, the first paper in Van Diemen's Land, started 8th January 1810. The *Sydney Morning Herald* began as a weekly in 1831, became bi-weekly in 1832, tri-weekly in 1838, and daily in 1840. The *Melbourne Argus* began 2nd January 1846, the *Age* 17th October 1854, and the *Leader* in 1856. Characteristic of the newspapers of Australasia is the large number of advertisements; in fact, there is a keener appreciation of the value of advertising than in England, and consequently a newspaper is first of all an advertising medium. As a natural consequence, except in the case of the great metropolitan dailies, the press does not lead public opinion, but follows it; for in small colonial communities an editor's first care is to avoid alienating any influential section of advertisers. (Grattan Grey, *Australasia*, London, 1900.)

New South Wales.—Sydney, with a population of 332,000, in 1890 had 21 newspapers, about half being dailies; but in 1900, while the total increased nearly threefold (59), there were only 5 published daily. The largest paper is the *Morning Herald*, which may be considered the leader of Conservative journalism in Australasia. Its contemporary on the opposite side is the *Daily Telegraph*, which is run upon similar lines to the Melbourne *Age*. The *Bulletin*, however, is said to have the widest circulation throughout the whole of the Australasian colonies, but it temporarily lost ground through its strenuous opposition to the South African war. The two leading weeklies are *Town and Country* and the *Sydney Mail*, to which must be added the Radical and Republican *Truth*. (Grattan Grey, *Australasia*, London, 1901.)

In the provinces in 1890 there were 78 papers in 51 towns, mostly dailies, whereas in 1900, 168 papers were published in 118 towns, and the same tendency is shown in favour of weeklies, which, with but few exceptions, is characteristic of Australia.

Queensland.—Brisbane in 1890, with 60,000 inhabitants, had 26 papers, 8 of them being dailies, and in thirty-five other towns there were 61 papers, for the most part dailies. In 1900 the capital, with a population of 101,000, had 3 dailies (*Courier*, *Evening Observer*, &c.) and 20 weeklies, while 86 papers, mostly weeklies, were published in forty-one other towns.

South Australia.—Adelaide in 1890, with a population of 45,000, seems to have had 24 papers, 10 being dailies; and 18 papers, mostly dailies, appeared in sixteen of the smaller towns. In 1900 Adelaide had 130,000 inhabitants, but only 4 daily papers (*Register*, *Advertiser*, *Express and Telegraph*, and *Evening Journal*) and 13 weeklies (*Observer*, *Australische Zeitung*, &c.); and 27 papers, mostly weeklies, appeared in twenty-two other towns.

Victoria.—Melbourne, with a population of 400,000 in

1890, had 46 town papers, nearly half of them daily, and 21 suburban papers, mostly weekly; and 82 papers, most of them dailies, appeared in seventy smaller towns. In 1900 Melbourne had a population of 491,800, and out of 131 town and suburban papers had only 4 dailies (*Argus*, *Age*, *Standard*, *Shipping Gazette*). The struggle for the lead between the *Argus* and the *Age* has resulted in the victory of the latter, which both in position and influence has eclipsed its senior contemporary. The *Argus*, however, is intimately connected with the earliest associations of colonists in Victoria, and maintains a high standard of literary excellence, and the decline in its circulation is due solely to its conservatism. The two leading Melbourne weeklies are the *Australasian* and the *Leader*, issued respectively from the *Argus* and the *Age* offices. Both have an extensive intercolonial circulation. The popular evening paper is the *Herald*, which enjoys an extensive circulation, but is said to display occasionally a tendency towards "yellow" journalism. (Grattan Grey, *Australasia*, London, 1901.) 179 papers, mostly weeklies, were published in 122 smaller towns, Ballarat having 9, Geelong 5, and Bendigo 4.

West Australia.—Perth in 1890, with 10,000 inhabitants, had 2 dailies and 3 weeklies; and 1 weekly, the *Herald*, was published at Fremantle. In 1900 Perth had 3 dailies and 3 weeklies, and 12 papers, mostly weeklies, were published in nine smaller towns.

Tasmania.—In 1890 Hobart, with 29,000 inhabitants, had 4 dailies and 6 weeklies; Launceston had 2 dailies and 3 weeklies, and La Trobe had 1 daily. In 1900 Hobart had 2 dailies (the *Hobart Mercury*, &c.) and 7 weeklies, Launceston 2 dailies (the *Launceston Examiner*, &c.) and 5 weeklies, and Burnie and Devonport West 1 weekly apiece.

New Zealand.—Taking its size and population into account, no country in the world has been so productive of newspapers as New Zealand. The newspapers of the country districts are extremely numerous, and in general successful.

Otago.—Dunedin in 1890 had 3 dailies and 11 weeklies, and in 1900, with a population of 24,300, it had 2 dailies (*Otago Daily Times*, &c.) and 5 weeklies (*Witness*, &c.). In 1890 there were 12 papers, mostly dailies, published in eleven of the smaller towns, and in 1900, 21 papers, mostly weeklies, in sixteen towns. A notable exception to the vogue of the weekly paper is Invercargill, which has 3 dailies and 1 weekly.

Wellington had in 1900 the same number of papers as in 1890, *i.e.*, 3 dailies and 3 weeklies; but 23 papers, mostly weeklies, appeared in seventeen of the smaller towns, as against 14 papers, mostly dailies, in ten smaller towns in 1890.

Auckland, the capital, which had 3 dailies and 6 weeklies in 1890, had in 1900 only 2 dailies (*New Zealand Herald*, &c.) and 3 weeklies (*Weekly Herald*, &c.); but whereas in 1890 there were only 8 other papers, mostly dailies, published in six of the smaller towns, there were in 1900 12 papers, mostly weeklies, published in eleven towns.

Napier in 1890 had 2 dailies and 1 weekly, and nine smaller towns published 12 papers, mostly dailies. In 1900 Napier had 3 dailies (*Telegraph*, &c.) and 1 weekly, while 7 papers, mostly weeklies, were published in five other towns.

Christchurch, which had 4 dailies and 5 weeklies in 1890, had 5 dailies (*Press*, &c.) and 6 weeklies (*Weekly Press*, &c.) in 1900, while the numbers in the provinces remained the same, namely, 12 papers in nine towns, but they were mostly dailies in 1890 and mostly weeklies in 1900.

Nelson.—In 1890, 2 daily papers were published in the capital. In 1900, 3 dailies appeared in the capital, and 2 weeklies in the smaller towns.

Marlborough.—In 1900, 2 dailies and 2 weeklies were published at Blenheim, being double the number that appeared in 1890, and 2 weeklies were published in the smaller towns.

Taranaki.—In 1900, 2 dailies and 2 weeklies were published at New Plymouth, being double as many as appeared in 1890; and 2 dailies and 6 weeklies were published in five smaller towns.

Westland Province.—In 1900, 6 dailies and 7 weeklies were published in seven towns of this province, as against 7 papers, mostly dailies, in 1890.

Totals of Newspapers, 1900.

Great Britain and Ireland	2,902	China	40
United States	15,904	Siam	5
France	2,400	Straits Settlements	12
Germany	3,278	Cochin China	4
Austria	393	Japan	150
Hungary	171	East Indies	39
Sweden	213	South Africa	109
Denmark	145	West Africa	10
Iceland and Faroe Islands	3	Central Africa, &c.	76
Norway	132	Egypt	21
Belgium	290	Canada	742
Netherlands	312	Central and West Indies	129
Luxemburg	12	South American Republics	340
Russia	280	Australasia—	
Italy	251	New South Wales	227
Spain	338	Queensland	109
Portugal	79	South Australia	44
Switzerland	600	Victoria	310
Greece	47	West Australia	18
Rumania	47	Tasmania	18
Servia	24	New Zealand—	
Bulgaria	15	Otago	28
Montenegro	2	Wellington	29
Turkey	22	Auckland	17
Persia	3	Hawkes Bay	11
Syria	6	Canterbury	23
India	600	Sundry	36
Ceylon	10	Total	31,026

AUTHORITIES.—*Press Directories*, Mitchell's, Sell's, and Willing's. —FOX-BOURNE (H. R.). *English Newspapers*, 2 vols., London, 1877. —*Returns of the Newspapers in the British Museum.*—*Progress of British Newspapers in the Nineteenth Century*, illustrated, 1901. Simpkin Marshall and Co. (G. F. B.; D. E.)

Newton, a city of Kansas, U.S.A., capital of Harvey county, on the Atchison, Topeka, and Santa Fé and the Missouri Pacific railways, at an altitude of 1447 feet. Its site is level, its plan regular, and it is divided into four wards. The surrounding country is a fertile agricultural region, for which Newton serves as a supply and distributing point. Population (1900), 6208, of whom 756 were foreign-born and 251 negroes.

Newton, a city of Middlesex county, Massachusetts, U.S.A., on the right bank of the Charles river, and on the Boston and Albany Railway, in the eastern part of the state. Including an area of 18 square miles, it formerly contained several villages, which have extended until they have finally merged into one another, and at present the entire area is covered with urban settlement. Most of the inhabitants have their business interests in Boston. Population (1900), 33,587, of whom 10,068 were foreign-born and 505 negroes.

Newton, Alfred (1829–——), English zoologist, was born at Geneva on 11th June 1829. In 1854 he was elected travelling fellow of Magdalene College, Cambridge, of which he had been an undergraduate, and subsequently visited many parts of the world, including Lapland, Iceland, Spitsbergen, the West Indies, and North America. In 1866 he became the first occupant of the chair of zoology and comparative anatomy at Cambridge. He is especially known as an authority on ornithology, and his services to ornithology and zoogeography were recognized by the Royal Society in 1900, when it awarded him a Royal medal. He is the author of many books, including *Zoology of Ancient Europe* (1862), *Ootheca Wolleyana* (1864), *Zoology* (1874), and a *Dictionary of Birds* (1893–96), the last being an acknowledged standard work. The articles on BIRDS (in great part) and ORNITHOLOGY in the ninth edition of this Encyclopædia came from his pen, and he also wrote some of the smaller ones on ornithological subjects. He contributed many memoirs to scientific societies, and edited *The Ibis* (1865–70), the *Zoological Record* (1870–1872), and *Yarrell's British Birds* (1871–82).

Newton, Sir Charles Thomas (1816–1894), English archæologist, was born on 16th September 1816 at Bredwardine in Herefordshire, and educated at Shrewsbury and Christ Church, Oxford. His tastes were rather for classical art than for philology; he only obtained a second class in the schools, and he entered the British Museum in 1840 as an assistant in the Antiquities Department. All manner of antiquities, classical, Oriental, and mediæval, as well as ethnography, were then lumped together under one administration; and although the department possessed officers of great distinction as Egyptologists and numismatists, it had not, at the time of Newton's appointment, a single distinguished classical archæologist. The twelve years which he spent in it were years of assiduous self-instruction. In 1852 he quitted the Museum for a time to become vice-consul at Mitylene, with the object of exploring the coasts and islands of Asia Minor for antiquities. Aided by funds supplied by Lord Stratford de Redcliffe, then British ambassador at Constantinople, he made in 1852 and 1855 important discoveries of inscriptions at the island of Calymnos, off the coast of Caria; and in 1856–57 achieved the great archæological exploit of his life by the discovery of the remains of the famous mausoleum of Halicarnassus, one of the "seven wonders" of the ancient world. He was greatly assisted by Murdoch Smith, afterwards celebrated in connexion with Persian telegraphs. The results were described by Newton in his *History of Discoveries at Halicarnassus* (1862–63), written in conjunction with Mr R. P. Pullan, and in his *Travels and Discoveries in the Levant* (1865). These works included particulars of other important discoveries, especially at Branchidae, where he disinterred the statues which had anciently lined the Sacred Way, and at Cnidos, where Mr Pullan, acting under his direction, found the colossal lion now in the British Museum.

In 1855 the regius professorship of Greek at Oxford was offered to Newton, but he declined it. In 1860 he was made British consul at Rome, but had scarcely entered upon the post when an opportunity presented itself of reorganizing the amorphous department of antiquities at the British Museum, which was divided into three and ultimately four branches. The Greek and Roman section naturally fell to Newton, who returned as Keeper, and held the office until 1885, declining the offer of the principal librarianship made to him in 1878. The Mausoleum Room, to accommodate the treasures he had found in Asia Minor, was built under his supervision, but the most brilliant episode of his administration was the acquisition of the Blacas and Castellani gems and sculptures. The Farnese and Pourtalès collections were also acquired by him. He maintained an intimate connexion with the important excavations carried on during his term of office in Asia Minor and other regions of the ancient world, and took a leading part in the foundation of the Society for the Promotion of Hellenic Studies, the British School at Athens, and the Egypt Exploration Fund. He was Yates professor of classical archæology at University College, London, from 1880 to 1888. When, on his retirement from the Museum, his bust by Boehm, now placed in one of the sculpture galleries, was presented to him as a testimonial, he desired the unexpended balance to be given to the school at Athens. After his retirement he was for long much occupied with the publication of the Greek inscriptions in the British Museum, but his health failed greatly in the latter years of his life. He died at Margate on 28th November 1894. He had married in 1861 the daughter of his successor in the consulate at Rome, the painter Severn, herself a distinguished artist. She died after a short illness in 1866. Newton was knighted for his services to classical archæology. His narrative of his own explorations is somewhat dry, but there is much entertaining as well as instructive reading in his collected *Essays on Art and Archæology* (1886), especially those on the Mycenæan, Cyprian, Olympian, and other epoch-making discoveries. (R. G.)

Newton, John (1823–1895), American soldier, was born in Norfolk, Va., 24th August 1823, and after graduating at the U.S. Military Academy in 1842, was engaged on engineering duties. During the Civil War he was detailed upon the defences of Washington, and fought in the great battles of 1862 in the east. Promoted from brigadier-general (September 1861) to major-general of volunteers (March 1863), he commanded the corps of General Reynolds at Gettysburg after the death of that officer. In the west, in 1864, he took part in Sherman's invasion of Georgia. Returning to regular engineer duty once more in 1866, he enlarged and improved New York harbour and the Hudson and East rivers (1866–85), removing the dangerous rocks at Hell Gate, and solving new problems with great success. Appointed chief of engineers in March 1884, with the rank of brigadier-general, he retired from active service in August 1886. In 1887–88 he served as commissioner of public works in New York City, where he died 1st May 1895.

Newton-Stewart, a police burgh of Wigtownshire, Scotland, on the river Cree, 49¾ miles west by south of Dumfries. A tweed mill, an agricultural implement factory, and tanneries are the chief industrial features. There are two secondary schools—one for girls and one for boys. Population (1901), 2204.

Newtownards, a market town and urban sanitary district in the county of Down, Ireland, 9½ miles east of Belfast by rail. There are a weaving factory and a hosiery factory. A new market occupying 3½ acres has been erected. Population (1881), 8676; (1901), 9110.

New Ulm, a city of Minnesota, U.S.A., capital of Brown county, on the south bank of the Minnesota river, and on a line of the Chicago and North-Western Railway, in the southern part of the state. It was founded in 1854, destroyed in 1862 by Indians, but rebuilt. Population (1890), 3741; (1900), 5403, of whom 1924 were foreign-born.

New Westminster, a town on the north bank of the Fraser river, British Columbia, 15 miles from the mouth. It was founded in 1859, and was the capital of British Columbia when the British possessions on the Pacific coast formed two colonies—that is, British Columbia (the mainland portion) and Vancouver Island. The city is accessible to ocean-going ships of 16 feet draught. It is the chief centre of the farming country of the lower Fraser, and has one or two factories, but its chief trade is in connexion with the salmon canneries of the Fraser river. It has a small export lumber trade. In 1898 the greater portion of the business part of the city was destroyed by fire, and though much of it was rebuilt the establishment of the city of Vancouver, only eight miles distant, seriously affected New Westminster's prospects of rapid growth. It is connected with Vancouver by an electric railway. Population, about 6000.

New Whatcom, a city of Washington, U.S.A., capital of Whatcom county, at the head of Bellingham Bay, an arm of Puget Sound, and on a branch of the Great Northern Railway, in the north-western part of the state.

It is in the heavily forested region of the north-west, and its industries are chiefly related to lumber and its manufacture. It contains many saw and shingle mills, and ships large quantities of fir timber to southern parts. Population (1890), 4059; (1900), 6834, of whom 1425 were foreign-born.

NEW YORK.

NEW YORK, one of the original thirteen United States of America, and, from its pre-eminence in population, wealth, commerce, and industry, popularly known as the Empire State, is situated between 40° 29′ 40″ and 45° 0′ 42″ N., and 71° 51′ and 79° 45′ 54·4″ W. Its total land area is 47,620 square miles, or 30,476,800 acres. The climate of New York is in a general sense typical of that of the northern United States, hot in summer and cold in winter, yet healthful and stimulating. Apart from elevation, the important sources of local variation are the ocean, the Great Lakes, and certain marked irregularities of land surface which modify the direction and force of the winds. The effect of the ocean is greatly limited by the general eastwardly drift of the atmosphere. The population in 1880 was 5,082,871; in 1890, 5,997,853, exclusive of 5321 specially enumerated; in 1900, 7,268,894. The total increase in the last ten years of the 19th century (1,265,720, including those specially enumerated) was greater than in any former decade, while the percentage of increase (21·1) was greater than at any census since 1860. Since 1820 New York has been the most populous state in the Union. Of 160 cities in the United States (excluding Honolulu, in Hawaii) in 1900 having a population of 25,000 or more, 12 are in New York, namely, Greater New York, 3,437,202; Buffalo, 352,387; Rochester, 162,608; Syracuse, 108,374; Albany, 94,151; Troy, 60,651; Utica, 56,383; Yonkers, 47,931; Binghamton, 39,647; Elmira, 35,672; Schenectady, 31,682; Auburn, 30,345. The average population per square mile increased from 106·74 in 1880 to 126·1 in 1890, and 152·6 in 1900. New York has always been distinguished for a diversity of races. Out of 10,039,217 immigrants who arrived at the port of New York between 1st January 1856 and 30th June 1898, the declared destination of 3,930,857, or 39·2 per cent., was New York state, Germans, Irish, and English largely predominating. In 1900, 1,900,425 of the population were foreign-born and 99,232 were negroes. Of the native whites, those of foreign parentage numbered 2,415,845. Of the total population, 3,614,780 were males and 3,654,114 were females.

Recent History.—The state, owing to its size and its reflection of changes in political sentiment, has been an important factor in national politics. Since 1864 its electoral vote, which was then cast a second time for Abraham Lincoln, has regularly alternated between the Democratic and Republican candidates, till 1900, when it was cast the second time for William McKinley, the Republican candidate; and in each instance, except in 1868, when it went to Horatio Seymour, the Democrat candidate, and 1876, when the national contest was determined by the Electoral Commission, the candidate receiving the electoral vote of New York became President. The popular vote of the state in the Presidential contest of 1896 was: Republican, 819,838; Democratic, 551,369; National Democratic, 18,950; Prohibitionist, 16,052; Socialist-Labour, 17,667—a Republican plurality of 268,469; in the Presidential contest of 1900 the vote stood: Republican, 822,013; Democratic, 678,462; Socialist-Labour, 12,621; Prohibitionist, 22,077; Social Democratic, 12,869—a Republican plurality of 143,551. The pluralities of 1896 and 1900 are to be ascribed largely to the overwhelming sentiment in favour of the maintenance of the gold standard. Party preponderance in the state's delegation in the national House of Representatives has often shifted. Since 1860 only three of the United States senators from New York have been Democrats. Democratic governors were elected in 1874, 1876, 1882, 1885, 1888, and 1891; Republican governors, in 1879, 1894, 1896, 1898, and 1900. Local causes have sometimes produced marked results in gubernatorial contests, as when Cleveland (Democrat) received in 1882 a plurality of 192,854, and Morton (Republican) received in 1894 a plurality of 156,108. Since 1876 the control of the legislature has rested about four-fifths of the time with the Republicans, and since 1894 inclusive continuously.

During the war with Spain, New York furnished 20,870 men to state volunteer organizations, 3400 (estimated) to the United States navy, 2000 (estimated) to United States volunteer organizations, and 3000 (estimated) to the regular army, making a total of 29,270. The volunteer organizations included 210 cavalry and 325 artillery.

Constitution.—The present constitution was adopted 6th November 1894, and came into force 1st January 1895. Its main features are:—Separation of city from state and national elections; safeguards against abuses in legislative procedure, and against abuse of the elective franchise; provisions for the preservation of the forests; prohibitions of gambling; abolition of the statutory limitation of the right of recovery for injuries causing death to $5000; a new apportionment of senate and assembly districts, under which (1) no county may have more than three senators unless it shall have a full ratio for each senator, although smaller counties may receive a senator, or an additional senator, on a major fraction of a ratio, and (2) no county shall have more than one-third of all the senators, and New York and Kings counties together not more than one-half of all; the strengthening of civil service reform; the prohibition of the contract-labour system as to convicts; authority to improve the canals; provisions for free public schools, and prohibition of use of public money in aid of sectarian schools; the revision of the judiciary system; provision that there shall be a naval as well as a land force of militia, and that the militia shall not be reduced below 10,000 men. Suffrage is extended to every male citizen, 21 years old, who has fulfilled certain conditions of residence and who is not legally disqualified. Legislative power is vested in the Senate and Assembly, the former consisting of 50 members, chosen for two years, and the latter of 150, chosen for one year. Each member of the legislature is allowed a salary of $1500 a year, and a limited amount for travelling expenses. Restrictions are placed on private or local legislation, and on the debt-incurring power. The legislature meets every year on the first Wednesday in January. The executive power is vested in a Governor, who holds office for two years. A Lieutenant-Governor must be chosen at the same time and for the same term. The Governor is commander-in-chief of the military and naval forces of the state; has the right of appointment, with the advice and consent of the Senate, of different officials; has the right of removal, generally after hearing, of various state and local officers; and has power to fill vacancies. He has also extensive pardoning power. He is required to send an annual message to the legislature, may convene the legislature in extraordinary session, and possesses a limited veto in legislation. He receives $10,000 a year and a furnished residence. The Lieutenant-Governor, except when he becomes Governor, is president of the Senate, but has only a casting vote. The constitution provides for the election of a Secretary of State, Comptroller, Treasurer, Attorney-General, and State Engineer and Surveyor. The Superintendent of Public Works, the Superintendent of State Prisons, the State Board of Charities, the Prison Commission, and the Lunacy Commission are appointed by the Governor, with the advice and consent of the Senate. Appointments and promotions in the civil service are, by the constitution of the state, required to be made according to merit and fitness—to be ascertained, so far as practicable, by competitive examinations; but a preference in appointment and promotion, without regard to their standing in the list, is given to honourably-discharged soldiers and sailors of the Civil War. In 1900, 3190 persons were examined in the competitive merit class.

Judiciary.—The state is divided into four judicial departments, in each of which there is an Appellate Division of the Supreme Court. The justices composing the Appellate Division in each department are designated by the Governor from all the justices elected to the Supreme Court, but a majority of them must be residents of the department, as must the presiding justice, who is designated by the Governor. By the constitution of 1894, the Superior Court of the city of New York, the Court of Common Pleas for the city and county of New York, the Superior Court of Buffalo, and the City Court of Brooklyn, were abolished, and their jurisdiction, original and appellate, transferred to the Supreme Court and its appellate divisions. The justices of the Supreme Court are chosen at the general elections for terms of fourteen years. Circuit courts, and courts of oyer and terminer, were abolished, and their jurisdiction vested in the Supreme Court. The Supreme Court has general jurisdiction in law and equity. The Court of Appeals was continued. It consists of the chief judge and six associates, all chosen by the electors of the state for fourteen years. Five constitute a quorum, and the concurrence of four is necessary to a decision. Jurisdiction, except where judgment is of death, is limited to the review of questions of law. The legislature may restrict the jurisdiction of the court, but cannot make the right to appeal depend upon the amount involved. The existing county courts were continued. Courts of Sessions, except in the county of New York, were abolished from and after 31st December 1895, and their jurisdiction was transferred to the county courts. The Surrogates courts were continued. The electors of the several towns elect justices of the peace. Inferior local courts not of record, with civil and criminal jurisdiction, may be established by the legislature.

Local Government.—The state is divided into 61 counties, in each of which, unless it be coextensive with a city, there is a board of supervisors. The constitution provides for the election of the sheriffs, clerks of counties, district attorneys, and registrars by the electors of the respective counties; but any of them may be removed by the Governor after giving to such officer a copy of the charges against him, and an opportunity of being heard in his defence. All county, city, town, and village officers, whose election or appointment is not provided for by the constitution, are, at the discretion of the legislature, to be chosen by the electors of the various divisions, or appointed by such authorities thereof as the legislature shall designate. No county or city is, as a rule, allowed to become indebted to an amount exceeding 10 per cent. of the assessed valuation of its taxable real estate. The cities are classified as follows:—1st class, those having 250,000 or more inhabitants; 2nd class, 50,000 to 250,000; 3rd class, all other cities. By the census of 1900, Greater New York and Buffalo come within the 1st class; Rochester, Syracuse, Albany, Troy, and Utica within the 2nd; and the rest in the 3rd. By a law of 16th July 1898 the counties of New York, Kings, Queens, Richmond, and Westchester were constituted a Metropolitan Elections District, at the head of which was placed a superintendent, whose duty it is to prevent violations of the laws relating to elections.

Militia.—This includes all able-bodied male citizens between the ages of 18 and 45, who are residents of the state, subject to any exemptions created by federal or state law. By the constitution, there shall be maintained at all times a force of not less than 10,000 enlisted men, fully uniformed, armed, equipped, disciplined, and ready for active service. Under the Act of 2nd April 1898, the militia of the state consists of two parts—the active, comprising the organized and uniform forces known as the National Guard and Naval Militia, and the reserve, consisting of the rest of the militia. In times of peace the National Guard shall be not less than 10,000 and not more than 18,000 enlisted men. On 31st December 1901, 41 armouries were owned by the state, 16 by counties, 1 by the 7th regiment, and the United States was furnishing the use of two ships for the 1st and 2nd Naval Battalions. There was one state arsenal, in New York City.

Correction.—By the constitution the legislature is required to provide for the occupation and employment of prisoners sentenced to the state prisons, penitentiaries, gaols, and reformatories, but the products of this labour may be disposed of only to the state or a political division thereof, or to or for public institutions of the state. The penal institutions of the state include the state prisons at Sing Sing, Auburn, and Clinton, the Elmira Reformatory, the Eastern Reformatory at Napanoch, the reformatory for women at Bedford, the houses of refuge for women at Albion and Hudson, the six penitentiaries situated at New York, Brooklyn, Albany, Syracuse, Rochester, and Buffalo, the county gaols, the state industrial school at Rochester, the house of refuge for juvenile delinquents at New York, and the state hospitals for insane convicts at Matteawan and Dannemora. In the fiscal year ending 30th September 1901 the daily average number of convicts in the three state prisons was 3492, as against 3468 in 1900. On 1st October 1901 the number of inmates of the various penal institutions was: three state prisons, 3323; Elmira Reformatory, 1276; Eastern Reformatory, 234; houses of refuge for women, 359; six penitentiaries, 2206—total 7398, a decrease of 2453 since 1895. Including gaols and workhouses, the total prison population was 11,157, a decrease of 1504 since 1st October 1895. For the year ending 30th September 1901 the cost of care and maintenance of the three state prisons was $483,644; the net earnings of the convicts amounted to $45,441. At the Elmira Reformatory instruction is given in trades, manual training, physical training, military organization, letters, and religious exercises. Three characteristics of the system there employed are (1) the indeterminate sentence, (2) the parole or conditional release, (3) the grades and marking system. The results have been highly satisfactory. The condition of the county gaols and of the penitentiaries in 1898 was pronounced by the Prison Commission to be very bad. The Commission's report for 1901 states that "marked progress has been made during the year in the work of gaol improvements."

Sanitation.—The health of the state is cared for by the Board of Health and the Board of Commissioners of Quarantine. During 1900 there were 130,268 deaths reported for the state, making a death-rate of 17·9 per thousand of the reporting population, as against 19·6 in 1890.

Care of the Insane.—The whole number of committed insane in the state, 30th September 1900, was 23,778, an increase of 755 over the previous year. Of these, the whole number in state hospitals, including the Matteawan state hospital for insane criminals (752 patients), was 22,840; on 1st October 1899 there were 21,435 inmates of the state hospitals; on 1st October 1900, 22,088. There are 11 state hospitals, besides that at Matteawan, situated at Utica, Willard, Poughkeepsie, Middletown, Buffalo, Binghamton, Ogdensburg, Rochester, Long Island, New York, and Gowanda. In 1900, of those discharged, 1029 had recovered, 1249 were handed over to the custody of friends or public officials, and 49 were adjudged not insane. The expenditures for the year ending 30th September 1900 for the support of the state hospitals were $3,594,873, or $164.79 per inmate.

Charities.—By the constitution the legislature is required to provide for a State Board of Charities, which shall visit and inspect, with certain exceptions, all institutions, state, county, or municipal, which are of a charitable, eleemosynary, correctional, or reformatory character, and institutions for epileptics or idiots. There are 14 state institutions subject to the authority of the Board, situated at Rochester, Syracuse, Batavia, Newark, Bath, Iroquois, Albion, Bedford, Rome, Sonyea, Oxford, Hudson, and Tarrytown, and in the Adirondacks. The receipts of these institutions for the fiscal year ending 30th September 1900 amounted to $1,345,720; their expenditures to $1,254,223, $837,670 being for maintenance and $380,000 for improvements, while $36,553 were returned to the state treasurer. The number of their beneficiaries was 7056. Besides these, there are ten other institutions, mainly supported by state appropriations, but under private management. The receipts of these institutions for the fiscal year ending 30th September 1900 were: from cash in hand, $63,925; from public sources, $612,471; from private sources, $307,699; their expenditures aggregated $940,189. The total number of their beneficiaries was 3273. Provision is made for the separate care of idiotic and feeble-minded persons. Besides state institutions, the Board also has under its control over 1000 other institutions, societies, and associations under private control, including hospitals, homes, dispensaries, orphan and other asylums, reformatories, day nurseries, general and special relief societies, and other charitable organizations. The almshouses are county, city, and town institutions. Their inspection in 1900 showed general improvement. The number of inmates of the county almshouses on 1st October 1899 was 5496; on 1st October 1900, 5472. Of the latter, 754 were able-bodied; 3603 sick or infirm; 35 insane; 621 feeble-minded or idiotic; 152 epileptic; 154 blind; 75 deaf; 78 minors. The total number of persons supported during the year was 15,780. Of these, 8172 were native, 7608 foreign. The total expenditures in direct connexion with the almshouses were $762,572. In the city and town almshouse institutions, on 1st October 1899, there were 7476 inmates; on 1st October 1900, 7364. The total supported during the year was 70,409. Of these, 30,915 were native, 39,494 foreign. The total expenditures in direct connexion with these almshouses were $1,495,519. The number of persons receiving temporary relief during the year was 209,092, and the total expenditures were $1,120,876. The number and classification of beneficiaries in institutions subject to the supervision of the Board, on 1st October 1900, was as follows:—Aged and friendless persons, 3368; almshouse inmates, 10,794; blind, 641; deaf, 1672; dependent children, 26,998; disabled soldiers and sailors, 1969; epileptics in almshouses, 357; epileptics in Craig Colony, 612; hospital patients, 6217; idiotic and feeble-minded in almshouses, 1257; idiotic and feeble-minded in state institutions, 1312; juvenile offenders, 3658; inmates of reformatories, 1800; total, 60,655. During the year ended 30th September 1900 the institutions under the supervision of the Board had an income of $17,312,302. They expended $16,107,496, and owned real and personal property conservatively estimated to be worth $66,805,054.

Education.—By the constitution the legislature is required to maintain a system of free common schools, wherein all the children of the state may be educated. The use of public money in aid of sectarian schools is forbidden. The public schools are under the supervision of a State Superintendent of Public Instruction, and of local commissioners and superintendents. Besides the state normal college at Albany, there are state normal and training schools at Brockport, Buffalo, Cortland, Fredonia, Geneseo, Jamaica, New Paltz, Oneonta, Oswego, Plattsburg, and Pottsdam. On 31st July 1900 there were in the state 11,740 school districts. The number of licensed teachers employed for the legal term of 160 days during the preceding year was 31,768. The number of children of school age was 505,018 in the towns and 1,064,635 in the cities—a total in the state of 1,569,653. The number of children attending school some portion of the year was in the towns 454,215 and in the cities 755,359—making a total of 1,209,574 for the state. The average daily attendance in the towns was 305,800 and in the cities 551,688, showing an average attendance for the entire state of 857,488. The amount paid for teachers' salaries was $19,218,892, and the average annual salary was $604. The sum of $1,030,393 was expended for buildings, sites, and repairs in the towns, and $7,518,250 in the cities. The total reported value of the schoolhouses and sites was $81,768,495. The total expenditures for the public schools were $33,421,491, an increase over the previous year of $5,368,500. The total expenditures for public educational interests directly connected with the department were $34,513,455. The University of the state of New York, incorporated 1st May 1784, and made a constitutional body 1st January 1895, is a supervisory and administrative, not a teaching institution. Its powers are exercised by nineteen elective regents, and by the Governor, Lieutenant-Governor, Secretary of State, and Superintendent of Public Instruction, who are *ex officio* regents. Regents are elected in the same way as United States senators, and are the only public officers in New York state chosen for life. They are unsalaried. The regents have power to incorporate, and to alter or revoke the charters of universities, colleges, academies, libraries, museums, or other educational institutions; to distribute to them funds granted by the state for their use; to inspect their workings, and require annual reports under oath of their presiding officers; to establish examinations as to attainments in learning, and confer on successful candidates suitable certificates, diplomas, and degrees. On 30th June 1900 the institutions in the University included 34 colleges, 76 professional and technical schools, 140 academies, 565 high schools, and 175 libraries. During the fiscal year ending 30th September 1900 there was expended for academies $2,018,953, for high schools $4,077,420, for colleges and for professional and technical schools, $7,663,037.

Churches.—By the census of 1890 there were in the state 8237 religious organizations, 7942 church edifices, church property of the value of $140,123,008, and 2,171,822 church members or communicants. Membership and property were distributed as follows:—

Denomination.	Membership.	Property.
Baptist	142,736	$13,625,588
Catholic	1,153,650	25,769,478
Congregationalist	45,686	5,175,262
Friends	7,078	767,450
Jewish	45,807	4,315,200
Lutheran	89,046	4,693,375
Methodist	265,551	18,305,200
Presbyterian	168,564	22,727,192
Protestant Episcopal	127,961	31,142,613
Reformed	55,973	7,698,280
Unitarian	4,470	1,717,500
Universalist	8,526	1,798,250

Wealth.—By the census of 1890, New York stood easily first in the valuation of real estate and improvements, gold and silver, coin and bullion, machinery of mills and product on hand (raw and manufactured), railways and equipments, telegraphs, telephones, shipping, canals and improvements, and miscellaneous property. She stood third in the value of live stock on farms, farm implements, and machinery; and ninth in the value of her mines and quarries, including the product on hand. The following table shows the proportionate valuations of real and personal property for the purposes of taxation from 1875–1900:—

Year.	Assessed Valuation, Real Property.	Assessed Valuation, Personal Property.	Total Assessed Valuation, Real and Personal Property.	Percentage, Real Property.	Percentage, Personal Property.
	$	$	$		
1875	1,960,352,703	407,427,399	2,367,780,102	82·8	17·2
1880	2,315,400,526	322,468,712	2,637,869,238	87·8	12·2
1885	2,762,348,218	332,383,239	3,094,731,457	89·3	10·7
1890	3,298,323,931	385,329,131	3,683,653,062	89·5	10·5
1895	3,841,582,748	450,499,419	4,292,082,167	89·5	10·5
1900	4,811,593,059	649,709,693	5,461,302,752	88·1	11·9

The extreme undervaluation, of personal property especially, is evident.

Finances.—The debt of the state, 30th September 1901, was $10,075,660. The capital of the several trust funds belonging to the state was: Common School Fund, $4,573,140; Literature Fund, $284,201; United States Deposit Fund (1837), $4,014,520; Military Record Fund, $39,121—total $8,910,982. The balance in the treasury, 1st October 1900, was $7,289,802; receipts from all sources during the fiscal year, $30,544,694—total, receipts and balances, $37,834,496. The total receipts, however, include temporary loans, transfers to and from various funds, and transactions on account of trust funds. Deducting these, the receipts would amount to $27,704,817, practically representing the product of taxation. The payments for all purposes amounted to $28,045,146, leaving in the treasury, 30th September 1901, $9,789,350. The general property tax, at the rate (1900) of $1\frac{26}{100}$ mills on the dollar, amounted to $10,704,153. The receipts from indirect taxes were $15,565,890. Of the latter, the tax on corporations yielded $4,966,680; on transfers of property, $4,084,606; licences for the sale of liquors, $4,197,858. The appropriations for the year were: for General Fund, $11,814,481; for Canal Fund, $1,760,921; for School Fund, $4,225,500; for the insane, $4,506,705—total, $22,307,607. The liquor-tax law of 1896, since amended, divided licence taxes into six grades: for cities of 1,500,000 or more, $800; of 500,000 or more, $650; of 50,000 or more, $500; of 10,000 or more, $350; of 5000 or more, $300; of 1200 or more, $200. In any other place the tax is $100. There are different rates for places where liquors are not to be drunk on the premises. In the law there were also local option provisions. For the fiscal year ended 30th September 1901 the net receipts from liquor licences, fines, and penalties were $12,415,046. Of this the state received $4,198,377; towns and cities, $8,216,669. The number of licences issued during the last year of the old law, 1895–96, was, in the cities, 22,937; outside cities, 10,320—total, 33,257. The number of certificates (saloon, hotel, and club) in force, 30th April 1901, was 26,835.

Banking.—On 12th September 1901 there were 195 banks of deposit and discount in the state system, having capital stock, $28,245,700; surplus funds and undivided profits, $29,176,768. The total resources of such banks, 12th September 1901, were $403,477,311; of savings banks, 1st July 1901, $1,105,076,764; of trust companies, $966,528,398; of safe deposit companies, $5,475,091; of foreign mortgage companies, 1st January 1901, $5,690,620; of building and loan associations, $59,653,737—total, $2,545,901,921, an increase of $283,899,506 over the previous year. On corresponding dates in 1900 the total resources of the same classes of institutions amounted to $2,185,433,300, an increase of $121,116,072 over the previous year. On 30th September 1901 there were 341 national banks in operation in the state, with an aggregate capital of $104,828,290 and a combined surplus and undivided profits of $107,792,289. There has been a large increase in the organization and business of trust companies with banking functions. The reports of these institutions, 31st December 1900, showed, among total resources of $797,983,512, loans on collateral, $387,911,415; on personal securities, $39,840,066; in stock investments, $196,852,583; bonds and mortgages, $40,730,576; cash on deposit with other banks, $96,337,243; while they showed, among liabilities, general deposits of $392,753,744; deposits in trust, $245,367,996; surplus funds, $76,123,784; capital stock, $47,150,000. These figures show an increase, as compared with the year before, of $59,700,000 in loans on collateral security, of $25,700,000 in cash on deposit with other banks, of $28,600,000 in stock and bond investments, of $31,800,000 in trust deposits, and of $82,700,000 in general deposits. The reports of trust companies, 1st July 1901, showed total resources of $966,528,398; deposits, $802,518,096; aggregate capital, $47,450,000; surplus and undivided profits, $98,391,728; earnings for six months, $22,159,857; expenses, including interest and taxes, $11,828,393. In 1890 building and loan associations were placed under the supervision of the Superintendent of Banks. The whole number on the official list, 31st December 1898, was 373, of which 360 were building and loan associations and 13 building lot associations. About 1888 there sprang up in New York state a new type called "national," whose loaning territory is not limited, and who have soliciting agents. There were 48 of these on the list. The assets of the "nationals" were $17,729,057; of locals, $30,905,857—total, $48,634,914.

Insurance.—During the year ending 30th September 1900 the total receipts of the insurance department were $297,944; total expenditure, $183,752. The gross receipts of life and casualty companies doing business in the state were $392,358,740. The disbursements were $261,467,238, as follows: $120,945,587, paid in claims; $22,190,804, lapsed and suspended policies; $22,568,260, dividends to policy-holders; $980,562, dividends to stockholders; $45,223,551, commissions; $23,458,090, salaries and medical examiners' fees; $26,100,380, miscellaneous purposes. The business done in the state during 1900, including "industrial" business, was as follows: policies in force, 3,320,149, insuring $1,476,150,662; issued during 1900, 898,073, insuring $332,173,010; premiums received, $54,775,074; claims incurred, $21,896,164; claims paid, $21,921,741. For the fire and marine companies the receipts during the year were $158,934,378, the disbursements, $155,803,510, being less than the receipts by $3,130,868. In business done in the state the fire premiums received were $22,867,152; fire losses incurred, $16,377,644; fire losses paid, $16,040,452; estimated expenses of business, $7,622,383; showing, on the whole, an apparent net excess of fire losses incurred and estimated expenses over fire premiums received of $1,132,875. The receipts of fraternal organizations were $41,178,094, and disbursements $38,549,276. The receipts of co-operative associations were $10,222,172; payments for claims, $6,613,074; and for expenses, $2,589,763. The following table gives other important statistics:—

Number of Companies.	Assets.	Liabilities except Capital.	Capital.	Surplus.	Risks in Force.
	$	$	$	$	$
Fire (169) .	313,875,420	148,200,737	79,259,239	107,034,939	22,423,334,216
Marine (13) .	17,407,568	4,612,549	200,000	12,595,019	621,263,991
Life (40) .	1,723,737,723	1,565,459,781	10,340,500	158,277,942	8,345,379,153
Casualty (31)	47,326,359	18,865,766	14,894,000	13,566,592	4,416,101,854
Totals (253)	2,102,347,070	1,737,138,833	104,693,739	291,474,492	35,806,079,214

Transportation.—The state canal system comprises the Erie, Oswego, Champlain, Cayuga and Seneca, and Black river canals, having a total length of 638 miles. The privately-owned Delaware and Hudson canal, from Rondout to the Pennsylvania state line, has been almost entirely abandoned. The Erie canal, extending across the state and forming a low-level route to the west, largely contributed to the commercial supremacy of city and state. Lately its relative importance has rapidly declined. In 1890 the value of property transported on all the state canals was $145,761,068, including $112,470,461 on the Erie; in 1900 it was only $84,123,772, including $66,903,696 on the Erie. In 1890 there went from tide-water, by the canals, 1,304,274 tons; in 1900, 834,481 tons. In 1890 there arrived at tide-water, by the canals, 2,846,930 tons; in 1900, 1,340,631, comprising, by way of the Erie, 596,246 tons from western states and 341,001 from New York, and by the Champlain canal, 134,798 tons from Vermont and Canada and 268,586 from New York. In 1868, 44 per cent. of the tonnage across the state was canal-borne; in 1898, 5 per cent. A committee of experts in 1900 recommended the enlargement of the Erie canal at a cost of $58,894,668, so as to admit 1000-ton boats. The railway facilities of the state show steady improvement. On 30th June 1901 the length of steam railways (not including second track, sidings or turnouts) in operation was 8143 miles. Of elevated railways (all in Greater New York) there were 73 miles. Of surface lines there were 1545. Only 70 miles of surface lines were worked by horses. The expenses of the steam railways per mile worked, for the year ending 30th June 1901, were, for maintenance of way and structure, $2045; for maintenance of equipment, $2100; for conducting transportation, $6345; for general expenses, $375; total, $10,865. For all the railways doing business in New York the entire passenger train mileage was 79,129,682; the freight mileage, 80,794,862; all other mileage, 31,563,264; the number of passengers carried, 199,358,549; the tons of freight carried, 197,041,867. The passenger profit per mile worked was $1040; the freight profit, $3886; the gross earnings, $15,793; the net earnings, $4926. In 1900 the state appropriated $150,000 for good roads, and in consequence 23 roads, covering 53·8 miles, were constructed at a cost of $377,594, one-half being paid by the localities.

Commerce.—The value of the foreign imports into the port of New York was, of dutiable goods, in 1900, $304,855,071; 1899, $294,505,183; of free goods in 1900, $221,251,710; 1899, $224,290,748; of specie and bullion in 1900, $29,039,486; 1899, $31,191,223. The value of exports to foreign ports was, of domestic exports in 1900, $526,153,270; 1899, $467,554,122; of foreign exports in 1900, $12,090,402; 1899, $9,059,156; of specie and bullion in 1900, $102,933,991; 1899, $84,729,255. The total foreign imports were valued at, in 1900, $555,146,267; 1899, $549,987,154; the total exports in 1900, $641,177,663; 1899, $561,342,533. For the fiscal year ended 30th June 1900 the value of the imports and exports of the port of New York was $1,168,785,559, of which $140,638,207 was carried in American vessels, $1,024,613,977 in foreign vessels, and $3,533,375 in land vehicles. Of the entire $233,164,871 received from duties at all the ports of the United States in the year ended 3rd June 1900, $152,333,877 was received at the port of New York. Of 34,014 vessels, with a tonnage of 28,163,005, which entered all United States ports in the same year, 12,287, aggregating 10,169,040 tons, entered the ports of the state of New York. Of 23,333 vessels with a tonnage of 5,164,839, registered, enrolled, and licensed in the United States, 30th June 1900, 4988, aggregating 1,354,444 tons, belonged to New York ports.

Manufactures.—By the census of 1900 New York stood first in manufactures. Out of a total production of $13,040,013,638 for the whole Union, that of New York was $2,175,766,900. The number of establishments reporting was 78,659; capital value, $1,679,906,515; wage-earners, 849,092; wages, $408,864,952; salaried officials, 74,482; salaries, $82,077,648. In 1890 the number of establishments was 65,840; capital value, $1,130,161,195; value of product, $1,711,577,671; wage-earners, 752,066; wages, $370,380,559; salaried officials, 98,018; salaries, $96,466,083. Out of the 369 industries specified in the census of 1890, New York, in value of product, was first in 164, second in 60, third in 36, fourth in 13, and of importance in almost all. Industries whose product was valued at $20,000,000 or more were baking (bread, &c.), carpentering, chemicals, men's clothing (factory-made), women's clothing (factory-made), roasting and grinding of coffee and spices, flour and grist mills, foundries and machine shops, furniture, hosiery and knitted goods, leather, malt liquors, lumber, masonry, plumbing and gas-fitting, printing and publishing (book and job), printing and publishing (newspapers and periodicals), and tobacco, cigars, and cigarettes.

Labour.—In 1901 the Bureau of Labour Statistics, the State Factory Inspector's Department, and the Board of Mediation and Arbitration were superseded by a Department of Labour. A free public employment bureau was opened in New York City in 1896. On 30th September 1901 there were 1881 labour organizations in the state, with a membership of 276,141 persons—261,523 men, 14,618 women. The whole number of wage-workers was estimated in 1898 at 1,755,000. The general average of wages for organized labour for seven quarters (four in 1897 and three in 1898), per quarter, was $167 for men and $80 for women. In 1898, as compared with 1897, there was a general increase in the earnings of men, but an opposite tendency in those of women; the average quarterly earnings of men approximated, in 1899, \$187; 1900, \$179; 1901, \$189. Children under 14 are forbidden to be employed in factories. Children between 14 and 16 may be so employed on the certificate of a health officer.

Agriculture.—By the census of 1890 New York stood third in the number and in the valuation of farms, second in the value of farm products, and seventh in the number of improved acres. The number of farms was 226,223; their valuation, including implements, machinery, and live stock on hand, \$1,139,310,716; the value of their product, \$161,593,009. The live stock included 664,430 horses, 4386 mules, 37,293 working oxen, 1,440,230 milch cows, 653,869 other cattle, 843,342 swine, and 1,528,979 sheep, not including spring lambs. The product of wool was 6,715,686 ℔. Dairy products, in which New York stood easily first, embraced 663,917,240 gallons of milk, 98,241,813 ℔ of butter, and 4,324,028 ℔ of cheese. The state also stood first in buckwheat, 4,675,735 bushels; Irish potatoes, 24,616,736 bushels; maple syrup, 457,658 gallons; hops, 20,063 ℔; pears, 588,767 bushels; grapes for the table, 60,687 tons: second in hay, 6,675,658 tons; maple sugar, 10,485,623 ℔; grapes for wine, 15,172 tons, making 2,528,250 gallons of wine: third in honey, 4,281,964 ℔; rye, 3,065,623 bushels: fourth in wax, 66,654 ℔; barley, 8,220,242 bushels; apples, 8,493,846 bushels: seventh in plums and prunes, 73,411 bushels: ninth in oats, 38,896,479 bushels: tenth in tobacco, 9,316,135 ℔: seventeenth in wheat, 8,304,539 bushels: twenty-first in Indian corn, 15,109,969 bushels. In market-garden products, including small fruits, she stood first, with a valuation of \$3,400,172. The production of cereals, hay, and potatoes was as follows in 1900: barley, 3,751,942 bushels; buckwheat, 3,280,158 bushels; Indian corn, 17,236,032 bushels; oats, 44,538,974 bushels; rye, 3,189,165 bushels; wheat, 6,496,166 bushels; hay, 3,351,991 tons; potatoes, 27,481,356 bushels.

Forestry.—On 30th September 1899 the state owned, in the Forest Preserve, 1,200,673 acres. On 15th November 1900 the aggregate was 1,327,315 acres, of which 1,250,803 were in the "Adirondack Preserve" and 76,512 in the "Catskill Preserve." Of the increase, 125,478 acres were purchased at a cost of \$381,320, an average of \$3 an acre. The purchases for the Catskill Preserve, in the year ended 30th September 1900, amounted to 18,126 acres and cost \$42,817, an average of over \$2 an acre. On 30th September 1901 the aggregate owned by the state was 1,408,181 acres, of which 1,325,851 were in the Adirondack Preserve and 82,330 in the Catskill Preserve. Purchases in the Catskill region during 1901 amounted to 5605 acres, at an average of over \$2 per acre. The Adirondack Park was increased by 36,458 acres, at nearly \$4 per acre. Of this park, comprising 3,226,144 acres, the state owns 1,163,414 acres. The assessed valuation of the state lands in the Forest Preserve counties in 1901 was \$2,459,223. The New York State College of Forestry, which constitutes a department of Cornell University, has the use of a large tract in the Adirondack Preserve.

Fisheries.—By the census of 1890 New York stood fourth in fisheries products, with a valuation of \$3,798,815, as against \$4,380,565 in 1880. In the Menhaden fisheries she still stood first, although in 1880 the value of their product was \$1,114,158, and in 1890 only \$628,212. In the oyster fisheries she stood third, with a valuation of \$1,765,088, as against \$1,577,050 in 1880. She stood fifth in her general fisheries, the value of their product being \$1,396,767, as against \$1,689,357 in 1880. In 1889 the number of persons employed was 9321; in 1880, 7266. In 1889 the capital employed was \$5,125,361; in 1880, \$2,629,585. In 1889 the number of vessels employed was 809, net tonnage 9770, value, \$1,052,192; in 1880, the number of vessels was 541, tonnage, 11,582; value, \$777,600. In the value of inland fisheries New York by the census of 1890 stood sixth, with a valuation of \$82,412; in the products of the Great Lake fisheries she stood fifth, with a valuation of \$165,116. The Fisheries, Game and Forest Commission is charged with the duty of stocking the waters of the state.

Mineral Resources.—According to the census of 1890, New York in 1889 stood sixth among the states in the value of her mineral productions, which embraced iron ores, petroleum, natural gas, stone, gypsum, graphite, corundum, salt, and mineral waters, and were valued at \$24,156,206 out of a total of \$587,230,662. In 1898 she stood fifth in clay products, including various kinds of brick, tile, sewer pipes, ornamental terra-cotta, fire-proofing, and pottery, valued at \$6,448,989. In 1899 she stood fifth in limestone, valued at \$1,545,669; fourth in marble, valued at \$338,816; second in sandstone, valued at \$1,218,053; and first in mineral waters, with a value of \$809,056. Slate for roofing and other purposes is obtained in abundance in the slate belt in eastern New York and western Vermont, and the only cherry-red slate found in the world is in New York. The production of fibrous talc in the United States is carried on exclusively in St Lawrence county. Colourless tourmaline is found at Dekalb. The granite product decreased from \$516,847 in 1898 to \$306,711 in 1899; natural gas increased from \$229,078 to \$294,593; petroleum, from 1,205,250 brls. to 1,320,909 brls., while the price rose from 91½ cents per brl. to \$1.29⅝. In 1899 New York stood sixth in the value of iron ore production, the total product being 443,790 long tons, valued at \$1,241,985, including 344,159 long tons of magnetite, 45,503 tons of red and 31,975 of brown hæmatite, and 22,153 tons of carbonate. The increase of total product over 1898 was 263,839, or nearly 150 per cent. In 1880, 1890, and 1900 New York and Michigan produced more than half the salt mined in the United States.

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New York City, the largest city of the state of New York, U.S.A., and of the United States. According to the United States census of June 1900, the city of New York contained a population of 3,437,202. Its population by the census of 1890 was 1,515,301. The immense growth of the decade, as shown by this comparison, was due largely to a change of boundary lines in the year 1897, by virtue of which there was annexed to the city of New York the populous city of Brooklyn, which in 1890 had a population of 806,343 (or, including suburbs annexed soon afterwards, 838,547), and which, at the time of its absorption into the metropolis, had a population of over 1,000,000. The original town, named by its Dutch founders New Amsterdam, had been situated at the extreme south end of Manhattan Island, and its growth had been gradually northwards, involving the absorption of several villages, until at length the boundaries of the city had become coterminous with those of the island and of the county of New York. Manhattan Island is 13½ miles long, and has an average width of 1¾ miles. Its total area is 21 square miles. By an enactment of May 1873, which came into effect on 1st January 1874, there was added what for some time afterwards was known as the Annexed District, this being an area somewhat less in extent than Manhattan Island, directly to the north, between the Hudson river on the west and Long Island Sound on the east. Some slight further additions were made in 1895 in rectification of the boundaries of this Annexed District, and thus the total area in 1897, before the larger consolidation was effected, was 40·22 square miles. The area of the enlarged city, by virtue of the Act which came into effect on 1st January 1898, is 307⅓ square miles. The great extent of this area is due to the inclusion of (1) a large part of the suburban county of Queens, adjacent to the city of Brooklyn, comprising about 123·98 square miles; and (2) Staten Island, which had constituted Richmond county, and which lies between the Upper Bay of New York and the ocean, with an area of 57·19 square miles and a comparatively small population.

Population and area.

As constituted by this important enactment, the area and jurisdiction of the city of New York include all that pertains in the strict sense to the metropolis and the greater part of what may be regarded as the suburban belt—in so far as the state of New York is concerned. It happens, however, that the Hudson river, which forms the western boundary line of Manhattan Island, separates the state of New York from the state of New Jersey; and on the New Jersey side of the Hudson river very important residential and manufacturing suburbs have grown

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up, which would have been included as a part of the new metropolitan aggregation but for the practical impossibility of uniting in a single municipal corporation the populations and territories of urban districts which, though adjacent and belonging in the commercial sense to one community, are nevertheless in different states. But for this difficulty an area including Jersey City, Hoboken, Newark, Paterson, and many smaller New Jersey towns and cities would have been comprised in the consolidation, and the metropolis would thus at the opening of the 20th century have had an area of approximately 500 square miles and a population of approximately 4,500,000. This New Jersey population, of which, by the census of 1900, more than 1,000,000 lived within 20 miles of the New York City Hall, belongs in the commercial sense to the great community quite as essentially as any other portions of the so-called Greater New York. As actually constituted, the city of New York has an extreme length north and south of about 33 miles, and an extreme width east and west of about 18 miles. The consolidation was brought about by a law bearing the following title: "An Act to unite into one municipality under the corporate name of the city of New York the various communities lying in and about New York Harbour, including the city and county of New York, the city of Brooklyn and the county of Kings, the county of Richmond, and a part of the county of Queens, and to provide for the government thereof." This enactment for purposes of administration divided the city of New York as thus constituted into five boroughs, designated respectively Manhattan, the Bronx, Brooklyn, Queens, and Richmond. Manhattan perpetuates the earlier boundary line of New York City, in that it includes Manhattan Island, together with a few minute adjacent islands lying in the harbour and the East river, which latter separates Manhattan Island from Long Island, which lies to the eastward. The borough of the Bronx includes what had been known as the Annexed District lying beyond the Harlem river (which forms the northern boundary of Manhattan Island), and comprises territory extending from the Hudson river on the west to the East river and Long Island Sound on the east. The borough of Brooklyn comprises what had formerly been the city of Brooklyn. The borough of Queens (which includes Long Island City, Flushing, College Point, Jamaica, Lawrence, Far Rockaway, &c.) consists of that part of Queens county lying on Long Island beyond the limits of the city of Brooklyn, which was included in the consolidation. The borough of Richmond comprises what had been Richmond county, and what is still locally known as Staten Island. The two boroughs of Manhattan and Brooklyn, while much smaller in extent than the other three, include the great bulk of the population. The following table shows the areas of these five boroughs, together with their population in 1880, 1890, and 1900:—

Area and Population of New York City by Boroughs.

	Area, sq. miles.	Population.			Increase from 1890 to 1900.		Increase from 1880 to 1890.	
		1900.	1890.	1880.	Number.	Per cent.	Number.	Per cent.
New York City . . .	307·34	3,437,202	2,492,591	1,901,345	944,611	37·8	591,246	31·0
Manhattan Borough .	21·07	1,850,093	1,515,301	1,206,299	535,299	35·3	309,002	25·6
Bronx ,, .	39·33	200,507						
Brooklyn ,, .	65·77	1,166,582	838,547	599,495	328,035	39·1	239,052	39·8
Richmond ,, .	57·19	67,021	51,693	38,991	15,328	29·6	12,702	32·5
Queens ,, .	123·98	152,999	87,050	56,560	65,949	75·7	30,490	53·9

As shown by the above summary, the boroughs of Manhattan and Bronx, or what was formerly New York City, increased 35·3 per cent. from 1890 to 1900, as against an increase of 25·6 per cent. from 1880 to 1890. The percentage of increase in Brooklyn borough was substantially the same from 1890 to 1900 as in the ten years preceding, being 39·1 per cent. and 39·8 per cent. respectively, while Richmond borough increased 29·6 per cent. from 1890 to 1900, and 32·5 per cent. from 1880 to 1890. The largest percentage of increase is shown in Queens borough, which increased 75·7 per cent. from 1890 to 1900, as against 53·9 per cent. from 1880 to 1890. The rapid development of well-considered plans for the improvement of transit facilities to the suburbs in all directions has made it certain that the census of 1910 will show an unprecedented growth of population in the outer zones.

Not to pause here for review of the earlier history or growth of the city, it may be recalled that in the period immediately before and after the Civil War a great majority of the population was either of foreign birth or of foreign-born parentage; and of the alien elements, the Irish and the Germans greatly preponderated over all others. The state census of 1875 showed that the population had passed 1,000,000. The numbers for 1880 had grown to 1,206,299; and in that year the American-born were 727,629 and the foreign-born 478,670, of whom almost 200,000 were from Ireland and more than 153,000 from Germany. Many of the American-born were, of course, children of foreign-born parents.

In view of the profound changes in the origin of the more recent immigration to the United States, it is important to note the fact that in 1880 there were in the city of New York only 12,233 persons born in Italy, and only 4551 born in the Russian empire. The census of 1890 gave New York City a population of 1,513,501. By this time the density of the population in the more closely inhabited parts of Manhattan Island had reached a point much in excess of that of any other city in the world. The actual growth of the metropolis is in no manner truly indicated by the apparent gain of 300,000 people in the decade, inasmuch as a very large portion of the actual increase had overflown from Manhattan Island into the outer metropolitan zones on Long Island, in New Jersey, or northwards in Westchester county. The analysed returns for 1890 showed a foreign-born population of 875,358, of whom about 150,000 had come from Russia, Austria-Hungary, and Italy. Previous to 1870 the immigration from southern and eastern Europe had been insignificant. It had fairly begun before 1880, and had taken on importance in the following decade. Scarcely any one had come to America from Austria-Hungary before 1870; but about 350,000 had come in the decade ending in 1890, and in the last decade of the 19th century there came 597,047. Similarly there had set in a large stream from the Russian empire, chiefly Jews; and in the last years of the 19th century the persecution of that race in Russia multiplied the number of pilgrims to America. In the years from 1890 to 1900 the number that came from Russia was 507,089. From Italy there had come to the United States about 70,000 people in the sixty years from 1820 to 1880, and more than 307,000 in the next ten years. From 1890 to 1900 the Italian immigration was 655,694. Thus the Italian immigrants alone at the end of the century were as numerous as the Irish, Scottish, English, German, and Scandinavian all put together.

Every succeeding wave of immigration which spread across the North American continent had left some residue in New York City, and in the last years of the 19th century the establishment of large and distinct elements of Italians and Polish Jews was as marked a fact in the city's social and industrial situation as the influx of Irishmen and Germans had been in the period from 1850 to 1870. Newspapers in the Yiddish dialect of the Hebrew language, and Yiddish theatres, marked the advent of hundreds of thousands of Jews.

In 1900 the composition of the population by sex, general nativity, and colour is shown by the following table. The class "negro" includes all persons of negro descent; the class "coloured" includes negroes, and also Chinese, Japanese, and Indians.

Borough.	Males.	Females.	Native-born.	Foreign-born.	White.	Coloured.	Negro.
Bronx	101,756	98,751	138,965	61,542	197,923	2,584	2,370
Brooklyn	573,733	592,849	810,885	355,697	1,146,909	19,673	18,367
Manhattan	918,259	931,834	1,060,751	789,342	1,808,968	41,125	36,246
Queens	77,547	75,452	108,187	44,812	150,235	2,764	2,611
Richmond	34,410	32,611	48,334	18,687	65,863	1,158	1,072
Total	1,705,705	1,731,497	2,167,122	1,270,080	3,369,898	67,304	60,666

Out of 1,007,670 males of voting age (21 years and over) in the entire city in 1900, 460,445 were native-born and 547,225 foreign-born. Of the latter number, 300,660 were naturalized, 45,235 had filed their first naturalization papers, 152,782 were aliens, and the citizenship of 48,548 was returned by the U.S. census enumerators as unknown. Of the total 1,007,670 males of voting age, 65,556 were illiterate (unable to write), of whom 62,528 were foreign-born.

The topographical conditions undoubtedly afford the principal explanation of the unexampled density of the population on Manhattan Island. Practically the entire working-class population of what was New York City proper before the annexation of Brooklyn and the suburbs is lodged in tenement houses of an average height of five or six storeys. The width of the streets being greater than that in most of the Old World centres of dense population, there is comparatively free opportunity for the circulation of air and the admission of light. Reforms have from time to time been instituted by law in the construction and arrangement of New York tenement houses, especially as a result of an expert commission appointed in the year 1900 to advise the Governor and Legislature of the state. From the year 1895 to the end of the decade there was so great an advance as to constitute a transformation in the paving of New York, especially in the congested population areas—smooth asphalt being substituted for the former pavements of uneven stone. This movement for asphalt paving was accompanied by a complete change in the method and policy of public cleansing; so that from the position of a city of unfavourable repute as respects cleanliness of streets and the disposal of waste, New York had become before the year 1900 famous throughout America and of good reputation among municipal and sanitary experts in Europe by reason of the excellence of its street cleansing and its removal and disposal of domestic waste. The importance of perfect paving and of such cleansing as to keep the streets clear of dust can scarcely be over-estimated where, as in some parts of New York, from 3000 to 5000 people live in the tall tenement houses of single blocks as constituted by the intersections of the rectangular street system.

While in the older portion of New York, at the southern end of Manhattan Island, there is some degree of irregularity in the character of the network of the streets, the system for most of the city is regular in the highest degree. It consists of broad avenues running north and south on parallel lines about $\frac{1}{4}$th of a mile apart, intersected at right angles by cross streets extending from one river to the other $\frac{1}{20}$th of a mile apart. Business establishments have more and more tended to concentration at the lower end of Manhattan Island, and the consequence has been an ever-increasing pressure upon facilities for transit and communication up and down the avenues. The chief problem of local transit has been the devising of means by which to bring an ever-growing multitude of people southwards in the morning and then to send them northwards in the latter part of the afternoon.

Rapid transit.

The transit system in the earlier days consisted of omnibuses and horse tramways. The first great innovation was the elevated railways, which were constructed in parallel lines on several avenues in the period between 1877 and 1880, and which almost immediately found their capacity overtaxed. Surface street railways on all of the important avenues, with one exception (Fifth Avenue), were developed to such an extent as was possible with animal power, and later several of them were changed to the cable system. There was delay in the adoption of the electric trolley through the refusal of the authorities to permit the use of overhead wires. Subsequently, however, the lines were absorbed by one great company (the Metropolitan Street Railway Co.), which entered upon a comprehensive plan of substituting the underground electric trolley for horses and cables. At the end of the year 1900 this change had proceeded so far that, of the several hundred million passengers transported annually by this company, the great majority were patrons of electrical lines.

The demand being still unsatisfied, the municipal authorities, after careful consideration, decided in 1899 upon the construction of a great underground trunk-line railway with four tracks, to begin at a point near the lower end of the city and proceed northwards some 13 or 14 miles. At its northern end this trunk line will eventually serve several branches, and in like manner there will in all probability be connecting underground railways passing at two or three different points to Brooklyn on the east, and in due time, it may be hoped, more than one passing under the great Hudson (or North river, as it is locally called) to the New Jersey suburbs. Actual work on the construction of this great underground railway began in 1900. The capital for the construction of the main line was advanced by the municipal corporation itself, to the extent of $35,000,000, to a constructing and operating lessee, who was obliged to provide full interest and sinking-fund payments, and at the end of fifty years to deliver the railway itself (free of all financial encumbrance and of all costs, direct or indirect) to the municipal corporation as public property. This great undertaking in electrical transit was to be completed and in operation by the year 1904. It must have a profound influence upon the development of the northern suburbs.

In addition to this underground transit scheme which marked the end of the 19th century are to be noted the advanced plans for several additional great bridges, as well as various tunnels, to connect Manhattan Island with New Jersey on the west and with Brooklyn and the great expanse of Long Island on the east. The first great bridge, built jointly by the cities of New York and Brooklyn, was regarded as one of the engineering wonders of the world. It was begun in 1870, and opened to traffic in 1883. Some modifications and improvements introduced from time to time brought its total cost up to about $22,000,000 in 1900.

Bridges.

The more recent modifications had consisted of very important changes at both terminals, by virtue of which not only the surface electrical railway cars of the Brooklyn transit system were brought across to the New York terminus at the City Hall Park, but also the cars of the Brooklyn system of elevated railways. This arrangement, completed in 1899, added vastly to the practical capacity of the bridge as a means by which the hundreds of thousands of people living in Brooklyn and on Long Island were enabled to reach Manhattan Island for daily purposes of business. It is estimated that about 140,000 trolley cars cross the bridge each month.

The convergence, however, of enormous systems of local transit at either end of this one bridge had made the congestion at certain hours, morning and evening, almost indescribable. The great necessity for additional bridges had long been perceived, and a second one, also a suspension bridge, was begun in 1897, and was expected to be completed in 1903, the total cost, including approaches, being $12,000,000. The bridge spans the river at a clear height above the water-line of 135 feet. Its cables are suspended from towers of skeleton steel construction 335 feet high. Its width of 118 feet will permit—besides carriage-ways, foot and bicycle paths—six railway tracks, four for surface electric cars and two for the elevated system. One other suspension bridge and one cantilever bridge to cross the East river to the Brooklyn and Long Island portions of the metropolis had also entered the initial stages of construction in or prior to 1901.

The general tendency of great cities at the end of the 19th century towards the concentration of business and trade in the central districts, with the distribution of population through widening suburban zones, was strikingly illustrated in New York. Two American inventions, the results of which are better seen in New York than elsewhere, have lent themselves particularly to the new concentration of business offices and mercantile establishments. These inventions are the steel frame for high buildings, and the elevator or "lift." The distinctive movement toward the construction of high buildings, popularly known in America as "sky-scrapers," began earlier in Chicago than in New York, where it was scarcely seen in 1890. Its progress in New York, however, was amazingly rapid, so that by the end of the year 1900 the entire aspect of the city, especially from the bay or the rivers, had undergone a most startling transformation. Where there had been buildings of an average height of from four to five storeys, with six as the maximum and seven as a rare extreme, with church spires here and there breaking the monotony of the skyline, there began to appear buildings first of eight or ten storeys, then of fourteen or sixteen, and at length of twenty to twenty-three, twenty-four, and even twenty-nine storeys in height, their upper rows of windows being far above the tops of neighbouring church spires. These buildings were run up as steel skeletons filled in with fireproof materials, and were like portions of streets raised to a vertical position. Some of the largest of these buildings have fully 5000 tenants. The elevators, which in some of the great buildings are numerous and well-operated, are in fact an important part of the passenger traffic system of the city. As a part of the same remarkable movement differentiating central business areas from outlying residential districts must be remarked the rapid growth of vast general stores or magazines known in America as "department stores," situated at points of special convenience for customers using the various traffic lines, and tending to the extinction of thousands of small retail establishments.

High buildings.

With these profound changes working towards a redistribution of the population is to be noted a general improvement in the public health. In spite of the very rapid influx of a comparatively insanitary population from eastern Europe, with its tendency to overcrowding in congested quarters, there has been a steady reduction of the death-rate of New York, and all conditions would appear favourable for a further reduction in the first quarter of the 20th century. Thus the death-rate for the year 1900 was only 20·4 per thousand of population, whereas in 1895 it was nearly 22, in 1890 about 26·5, and in the years preceding and following 1880 it was nearly 30.

Health, water, and sewerage.

New York has long been fortunate, as compared with many population centres, in its possession of a wholesome and adequate supply of water. The original Croton Aqueduct, opened in 1842, was in its day the most important municipal water-supply undertaking in the world. This conduit, about 40 miles long, had a capacity of some 75,000,000 gallons per day. The subsequent growth of the city made it necessary to construct another and very much larger aqueduct from the same general source of supply, and this New Croton Aqueduct, so-called, was opened in 1890. Its cost was $25,000,000, and its daily capacity is considerably in excess of 300,000,000 gallons. Meanwhile, vast improvements were undertaken in the Croton watershed, where, by means of a series of dams, the drainage area has been increased to such an extent that with the completion of the system the storage capacity will in 1905 be about 75,000,000,000 gallons. The supply is of a pure and wholesome quality. Brooklyn has a separate supply derived from various streams, ponds, and wells on Long Island. With proper care and foresight the existing sources can be made adequate for the supply of the city for perhaps the first three decades of the 20th century. Supplementary supplies for future needs must be obtained by drawing upon more distant sources.

The outward flow of the vast volume of the Hudson river—taken in conjunction with certain peculiarly fortunate movements of the tides through the channel that connects Long Island Sound with the harbour and separates Manhattan from Brooklyn—has always availed to sweep sewage out to sea, and New York has thus been spared the difficult problem of sewage disposal. As compared with other cities of metropolitan rank, New York has for a number of years been exceptionally free from epidemic diseases. The public health department exercises great watchfulness over the crowded tenement-house districts, and through the co-operation of various public and private agencies there has been a marked improvement of general conditions. There is a comparatively small percentage of sordid and chronic pauperism in New York, and in periods of normal business activity the exhibition of poverty is small as compared with that in European cities. Even among the Polish Jews, who at the beginning of the 20th century formed the most notable new factor of the population, the abject conditions of overcrowding and sweat-shop labour were not so discouraging as they might have seemed; for this population was rapidly improving its economic condition, and its lot in New York was much better than in the towns of Russia and Poland whence it had come. The clothing trades, which had become highly specialized in New York, and had in the aggregate assumed enormous proportions, had in the course of a few years passed very rapidly into the hands of these Jewish newcomers, who by the year 1900 held something like a monopoly of the labour in that class of manufactures.

Until 1896 the administration of public charity was connected with that of correctional institutions, but in that year the administration of charity was placed in the hands of a separate department. Various hospital dispensary facilities are available, and there was appropriated in the municipal budget for the year 1900, and again for the year 1901, a sum of money falling little short of $2,000,000 for charitable relief, besides which a still greater amount of public money was distributed in form of subsidies to a great number of hospitals, infirmaries, orphanages, and other establishments of an eleemosynary character. It is stated that at ordinary times not more than one family in 200 in New York seeks relief from established charitable sources, whether public or private. So great is the development of manufactures and commerce in and about New York that it is only in periods of exceptional business depression that there is suffering through lack of employment. The standard of living among the working classes is high when compared with other metropolitan populations; and the thrift of the people is to some extent indicated by the statistics of the savings banks. There is no postal or municipal system for the receipt and custody of the savings of working people, but there were in New York in 1901 49 banks for savings organized and conducted as private enterprises in conformity with carefully devised laws of the state of New York, and subject to constant state inspection. The deposits in these banks for the year ending 1st January 1902 reached a total of $191,417,073, the number of individual depositors being 1,476,809. This in a total population of 3,437,202 would indicate an average of about two depositors to each family of the population, with an average of perhaps $275 deposited for each family in a single year. The total resources of savings banks were $795,876,362, just $230 for each inhabitant, or $1150 for each family of five persons. Large and constant remittances to Ireland and Germany, and those portions of eastern Europe whence the newer elements of the population have come, give further indication of the relatively high prosperity of the working class.

Charities and Savings.

The situation of New York affords unusually picturesque areas for public parks and places of resort, and while in the earlier period of the city's development there was far too little provision made for open spaces, the closing years of the 19th century disclosed a very earnest and comprehensive movement for the creation at no slight expense of a number of small parks and playgrounds accessible to the inhabitants of the tenement-house districts, together with recreation piers and free bathing facilities at convenient intervals along the extensive water frontage. The best-known recreation ground is Central Park, a beautiful tract conveniently situated in the heart of Manhattan Island, containing 862 acres. The principal park of Brooklyn is Prospect Park, with 516 acres. In the newer portion of New York City north of the Harlem river, and comparatively remote from the present mass of population, are three great tracts of park land, namely, Bronx Park, of 662 acres, in which were opened in 1899–1900 very extensive botanical and zoological collections; Pelham Bay Park, of 1756 acres, lying at the north-east end of the municipal area, with an irregular frontage on Long Island Sound; and Van Cortlandt Park, of 1132 acres, lying 5 miles west of Pelham Bay Park. These three great parks are connected by broad parkways. One of the most attractive bits of park area in America is the strip of high east bank along the Hudson river, known as Riverside Park, or Drive, which has been considerably extended northwards to connect with a system of new drives and parkways and so become part of the general park system. One of the noteworthy accomplishments of 1901 was that of a park to embrace

Parks.

the wonderful Palisades of the Hudson river, stretching for nearly 20 miles along the river's west bank. The new Ocean Park in the vicinity of the famous suburban seaside resorts known as Coney Island and Manhattan Beach will prove a great boon to the teeming millions of the metropolis. The total area of parks and open spaces under the care of the Park Commissioners of New York in 1901 was 6766 acres.

Not only the direct activities of the municipal government, but also to some extent the conditions and character of the city in general, may be better appreciated by a glance at the yearly budget of the corporation. The total amount of money appropriated by the fiscal authorities in the budget for 1900 was, in round figures, $90,779,000, and for the year 1901 it was $98,100,000. Nearly $7,000,000 of this aggregate was payable to the state government at Albany for the city's share of state taxes, the remaining $91,000,000 being for local purposes. The greatest item in this huge budget was that for the municipal debt. The total gross funded debt outstanding on 1st January 1900 was $358,104,307. This, however, was offset by the municipal stocks and bonds held as investments by the sinking fund to the total amount of $105,435,871, leaving a net funded debt of $252,668,436. The consolidation of New York, Brooklyn, and other areas involved the assumption of all outstanding indebtedness by the enlarged municipality. The budget for 1901 included in round figures $12,100,000 for interest on the city debt and $10,332,000 for debt redemption, being a total of more than $22,000,000.

The budget.

The next largest item of public expenditure was for education, the amount appropriated in the budget of 1900 being $14,619,111, while in the budget of 1901 there was a marked increase to $18,512,817. The number of schools under the control of the Board of Education was 507, and the total enrolment of pupils in July 1900 was 418,951, the average daily attendance being 378,211, and the number of teachers 8844. According to the U.S. census of 1900, the number of persons of school age (5 to 20 years inclusive) was 1,028,069. A special effort was made in the period from 1895 to 1900 to improve the system of elementary education and adapt it to the practical requirements of the population. Many of the large schools of the tenement-house districts are composed almost entirely of children whose parents are of foreign birth, and who speak languages other than the English in their homes. Public schools perform an inestimable service in teaching such children the English language, and in training them for citizenship. Evening schools are provided for children who have left the day school to earn their living, and for such older persons as may choose to attend. Under the compulsory education statute the attendance of children at some suitable school, or their equivalent instruction, is required between the ages of eight and fourteen years. Provision is made for more advanced instruction in ten high schools and in two institutions of still higher grade—one for young women, known as the Normal College, and the other for young men, known as the College of the City of New York. Many of the young women who graduate at the Normal College are subsequently employed as teachers in the various elementary schools. The College of the City of New York in 1901 had 2126 students and 80 instructors. Provision had been made for the erection of a new building for this institution, at an estimated cost of more than a million dollars. Besides the children receiving instruction in the schools under control of the Board of Education, 70,061 children were registered, at the beginning of the year 1900, in Roman Catholic parochial schools, and there were many thousands of children and youths in other schools under ecclesiastical or private control.

Education and police.

The items of expenditure in the budget of 1900 and 1901 that followed in magnitude the item of education are the police department, costing approximately $12,000,000 a year, and the departments of fire and street cleaning, the cost of each of which was about $5,000,000. There are eighty police precincts, each with its fully-equipped station-house containing quarters for policemen as well as for prisoners, and temporary accommodation for homeless and unfortunate persons. In all that pertains to their ordinary duties as guardians of the public peace, the 7000 policemen of New York are a very efficient and admirable body of men. The fire department is more elaborately equipped than that of any other city in the world, and probably possesses the highest average efficiency. The number of fire companies in the metropolitan area approximates 300, with a total force exceeding 3000 men. The statistics of 1899 showed fire losses in New York of $10,000,000, the total number of fires considerably exceeding 7000, and the buildings attacked by flames being of such value as to carry aggregate insurance approaching $200,000,000.

The total assessed valuation of real and personal property liable to taxation for general city purposes was $3,787,970,873 in 1901, and the tax rate for such purposes was about 2·3 per cent. This rate would produce $75,687,894 (after deducting $1,513,757 for estimated deficiencies in collection). In addition to the above, the rate of taxation for local county purposes, which varied with the different boroughs, was estimated to produce altogether $3,661,531. The discrepancy between the sum of these two amounts, $79,349,425, and the total budget for city and county purposes, was covered by estimated revenues from the so-called general fund, such as the tax on stockholders of banks, interest on taxes, school money from the state, licences, fees, proceeds of excise taxes, unexpended balance of previous year, &c.

The following table shows by boroughs the assessed valuation of real estate and personal property liable to taxation for city purposes:—

Boroughs.	Real Estate.	Personal.	Total.
	$	$	$
Manhattan and the Bronx . .	2,428,997,016	440,468,558	2,869,465,574
Brooklyn . .	658,962,119	89,241,624	748,203,743
Queens . . .	107,179,620	10,826,810	118,006,430
Richmond . .	42,639,506	9,655,620	52,295,126
Grand total .	3,237,778,261	550,192,612	3,787,970,873

The municipal charters granted by the legislature of the state of New York, under which the city has exercised the functions of a municipal corporation, had been amended and altered many times by successive enactments prior to the great enactment of 1897, which provided an extremely elaborate framework of municipal government and special code of laws for the government of the consolidated metropolis. This new charter came into force on 1st January 1898. It provided for a mayor, elected for a four-years' term, with very extensive executive and appointing powers; an elective chief financial officer, called a comptroller; and a municipal assembly composed of two branches, one of them called the council, and consisting of twenty-nine members, and the other a board of aldermen of sixty members. The twenty-ninth member of the council, who served as its president, acted also as vice-mayor, and was elected, like the comptroller and the mayor, by the voters of the entire city for a term of four years. The other municipal officers were appointed by the mayor, and after the first six months of his term they could be removed only upon the presentment of formal charges. The municipal assembly had no such authority as the London County Council, and incomparably less than the municipal councils of British, French, and German cities under the respective municipal codes of these countries. The real administrative work was performed by a series of boards, the most important of which was known as the board of estimate and apportionment, consisting of the mayor, comptroller, and the president of the council, all of whom were elected by the people, and the corporation counsel and the president of the department of taxes and assessments, who were both nominees of the mayor. This board was the actual budgetary authority, deciding both upon the total amounts to be raised by taxation and the distribution of the revenues to the various departments. The body that exercised authority over the policy of the metropolis in respect of public improvements, constituting an authority somewhat analogous to the old Metropolitan Board of Works of London, was entitled the board of public improvements, and consisted of the heads of six important departments, namely, water supply, highways, street cleaning, sewers, public buildings, and bridges. A single commissioner appointed by the mayor was at the head of each of these departments; and when they met as a metropolitan board, they were presided over by the mayor himself, or by a president of the board appointed by him. The police board had formerly consisted of four commissioners, but after 1901 of one commissioner appointed by the mayor and exercising a wide range of authority, which at first included also that of the supervision of all elections held within the metropolitan district. This power was taken away, however, by the state legislature in 1898, and vested in a separate bureau of elections, at the head of which was an official appointed by the governor of the state. The board of health consisted of two commissioners, with whom acted as *ex-officio* members the police commissioner and the president of the health office of the port of New York. There was a park board, consisting of three commissioners, a board of public charities, and a board in charge of the department of public buildings, each of which had three members. At the head of the fire department was a single commissioner, as was also the case in the department of correction. The board of taxes and assessments consisted of a president and three additional commissioners. The board of education had nineteen members, made up of representatives of the school boards of the several boroughs into which the metropolis was divided. There was also a board of docks, made up of three commissioners. In practical administration these boards had extensive power and responsibility, and also very potent influence in the shaping of the general policy to be pursued as respects their departments.

Government.

Experience in the working of the charter of 1897 soon showed the need of numerous amendments, some of them important and fundamental, others merely matters of minor detail. An able commission appointed by Governor Roosevelt to recommend charter changes made a report the recommendations of which were for the most part accepted by the legislature of the state in 1901, so that the revised charter came into effect with the new city administration at the beginning of the year 1902. One of these changes abolished the council and increased the number of members of the board of aldermen, thus providing a single instead of a double chamber. The powers of the board of aldermen were also to some extent increased. An unfortunate change reduced the term of the mayor from four years to two. It had been found necessary to give a more distinct administrative character to the several boroughs into which the metropolis is divided, and the elective borough presidents became, under the revised charter, officials of very considerable importance, having large authority with respect to public improvements, and becoming members of the board of estimate and apportionment, the membership of which was otherwise modified. A considerable number of small local-improvement districts were created for the better care of such matters as street-paving and the like. The Health Department was placed under the control of a single commissioner. An important new branch of the municipal government was created in the so-called Tenement House Department, with wide authority, under a new and greatly reformed building code, to supervise the structure of tenement houses and their occupancy in the interest of health and the general welfare. The educational system of the city on the administrative side was also changed in the charter amendments, so that the board of education in 1902 consisted of forty-six members appointed by the mayor.

The efficiency of the municipal government is to be tested by an examination of the work of the principal departments. These are to such an extent independent of one another that it is conceivable at any given time that the department of education, for example, should meet the demands made upon it with an admirable intelligence and an almost perfect system, while the police department might be relatively inefficient or corrupt. The ultimate authority to which appeal is constantly made is the legislature of the state of New York, which meets annually at Albany. Hundreds of Bills are introduced at each legislative session relating specifically to the affairs of the metropolis.

Higher education, libraries, art, and music.

Two important American universities are situated in New York City, namely, Columbia University and the University of New York. Columbia, which was chartered as King's College in 1754, and incorporated as Columbia College in 1784, was removed in 1857 from its old site in Church Street, near the lower end of Manhattan Island, to more spacious buildings in Madison Avenue, between 49th and 50th Streets. In 1896 the name "University" was adopted, the institution having outgrown the original school of arts, which still retains within the university the name of Columbia College. In the following year the university moved to a group of magnificent buildings which had been erected on a commanding site, a little more than three miles north of the old one, known as Morningside Heights. In 1902 Professor Nicholas Murray Butler was made president of Columbia, to succeed Seth Low, who had become mayor of New York. The university has seven departments, and in 1902 the total number of professors and instructors was nearly 500, and the total number of students about 4000. Affiliated with Columbia University is Barnard College for women and the Teachers' College, both of which also have admirable buildings on Morningside Heights, adjoining the grounds of the university, and the foregoing statistics of teachers and students include these.

The New York University, which, like Columbia University, is a chartered institution under the control of an independent corporation, began its career in 1839, and was housed in Washington Square from that time until 1894, when it was removed to its present site, known as University Heights, a little more than four miles north of the site of Columbia University. Like its neighbour, the New York University also occupies an admirable new group of buildings. In all departments it had, in the year 1901, 1824 students and 186 instructors.

Besides the public school system, Brooklyn has several notable educational institutions, among which may be mentioned Adelphi College, an excellent local institution for both sexes, with power to confer degrees; the Pratt Institute, a well-endowed school for technical training and instruction in the applied arts, with many well-conducted departments; the Packer Institute for young women; the Brooklyn Institute, which maintains a great variety of popular lecture courses and classes, with museums and other educational facilities. In the borough of Manhattan a great centre of popular instruction has long been the Cooper Institute, founded by the distinguished philanthropist Peter Cooper, which maintains practical trade classes and a great variety of instruction in evening classes, besides an important art school and several lecture courses in the great assembly hall. The Carnegie Music Hall in Manhattan borough is also to be noted as a centre of popular culture. The Roman Catholic Church maintains several large institutions for advanced education, and the Hebrews, recognizing the needs of a great influx of Jewish population, support some admirable centres for industrial and practical training.

Among important enterprises of a popular educational character is the New York public library, formed by the consolidation of two important existing reference libraries, the Astor and the Lenox, with the fund left by the will of Samuel J. Tilden, and known as the Tilden Trust for the Establishment of a Free Circulating Library. The headquarters of the New York public library are to be in a monumental building, of white marble, the construction of which was begun in the year 1900 by the municipal corporation on the site of an abandoned reservoir extending from 40th to 42nd Streets on Fifth Avenue. This building, the capacity of which can easily be extended in the future, will have shelving space for perhaps a million and a half volumes. A number of libraries under separate control, but receiving large annual subsidies from the municipal treasury, are, according to plans formed in 1900, to be consolidated with the New York public library, which is to use their numerous buildings and branches as sub-stations. In addition to this, Mr Andrew Carnegie gave to the city of New York in 1901 the sum of $5,200,000 for the erection of sixty-five more branch library buildings in different parts of the city.

An important educational agency is the American Museum of Natural History, with great collections constantly growing, and housed in a vast edifice built by the municipal corporation. The municipality has also provided a structure, greatly extended at the end of the 19th century, for the collection of paintings, statuary, and other works of art, belonging to the Metropolitan Museum of Art. The Museum of Natural History is situated in a small park annexed to the Central Park on the west side, and the Metropolitan Museum of Art is within the enclosure of Central Park near Fifth Avenue.

The architectural transformation of New York at the end of the 19th century was notable chiefly from the point of view of its daring and skilful use of iron and steel, and its marvellous adaptation to the new conditions of industry and commerce, but it had also many specimens to show of buildings of merit from the standpoint of architecture as a fine art. No great metropolis, however, had done so little as New York to produce those notable effects in architecture that are derived from the symmetrical and balanced placing of buildings of a public character with reference to each other, with suitable approaches and with open spaces about them; and no other great and rich city of any period of the world's history, perhaps, was so lacking in the embellishment of great public fountains, heroic monuments, and groups of statuary. Nevertheless, the wealth of the city was so enormous, and its structures, both public and private, in their infinite architectural variety were so costly and substantial, as to create the general impression of a magnificent city. And this impression was enhanced by the marvellous purity of the atmosphere and clearness of the sky, due not merely to a favourable climate, but also to the exclusion of smoke-producing bituminous coal.

Among other highly-marked tendencies at the end of the century was the development of New York as a musical centre, where grand opera, without Government subsidy, was produced on a more elaborate scale than elsewhere, while various musical interests, fostered in considerable measure by the large population of German origin, were prosperous to an encouraging degree. There was also to be noted the extremely rapid multiplication of theatres and kindred places of popular entertainment and resort. These had more than doubled in number since 1880; and of theatres and music halls alone there were not fewer than seventy-five. This development of New York as the chief centre of America for purposes of entertainment had, in the last years of the 19th century, brought about a wholly unprecedented influx of well-to-do visitors from other parts of the country; and this influx in turn had made it profitable to build a series of enormous and magnificent hotels for the accommodation of the ever-increasing multitude of prosperous strangers. In these regards New York had begun to bear a strong resemblance to London. In earlier periods New York had not, in any such sense as London or Paris, been a great national metropolis. Boston, Philadelphia, and Baltimore in the east, and other cities of the south and west, were centres which before 1880, or even 1890, would not for a moment have acknowledged themselves provincial with reference to New York as a metropolis. And their pretensions would have been fully justified, for in many respects their position as local centres was analogous to that of such German cities as Hamburg, Frankfort, Munich, and Dresden in their relation to Berlin. But as the aggregation of all kinds of German interests at Berlin in the last twenty years of the 19th century was at a far higher rate relatively than the development of other German cities, so the progress of New York in the same period, and especially in the closing years of the last decade of the century, was tending to make for the position

New York as the metropolis of the country.

not merely of primacy among American cities, but for that of unquestioned metropolitan rank and position as a centre of national and international transportation, trade, and commerce.

Previous to 1880 New York was not recognized in any unqualified sense as the metropolitan centre of the country in respect of such enterprises as the publication of books and periodicals, but the publishing trade has steadily tended to concentrate. The growth of New York has been especially marked as the chief centre of North America for the issue of all kinds of periodical literature. While the daily newspapers have a larger circulation and a wider influence than those of other American cities, there is in America no such distinction as in England between the metropolitan and the provincial press. Boston, Philadelphia, Baltimore, Chicago, St Louis, San Francisco, New Orleans, and other American cities are for their own localities important centres of newspaper publishing.

Banks.

The progress of New York as a great banking and financial centre had been also especially rapid in the closing years of the 19th century, its banking houses and financial institutions having multiplied in number, and having developed even more in the extent of their capital and the volume of their transactions. Thus the banks of deposit in the metropolis numbered considerably more than 100, with capital and surplus exceeding $150,000,000 ; and about 40 trust companies, having a banking character, had an aggregate capital of more than $110,000,000. Besides those institutions were the savings banks, 49 in number, with total resources of nearly $700,000,000. The position of New York as the banking, financial, and general commercial centre of the United States is indicated in the statistics of the New York Clearing-House Association, when compared with the clearings of other cities. All the considerable cities of the United States, to the extent of nearly a hundred, maintain bank clearing-houses, yet in most weeks the clearings of the New York association aggregate more than three-fourths of the total clearings of the entire country. For the calendar year 1901 the average daily clearings of the New York Clearing-House were, in round figures, $262,000,000, and the total for the year was $79,420,418,435. Previous to September 1897, the London clearings had generally been considerably larger than those of New York, but in the years 1898, 1899, 1900, and 1901 the New York clearings were greatly in excess of those of the British metropolis. Thus the London clearings for 1901 were $46,529,000,000, while those for New York were $79,420,000,000.

The amalgamation of the capital engaged in various branches of industry, which had been brought about with great rapidity in the period from 1896 to 1899, had enhanced the tendency towards the concentration of banking and financial operations ; and this tendency had in turn increased the financial importance of New York as compared with other American cities. The central offices of numerous vast enterprises were, in the closing years of the 19th century, brought to New York, and the metropolis became the home of a rapidly increasing number of individuals of great wealth. Thus New York was fast becoming a centre of luxury, display, and entertainment, and an agreeable place of resort at all times of the year—but especially in the winter months—for thousands of people of refined or luxurious taste from the south, the west, and all portions of the country.

Commerce.

For the fiscal year ending with June 1901 the port of New York handled almost exactly 47 per cent. of the total value of the import and export trade of the United States. Twenty years earlier New York had been credited with about 57 per cent. of this total trade. The proportion had gradually declined with the development of other ports, notably those of the Gulf of Mexico and the Pacific coast. The actual value of New York's foreign trade, however, had increased enormously, even if the relative proportion had declined. For a few years following 1870 the total foreign trade of the United States was about $1,000,000,000. The period from 1880 to 1890 had averaged about $1,500,000,000. It gradually increased until for 1900 it exceeded $2,533,800,000, of which amount the exports of merchandise reached nearly $1,500,000,000, while the imports of merchandise were valued at $829,000,000. Of this total importation, $526,100,000 came to the port of New York. Of the total exports of merchandise, somewhat more than $538,000,000 was shipped from New York ; and if one includes the imports and exports of the precious metals, the total foreign commerce of the port of New York for 1900 exceeded $1,196,000,000.

Political history.

Some authorities on the political history of New York have expressed the opinion that the frauds of the Tweed Ring, which were exposed in 1871–72, amounted, in the period from 1865 to 1871, including issues of fraudulent bonds, to a total of $200,000,000. This vast sum represented, in the main, a direct theft of public property. It was supposed at the time of the Tweed exposure that Tammany Hall was hopelessly discredited. The charter of the Tammany Society ought to have been annulled ; but the organization, within a surprisingly short time, had regained its control of municipal affairs. A shrewd local politician named John Kelly became the dominating personality in the Tammany Society; and the first move to mislead the public was the selection, as Tammany "sachems," of some of the most sincere and most conspicuous of the Democrats who had exposed and overthrown the Tweed *régime*. Tammany now posed as a reform body, with the objectionable elements all excluded. In these circumstances Tammany actually came near winning the mayoralty election of 1872, and in 1874 it was victorious. There had been much industrial distress, and by its superior system of minute neighbourhood organization Tammany distributed aid to the poor, promised public work to all the unemployed, and built up a strong support. By this time the more obscure members of the old Ring were reasserting themselves in Tammany, and the liquor interests were becoming dominant in the district and ward politics of the organizations. The dictatorship of John Kelly lasted from 1874 to 1886. He bore the sobriquet "Honest John Kelly," but his political character was far from that of a man of scrupulous views. There was no repetition of the extravagant crimes of the Tweed *régime*, but for the most part municipal government was on an exceedingly low and corrupt plane. During a part of this time Tammany yielded to public opinion to the extent of permitting men of upright personal character and excellent intentions to fill the office of mayor, but under the charter as it then was the power of the mayor was comparatively limited. From time to time there arose local organizations, which affiliated with the Democratic party in national politics, and which disputed the right of Tammany Hall to stand as the sole local representative of that great party. But Tammany was generally able to overcome and absorb such dissentient bodies. In 1884 there occurred a transaction of a particularly scandalous nature, the men chiefly guilty being known as the "boodle aldermen." To the aldermanic board there had now been restored a considerable measure of authority which at a former period had been withdrawn. Rival companies were seeking to obtain a franchise for working a street railway on Broadway, the main thoroughfare of the city. This privilege was so valuable that the city could have sold it for several millions of dollars. It was given away by the aldermen, and it was afterwards proved that a large number of them had accepted equal portions of a cash bribe of $500,000. Some of them were subsequently punished, but Tammany's power was not seriously impaired. John Kelly died in 1886, holding up to the date of his death an undisputed dictatorship in Tammany Hall, and this was equivalent during much of the time to an autocratic direction of all the affairs of the city. After Kelly's death it was announced that Tammany would henceforth acknowledge no single "boss," and for a time a group of three or four leaders jointly managed the affairs of the organization. But one of these, Richard Croker, gradually strengthened his hold upon the twenty-four district leaders who were officially the governing committee ; and Kelly had not been dead more than two years before Croker's authority came to be generally recognized. This remarkable politician was born near Cork, Ireland, in 1843, and was brought to New York in early childhood. As a youth he worked as a mechanic, but early became active in the politics of his ward, and in 1868 was elected alderman. In 1873, and again in 1876, he was elected coroner. In 1883 he was made a fire commissioner. His great political skill was shown in the campaign of 1886, when Henry

George, who was extremely popular, was an independent candidate for mayor, while Theodore Roosevelt was the Republican candidate. The better element of Democrats chose Abram S. Hewitt, and Mr Croker and the Tammany organization, appreciating the nature of the contest, endorsed and accepted Mr Hewitt, and secured his election. Though possessing the highest qualifications and the purest motives, Mr Hewitt's policy as mayor was largely rendered futile by the antagonism of Tammany Hall. At the next election, in 1888, Tammany did not hesitate to bring forward one of its own chiefs as its candidate, Mr Hewitt running as an independent candidate, and the Republicans having a strong nominee in Mr Erhardt. Tammany succeeded through the division of the opposing voters. An investigation of Tammany's government of the city was made by the Republican legislature of the state in 1890. Much evidence was secured illustrating the manifold improprieties of the Tammany system, but nothing of overwhelming importance was brought to light. There followed, however, an unusually earnest attempt on the part of good citizens, through the so-called People's Municipal League, to defeat Tammany in the election of 1890. This movement failed, however, and in 1892 Tammany not only won again, but by an overwhelming majority. Again the administration became more carelessly and more scandalously corrupt; and the state senate again, in 1894, made an investigation. This inquiry brought to light some of the facts respecting an elaborate system of blackmail which had grown up under the joint protection of Tammany Hall and the city government. Under this system large sums were paid for appointments to office and for promotions, and an elaborate method had been devised for collecting money regularly from the keepers of gambling-houses, houses of ill-fame, and other disorderly resorts, and from liquor-sellers for permission to violate certain details of the excise laws, such as midnight and Sunday closing. There followed a great outcry against Tammany Hall, and at length the so-called Independents were able to unite forces with the Republicans in a campaign which elected William L. Strong, a reputable and prominent merchant, as mayor. Under the Strong administration Colonel George E. Waring, junior, as head of the street cleaning department, quite revolutionized New York as respects its cleanliness. Theodore Roosevelt, as president of the police board, rendered efficient service, the public school system was vastly improved, and in numerous ways the administration of the city was greatly improved. In 1897, unfortunately, the opponents of Tammany failed to unite. The Citizens' Union nominated the Hon. Seth Low, president of Columbia University, who, though a prominent Republican, was not endorsed by the so-called Republican machine. Although Mr Low polled a much larger number of votes than the Republican candidate, the Tammany candidate, Robert A. Van Wyck, was successful, and Mr Richard Croker more than ever before was in control. Another legislative inquiry, under the chairmanship of Mr Mazet, was made in 1899, with the usual result of many disclosures that threw light upon the objectionable methods of Tammany rule. Mr Croker's power could not be understood without some knowledge of the relation between the great municipality and the government of the state of New York. Mr Croker was practically in control of the votes of a large portion of the members of the state legislature. The rapid development of vast business interests had made it increasingly important for many companies and individuals to ward off unfavourable legislation, or at times to seek the active favour of the law-making body. Instead of dealing directly with the members of the legislature through old-fashioned lobbies, so-called, these private interests found it more prudent and more effective to cultivate the favour of Tammany Hall on the one hand and of the Republican organization on the other. The receipt of large funds for political expenditure would naturally increase the authority of the men having charge of the disbursement of such funds, and render it more difficult to dislodge them. On the popular side the strength of Tammany Hall was largely due to the fact that it united in a compact body a great number of men whose livelihoods were directly affected, and whose rewards were made proportionate to their usefulness to the organization.

An awakened public opinion, and many determined and zealous efforts for municipal reform, while generally unsuccessful in the election of reform candidates for municipal offices, have nevertheless had beneficial effects of the most marked character upon the methods and results of departmental work. Thus, in spite of a world-wide impression that New York is habitually misgoverned, there was during the last ten years of the 19th century a very remarkable progress made in almost every department of local administration, in response to an exacting public opinion that demanded good streets, vigilant protection of the public health, an ample supply of good schools, and other municipal facilities such as progressive communities elsewhere had learned to value. Elections in New York had become honest and free from scandal, while the collection and disbursement of a vast public revenue had become relatively free from charges of peculation or fraud. The principal scandals of recent years had risen out of a sharp discrepancy between the habits and customs of a metropolitan population of diverse origin and certain rigid state laws relating to public morals which it had been made a part of the duty of the police to enforce. These laws, among other things, prohibit the existence of gambling places and other resorts of a so-called "disorderly" nature, and require the closing of drink-shops and various other establishments on Sunday. The existence of such laws, and the extreme difficulty of their enforcement, rendered possible a system of connivances and sale of indulgences that made the police department, and certain influential politicians who controlled it, the partners in a system of blackmail that permitted the conduct of a vast number of illegal establishments, and the paid protectors of Sunday opening and various other violations of law. While such connivances are demoralizing to the tone of a police department, it is obvious that they may exist without radical impairment of the efficiency of many other branches of the municipal administration.

The Citizens' Union and the various reform groups succeeded in the autumn of 1901 in forming a campaign union with the Republicans for the overthrow of Tammany rule and Croker domination. This fusion movement agreed upon Seth Low as candidate for mayor. The Tammany party, appreciating the danger of defeat, nominated a Democratic lawyer of the highest repute, Mr Edward M. Shepard, who had never been a member of the Tammany organization. Mr Low was elected by a substantial majority, and entered upon his two years' administration on the 1st of January 1902. His administration was marked by excellent appointments to the various administrative posts, and by honest, enlightened, and efficient methods throughout. Under Mayor Low, New York assumed its rightful position as one of the best governed of the world's great municipalities.

Thus the 20th century had opened for New York City in a period of colossal material development, of great projects, and of great expectations apparently well founded. (A. Sw.)

NEW ZEALAND.

Geography and Statistics.

THE British colony of New Zealand consists of a group of islands lying between 35° and 48° S. in the south Pacific Ocean. It is situated eastward of Tasmania and south-eastern Australia, and Wellington, its most central seaport, is 1204 miles from Sydney. Its area is 104,471 square miles, of which its two main islands, called North and South, contain 44,468 and 58,525 respectively, and Stewart Island 621. These three form a broken chain divided by Cook Strait, 16 miles wide, separating the first two islands, and Foveaux Strait, which separates Stewart Island from South Island. Outlying groups of islets, included in the colony, are the Chathams, 536 miles eastward of Lyttelton in South Island, which are settled, and carry sheep well; the Aucklands, three degrees south of Stewart Island, also useful for grazing; several uninhabited islets farther south; and the Kermadecs, a volcanic cluster about 500 miles north-east of North Island. Of these last, Raoul or Sunday Island, the largest, is fertile. North Island is 515 miles long, and varies in breadth from 6 to 200 miles. The length of South Island is 535 miles, and its greatest breadth 180. From the south-west corner of South Island to the Bay of Plenty in North Island run parallel mountain chains which are the chief physical feature of New Zealand. Some remarkable peaks, however, rise apart from these. Such are the active volcanoes Ruapehu (9008 feet), Ngauruhoe (7515 feet), and Tongariro, in the centre of North Island. West of these the extinct cone Egmont (8260 feet) curves up from the sea-shore, almost rivalling Fusi-yama in its solitary and symmetrical beauty. On the north-east coast of South Island the Kaikouras are high parallel ranges, among which Tapuae-nuku reaches 9462 feet. In North Island the rivers Waikato, Waihou, Wanganui, and Manawatu are navigable for small steamers, the first for about 100 miles, the others for about 50. The chief river of South Island, the Clutha, which is 154 miles long, can be ascended by small craft for about 30 miles. Of the harbours which are commercially important, Auckland and Wellington are naturally the finest; Lyttelton has been made very commodious, and Port Chalmers, Greymouth, and Westport have been greatly improved. The two last-named are the chief outlets for the coal of the west coast. Less successful have been the attempts to improve Napier, New Plymouth, and Gisborne, all ports of rich and productive districts. The famous fiords or sounds of the extreme south-west afford perfect shelter, but are cut off from the inhabited districts by precipitous mountains. They are regularly visited in summer by tourist steamers. The Sutherland waterfall near Milford Sound is 1904 feet high. The southern Alps and the lakes and glaciers on their eastern side have also become noted amongst climbers and travellers. The most beautiful of the lakes is Manapouri. On the west side of the Alps glaciers descend into the forest belt as low as 700 feet above the sea. But the largest glaciers are to the east of the watershed. Their names and extent are as follows :—

Name of Glacier.	Area.	Length.	Greatest Width.	Average Width.
	Acres.	Miles. ch.	Miles. ch.	Miles. ch.
Tasman	13,664	18 0	2 14	1 15
Murchison	5,800	10 70	1 5	0 66
Godley	5,312	8 0	1 55	1 3
Mueller	3,200	8 0	0 61	0 50
Hooker	2,416	7 25	0 54	0 41

The region of the thermal springs in North Island covers 660 square miles, and stretches from Mount Ruapehu to White Island, an ever-active volcanic cone in the Bay of Plenty. The most striking natural feature of the district, the Pink and White Terraces, was overwhelmed in the eruption of Mount Tarawera in 1886, when for great distances the country was buried beneath mud and dust. Fine lakes and waterfalls, innumerable pools, in temperature from boiling-point to cold, geysers, solfataras, fumaroles, and mud volcanoes still attract tourists in large numbers. The healing virtue of many of the springs, too, becomes more widely known every year. The Government maintains a sanatorium at Lake Rotorua, and there are private bathing establishments in several other places, notably near Lake Taupo. In South Island there are hot pools and a State sanatorium at Hanmer Plains. Experience shows that the most remarkable cures effected by the hot waters are in cases of gout, rheumatism, diseases of the larynx, and in skin disorders.

Climate. The healthiness of the climate is attested by the death-rate, which, varying (1896–1900) from 9 to 10 per thousand, is the lightest in the world. In 1896 it was as low as 9·10, and since 1886 it has not exceeded 10·35. Even in the boroughs the average is below 13. The rainfall in most of the settled districts ranges from 30 to 50 inches a year. There is, however, a drier strip nearly 200 miles long along the middle portion of the eastern coast of South Island. The rainfall at Christchurch is 26 inches. Nearly all the cereals produced are grown on the east coast.

Maori. In 1896 the Maori were reckoned at 42,113, including 5762 half-castes. In 1901 the number was 46,518. It is probable that the numbers for 1896 were slightly under-estimated. Half-castes have increased by 1327 since 1881. Pulmonary consumption is the chief scourge of the race. About 4600 Maori children are taught in schools, about 3000 of them in schools specially maintained for Maori. The tribes still own 5,000,000 acres of land, and draw considerable sums in rent from Europeans, to whom they lease about 2,000,000 acres. They cultivate the soil, and own cattle, sheep, and horses, but seldom work for wages, and do not engage in trade.

Population. In 1901 the population, excluding the Maori, numbered 772,455, of whom 406,161 were males and 366,294 females. It was distributed thus :—North Island, 390,373; South Island, 381,617; Stewart Island, 253; Chathams, 204; Kermadecs, 8. The Chinese amounted to 2792. The last-named numbered 3711 at the census of 1896. The decrease of the Chinese, who in 1881 numbered 5004, has been caused by a landing tax of £10 a head, increased to £100 in 1896. The colony lost 20,000 by white emigration in the seven years 1885–91. In the worst year, 1888, the departures exceeded the arrivals by 9000; while in 1893 the gain from outside was 10,412, and in every subsequent year there has been at least a slight gain, which in 1901 rose to 6522. A noteworthy feature of the vital statistics has been the fall in the birth-rate from 37·97 in 1881 to 25·31 in 1901. This is significant, as the colony has been prosperous since 1894, and the marriage-rate has risen from 5·70 in 1894 to 7·67 in 1900. Only the very low death-rate preserves an excess of births over deaths, which range from 11,500 to 13,500 annually. Males still exceed females by 10 per cent. Illegitimate births ranged from 3·20 in the 100 in 1885 to 4·63 in 1900. The population is now 8 to the square mile.

Population.

Year.	Population (exclusive of Maori) on the 31st December.
1880	486,029
1885	575,172
1890	625,508
1895	698,706
1900	770,682
1901	772,455

The increase from 1891 to 1901 in the four chief towns is thus shown :—

	Census, 1891.	Census, 1901.
Auckland and suburbs	51,287	67,226
Wellington and suburbs	34,190	49,344
Christchurch and suburbs	47,846	57,041
Dunedin and suburbs	45,869	52,390

A fifth college—the Victoria College, Wellington—was added in 1899 to the four previously affiliated to the New Zealand University. The number of undergraduates is about 2000, of whom 880 were keeping terms in 1899. The proportion of male to female students is about 2 to 1. Excluding Maori schools, the following summary shows the number of schools, teachers, and scholars in 1900:—

Education.

Description of Schools.	Number of Schools.	Teachers.	Scholars.
Public (Government) schools (scholars other than Maoris)	1674	3586	130,724
Colleges, grammar and high schools (aided or endowed)	26	195	2665
Private schools	304	831	15,555
Industrial schools and orphanages	7	...	1668
Native village schools, European children attending	85	151	3109
Private native boarding-schools, European children attending	4	...	72
School for deaf-mutes	1	...	50
Jubilee Institute for Blind	1	...	28
Totals	2102	4763	153,871

The proportion of persons unable to read or write sank from 21·19 in 1886 to 15·27 in 1901. There are eight schools of art, attendance 3000; schools of mines, attendance 300; a school of engineering, attendance 106; an agricultural college, attendance 34.

Crime.

The number of convicts in gaol was 508 at the end of 1899 (633 at the end of 1887). From 1888 to 1897 the annual number of convicted persons fell steadily till the decline amounted to 26 per cent. In the two years following 1897 there was a rise of 2·49 per cent. In 1896 New Zealand-born persons (whites) over fifteen years old formed 44 per cent. of the population, but only supplied 25 per cent. of the convictions. Persons imprisoned for drunkenness fell in number from 1200 in 1885 to 610 in 1899. The proportion of lunatics rose from 1 in 393 for 1896 to 1 in 288 for 1900.

Finance.

The public finances, embarrassed between 1884 and 1889, have since then yielded annual surpluses of from £100,000 to £500,000, which have been chiefly spent upon public works. The public debt is roundly £51,000,000. Two thousand two hundred miles of State railways pay somewhat over 3 per cent. on the cost of construction. Telephones as well as telegraphs are a State monopoly. The revenue from lands was £270,203 in 1901. The mainstay of the Treasury is customs revenue, which now exceeds £2,250,000 a year.

Revenue and Expenditure.

Year.	Total Receipts.	Total Expenditure.
1880	£3,285,042	£4,019,850
1885	3,859,996	4,282,901
1890	4,208,028	4,081,566
1895–96	4,619,402	4,403,749
1900–01	5,906,016	5,479,704

Public Debt.

Year ending	Amount of Debentures and Stock in Circulation.	Amount of Sinking Fund accrued.	Net Indebtedness.	Net Indebtedness per Head of White Population.
	£	£	£	£ s. d.
31st December 1880	28,583,231	2,000,320	26,582,911	..
,, 1885	37,587,776	3,469,264	34,118,512	57 12 9
31st March 1890	38,667,950	1,386,185	37,281,765	60 5 3
,, 1895	40,386,964	751,932	39,635,032	57 9 9
,, 1900	47,874,452	944,375	46,930,077	61 17 3
,, 1901	49,591,245	1,033,494	48,557,751	62 16 10

Commerce.

External trade has risen from £12,853,736 in 1886 to £24,697,881 in 1901.

Year.	Imports (excluding Specie).	Exports (excluding Specie).	Excess of Exports over Imports (excluding Specie).
1886	£6,319,223	£6,534,513	£215,290
1888	5,430,050	7,403,206	1,972,156
1890	5,928,895	9,569,316	3,640,421
1892	6,742,544	9,490,920	2,748,376
1894	5,990,177	9,221,550	3,231,373
1895	6,115,953	8,518,119	2,402,166
1896	7,035,379	9,299,907	2,264,528
1897	7,994,201	9,741,222	1,747,021
1899	8,739,633	11,938,335	3,198,702
1900	10,207,326	13,246,161	3,038,835

The re-export trade is extremely small. Trade with the United States has grown from £877,000 in 1891 to £1,520,000 in 1900. Trade with India and Ceylon reached £391,300 in 1900; that with Fiji and other Pacific islands was £622,000 in 1900. With these exceptions, New Zealand trade is almost all done with Australia and the United Kingdom; the latter's share in 1900 was 70·16 per cent. of the whole.

Industrial progress was checked from 1884 to 1895 by the low prices for wool, wheat, and meat, and by the after-effects of land and other speculation in the 'seventies. During these years, however, two new industries of great importance were developed, the export of butter and cheese and frozen meat. The character of the soil and the moist cool climate enable English grasses to be sown almost everywhere, and nearly eleven million acres are now laid down with these. The result is seen in the price obtained for New Zealand sheep in Smithfield Market, which is from ½d. to 1d. per lb higher than that given for frozen mutton from other countries. The figures below show the growth of the trade:—

Export of Frozen Mutton

Year.	lb	Year.	lb
1882	1,707,328	1896	123,576,544
1886	38,758,160	1900	192,074,451
1891	110,199,082	1901	212,208,968

In 1901 New Zealand sent a little over two million frozen sheep and a million and a quarter lambs to London, thus about equalling in quantity the mutton imported into England from South America. In the market for frozen lambs the colony remains at present without a rival. Frozen beef is also sent to England. The export of butter and cheese has risen in value from £207,687 in 1890, till in 1901 it amounted to £1,199,000. In London, New Zealand cheese fetches as high a price as Canadian. Though not ranking in importance with wool or frozen meat, dairy-farming is almost entirely carried on by small farmers and their families, who supply milk to factories. Most of these are co-operative, their shareholders being the farmers themselves. The profits of the industry are thus widely distributed among the producers. The development of dairy-farming has led to the spread of settlement, especially in the west of North Island, where large tracts of fertile soil formerly covered with forest have now been cleared and converted into dairy-farms.

Live Stock.

Year.	Horses.	Cattle.	Sheep.	Pigs.
1881	161,736	698,637	12,985,085	200,083
1886	187,382	853,358	16,564,595	277,901
1891	211,040	831,831	18,128,186	308,812
1896–97	249,813	1,138,067	19,138,493	209,834
1900–01	266,245	1,256,680	20,233,099	250,975

Mining.

In 1895 gold-mining, after being long at a standstill, began again to make headway. For many years the surface alluvial mining in South Island became less and less profitable. As in other countries, however, the working of quartz reefs compensated for this. The cyanide process of gold extraction, and the returns obtained by its means from the Waiki mine in the Upper Thames, caused an outbreak of gold fever, which led to the opening up of a few good and a great many worthless quartz-mines. In South Island the river-beds of Otago province have been successfully worked by means of ingeniously constructed dredges, and good returns secured. In 1901 the gold exported was 455,560 oz., valued at £1,753,784. The total value of the gold exported from New Zealand from the discovery of the metal in 1857 to 1901 was slightly over £58,000,000. Kauri gum still holds its place as an export, about £500,000 worth being dug up annually. The number of Istrians and Dalmatians who came from the Adriatic to dig for kauri gum led to the passing of restrictive laws.

The progressive output of coal from 1880 to 1900 is shown below. The output in 1901 was 1,227,198 tons:—

Year.	Raised in the Colony.	Imported.	Exported (excluding Coal for Fuel by Ocean Steamers).
	Tons.	Tons.	Tons.
1880	299,923	123,298	7,021
1885	511,063	130,202	2,371
1890	637,397	110,939	33,404
1895	726,654	108,198	26,151
1900	1,093,990	124,033	36,699

Land under cultivation increased from 8,489,000 acres in 1891 to 12,679,000 in 1901. The following table shows the comparison of the official assessments of the value of landed properties in 1888 and 1898 :—

	1888.	1898.	Increase, 1888-98.	
			Amount.	Rate per cent.
Unimproved value .	£75,497,379	£84,401,244	£8,903,865	11·79
Value of improvements	35,640,335	54,190,103	18,549,768	52·05
Total . . .	£111,137,714	£138,591,347	£27,453,633	24·70

Wool remains at the head of the list of exports. In the eleven years ending 1898 the wool-clip increased 65·14 per cent. But the description changes; there is much less merino, and more of the coarser and longer cross-bred. The number of sheep has increased from 16,564,000 in 1886 to 20,233,000 in 1901, though the increase has been almost all in North Island. The number of the flocks grows, and the average size diminishes even more rapidly. There were 9149 flocks in 1886; in 1901 the number had risen to 19,000—average size of each flock about 1050. The smaller size of the flocks and the breeding of sheep for meat rather than for wool, the cultivation of English grasses and of extensive crops of turnips and other roots on which to fatten sheep and lambs, all tend to change sheep-farming from the mere grazing of huge mobs on wide, unimproved runs held by pastoral licences. The "squatters" still occupy eleven million acres, but even these are more closely subdivided than in former days. How much more extensive is grazing—of the more scientific order—than agriculture, is seen at once from the figures of the amount of land broken up, for crops or other purposes, and the amount under sown grasses. There were 1,646,000 acres of ploughed land and over eleven millions sown with artificial grasses in 1899. This is exclusive of the vast area of native-grass land. It may be noted here that the area now occupied and utilized by whites is about 39,000,000 acres.

Sheep-farming.

Acreage and actual yield in principal corn-crops, 1901—Wheat: acres, 206,465; yield per acre, in bushels, 31·61; total bushels, 6,527,154. Oats: acres, 449,534; yield per acre, in bushels, 42·45; total bushels, 19,085,837. Barley: acres, 30,831; yield per acre, in bushels, 33·33; total bushels, 1,027,621. Rye: acres, 1388; yield per acre, in bushels, 22·45; total bushels, 52,214. Maize: acres, 14,232; yield per acre, in bushels, 36; total bushels, 502,697. This was the largest yield for seven years, except that of 1899, when the figures were: wheat, 13,073,416 bushels; oats, 16,511,388 bushels; barley, 1,677,908 bushels. The export of cereals has greatly diminished of recent years. Nearly 300,000 tons of potatoes were grown in 1899.

The manufactures have made steady progress. The figures of the census taken in March 1896, and given in the following table, showed a lower rate of increase for the preceding five years than ruled from 1886 to 1891. This is explained, firstly by the collapse of the native hemp industry between 1891 and 1896, and, secondly, by the financial depression of 1893 and 1894, caused by low prices and the Australian bank panic. The estimated private wealth of colonists fell from £236 per head in 1890 to £219 in 1895. It rose in 1900 to £296.

Manufactures.

Manufactories and Works, 1896, 1891, 1886.

	April, 1896.	April, 1891.	March, 1886.	Increase, 1891-96.	Increase, 1886-91.
Number of establishments .	2459	2254	1946	205	308
Employed—					
Males . .	22,986	22,664	19,601	322	3063
Females .	4,403	2,969	2,494	1434	475
Totals .	27,389	25,633	22,095	1756	3538

	Year 1895.	Year 1890.	Year 1885.	Increase, 1890-95.	Increase, 1885-90.
Wages paid—					
To Males .	£1,776,076	£1,705,641	..	£70,435	..
,, Females .	131,516	102,999	..	28,517	..
Totals .	£1,907,592	£1,808,640	..	£98,952	..
Total approximate value of manufactures or produce .	£9,549,360	£8,773,837	£6,711,379	£775,523	£2,062,458

Since 1896 progress has been much faster. The returns of trade and the income-tax, the briskness of the building trade in the towns, the almost entire disappearance of unemployed workmen, are admitted on all hands. The figures of the census of 1901 support this contention. The best proof of advance is perhaps found in the official returns of hands employed in the registered factories and workshops :—

Year.	Hands.	Increase.
1895 . . .	29,879	4028
1896 . . .	32,387	2508
1897 . . .	36,918	4531
1898 . . .	39,672	2754
1899 . . .	45,305	5633
1900 . . .	48,938	3633
1901 . . .	53,460	4522

The chief factory industries come under the following heads:—meat-freezing and tallow; tanning and wool-scouring; saw-mills and grain-mills; boots and shoes; woollen and clothing; butter and cheese; breweries; printing houses; foundries; agricultural implement and machine shops; soap and candle works; coach-building and furniture; gasworks. Except in meat-freezing, wool-scouring, butter- and cheese-making, and timber-sawing, manufacturing is almost entirely for consumption within the colony.

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(W. P. R.)

HISTORY, 1882–1902.

Between 1882 and 1902 five governors represented the Crown in New Zealand. Of these Sir Arthur Gordon quitted the colony in June 1882. His successor, Sir William Drummond Jervois, arrived in January 1883, and held office until March 1889. The earl of Onslow, who followed, landed in June 1889, and resigned in February 1892. The next governor, the earl of Glasgow, remained in the colony from June 1892 to February 1897, and was succeeded in August of the last-mentioned year by the earl of Ranfurly. The cabinets which administered the affairs of the colony during these years were those of Sir Frederick Whitaker, Sir Harry Atkinson (3), Sir Robert Stout (2), Mr Ballance, and Mr Seddon. Except in one disturbed month, August 1884, when there were three changes of ministry in eighteen days, executives were more stable than in the colony's earlier years. The party headed by Mr Ballance and Mr Seddon held office without a break for more than eleven years, a result mainly due to the general support given to its agrarian and labour policy by the smaller farmers and the working classes.

The industrial history of New Zealand during these two decades may be divided into two unequal periods. Thirteen lean years—marked, some of them, by great depression—were followed by seven years of prosperity. The colony, which in 1882 was under a cloud, has not often been busier and more self-confident than in 1902. A division into two periods also marks the political history of the same time; but here the dividing line is drawn in a different year. Up to December 1890 the Conservative forces which overthrew Sir George Grey in 1879 controlled Parliament in effect, though not always in name; and for ten years progressive legislation was confined to a mild experiment in offering Crown lands on perpetual lease, with a right of purchase (1882), and a still milder instalment of local option (1881). In September 1889, however, Sir George Grey succeeded in getting Parliament to abolish the last remnant of plural voting. Finance otherwise absorbed attention; the task of successive ministries was to make the colony's accounts balance, and search for some means of restoring prosperity. The years 1884, 1887, and 1888 were notable for heavy deficits in the treasury. Taxation, direct and indirect, had to be increased, and as a means of gaining support for this in 1888 Sir Harry Atkinson, who was responsible for the year's budget, gave the customs tariff a distinctly protectionist complexion. In the previous year Atkinson had reduced the scale of public expenditure, retrenching the salaries of public servants, from those of the governor and ministers to those of clerks drawing £125 a year, but leaving wages untouched. The number of members of the House of Representatives was cut down from 95 to 74, and their pay from £205 to £150. The cost of government was reduced in other ways, and the amount of State employment diminished. Public borrowing between 1882 and 1895, if not abandoned, was on a more modest scale. Private economy was also generally practised, and the colony made a resolute effort to live within its means. The commercial revival, however, came but slowly. The heavy borrowing and feverish speculation of the seven years 1872–79 must in any case have been paid for by reaction. The failure of the City of Glasgow Bank in 1879 precipitated this, and the almost continuous fall in the price of wool and wheat, together with the dwindling of the output of alluvial gold, postponed recovery. Landholders and cultivators were almost always mortgaged, and paid heavy rates of interest, usually from 6 to 9 per cent. An excessive amount of the better land was held in large estates, carrying but little population. The banks and other money-lending institutions virtually owned wide tracts, which were unsaleable at profitable prices. The principal local bank—the Bank of New Zealand—was in an unsound condition, and until in 1895 it was taken under control and guaranteed by the colony, the fear of its collapse overshadowed the community. The financial and commercial improvement which began in 1895 was doubtless to some extent connected with this venturesome but apparently successful stroke of policy. The revival, however, is mainly attributable to the steady conversion of the colony's waste lands into pasture, the development of two new and really great exports—frozen meat and dairy produce; the continuous increase of the output of coal; the invention of gold-dredging; the exploiting of the deposits of kauri gum; the reduction in the rates of interest on mortgage money; a general rise in wages, obtained without strikes, and partially secured by law, which has increased the spending power of the working classes. Undoubtedly also commercial activity has been stimulated by considerable public loans, while the systems of taxation and rating on land values, adopted in 1891 and 1896, have contributed to check land speculation.

During the years 1882–90 the leading political personage was Sir Harry Atkinson. He, however, withdrew from party politics when, in December 1890, he was overthrown by the Progressives under John Ballance. Atkinson's party never rallied from this defeat, and a striking change came over public life, though Ballance, until his death in April 1893, continued the prudent financial policy of his predecessor. The change was emphasized by the active intervention in politics of the trade unions. These bodies, impelled by a socialistic movement felt throughout Australia and New Zealand, decided in 1889 and 1890 to exert their influence in returning workmen to Parliament, and where this was impossible, to secure pledges from middle-class candidates. This plan was first put into execution at the general election of 1890, which was held during the industrial excitement aroused by the Australasian maritime strike of that year. It is therefore usually, but wrongly, attributed to the feeling caused by that great conflict of labour and capital. It had, however, been fully arranged before the conflict broke out. The number of labour members thus elected to the General Assembly was small, never more than six, and no independent labour party was formed. But the influence of labour in the Progressive or, as it preferred to be called, Liberal party, was considerable, and the legislative results noteworthy. Ballance at once raised the pay of members from £150 to £240 a year, but otherwise directed his energies to constitutional reforms and social experiments. These did not interfere with the general lines of Atkinson's strong and cautious finance, though the first of them was the abolition of his direct tax upon all property, personal as well as real, and the substitution therefor of a graduated tax upon unimproved land values, and an income-tax also graduated, though less elaborately. The land-tax, which is still levied, rises from nothing at all upon the small holdings of peasant farmers to 3d. in the £ upon the capital value of the largest estates—those worth £210,000 and upwards. It must be remembered that buildings, improvements, and live stock are exempted. In the case of mortgaged estates, part of the tax is paid by the mortgagee. In 1896 municipal and rural local bodies were allowed to levy rates upon unimproved land values if authorized to do so by a vote of their electors, and by the end of 1901 some sixty bodies, amongst them the city of Wellington, had made use of this permission. The income-tax is not levied on incomes drawn from land. In 1891 the tenure of members of the Legislative Council or nominated Upper House, which had hitherto been for life, was altered to seven years. In 1892 a new form of land tenure was introduced, under which large areas of Crown lands have since been leased for 999 years, at an unchanging rent of 4 per cent. on the prairie value. Crown tenants under this system have no right of purchase. In the same year a law was also passed authorizing Government to repurchase private land for closer settlement. At first the owner's consent to the sale was necessary, but in 1894 power was taken to buy land compulsorily. So energetically was the law administered by John Mackenzie, minister of lands from 1891 to 1900, that in March 1901 more than a million acres had been repurchased and subdivided, and over 6000 souls were living thereon. (These figures include the Cheviot estate, 84,000 acres, bought under another law.) Out of about one hundred estates bought, only four have been taken compulsorily.

On Ballance's sudden death his place was taken by Richard Seddon, minister of mines in the Ballance cabinet, whose first task was to pass the electoral Bill of his predecessor, which provided for granting the franchise to all adult women. This was adopted in September 1893, though the majority for it in the Upper House was but two votes. At three general elections after the date mentioned women voted in large and increasing numbers, though without affecting the strength or policy of parties. In 1893 was also enacted the Alcoholic Liquor Control Act, greatly extending local option. Under it all male and female electors have the right to vote triennially for the reduction or total refusal of licences in their districts. No compensation is paid. Up to 1902 prohibition had been carried in one rural district (Clutha) only, though the number of licences had been somewhat diminished since 1893; there was one licensed house to every 502 persons in the colony. In the Clutha district prohibition was followed by a diminution of drunkenness and minor police offences. In the colony generally drunkenness and petty crime have increased with the years of prosperity. [Summary convictions in 1895, 13,067; in 1900, 18,800. Serious crime, however, decreased.] In 1894 the Advances to Settlers Act authorized State loans on mortgage to farmers at 5 per cent., and about £2,500,000 has been lent in this way, causing a general decline in the rate of interest. The same year also saw the climax of a series of laws passed by the Progressives affecting the relations of employers and workmen. These laws deal with truck, employers' liability, contractors' workmen, the recovery of workmen's wages, the hours of closing in shops and merchants' offices, conspiracy amongst trade unionists, and with factories, mines, shipping, and seamen. In 1895 a law controlling servants' registry offices was added.

Meanwhile the keystone of the regulative system had been laid by the passing of the Industrial Conciliation and Arbitration Act, under which disputes between employers and unions of workers are compulsorily settled by State tribunals; strikes and lock-outs are virtually prohibited in the case of organized work-people, and the conditions of employment in industries may be, and in many cases are, regulated by the awards of public boards and courts. The Arbitration Act, consolidated and extended in 1900, was soon in constant use. In 1895 the chief question before parliament was the reconstruction of the Bank of New Zealand. Under a Government guarantee fresh capital was provided for the bank, its creditors and depositors were secured against loss, and the gradual liquidation of its assets was arranged for, subject to governmental audit and supervision. Up to 1902 this process was steadily carried out, and the bank's business increased. In 1896 the landing-tax on Chinese immigrants, which had been £10 since 1881, was raised to £100, resulting in a rapid diminution of the Chinese in the colony: 1896, 1897, and 1898 were marked by struggles over the Old Age Pensions Bill, which became law in November 1898; by 1902 it had become the means of conferring a free pension of £18 a year, or less, upon 12,300 men and women of 65 years of age and upwards whose private income was less than £1 a week. About 1000 of these pensioners were Maori. The total cost to the colony was about £205,000 annually. Complaints were made of certain evasions of the pensions law, and in 1901 an amending Act was adopted to check these. In 1898 the divorce law was amended on the lines of the Stephen Act of New South Wales, and the municipal franchise, hitherto confined to ratepayers, was greatly widened; in 1900 the English system of compensation to workmen for accidents suffered in their trade was adopted with some changes. In 1895 borrowing on a larger scale was begun, and in seven years as many millions were added to the public debt. Before this the Ballance ministry had organized two new departments, those of Labour and Agriculture. The former supervises the labour laws, and endeavours to deal with unemployment; the latter has done much practical teaching and inspecting work, manages experimental farms, and is active in stamping out diseases of live stock, noxious weeds, and adulteration. Butter, cheese, and New Zealand hemp are by law graded and branded by departmental inspectors before export.

The outbreak of the Boer war in October 1899 was followed in New Zealand by a prompt display of general and persistent warlike enthusiasm: politics ceased to be the chief topic of interest; the general election of 1899 was the most languid held for fifteen years. The desire of New Zealanders to strike a blow for the Mother Country took the practical shape of despatching to South Africa ten successive contingents—in all 6000 men and horses. As soldiers the New Zealand riflemen won from their Imperial commanders high praise for courage, intelligence, and discipline.

Noteworthy incidents of the period were the establishment in 1883 of direct steam service with London; a proposal to annex Samoa, vetoed by the Imperial Government in 1885; the volcanic eruptions of 1886, in which the Pink and White Terraces were overwhelmed and 101 lives lost; the payment of the first annual contribution to the Australasian Naval Squadron under an Act of 1887; the annexation of the Kermadec Islands in the same year; the maritime strike of 1890; the establishment of Victoria College in Wellington in 1899; the adoption of universal penny postage on New Year's Day, 1900; the addition to the colony of the Cook Islands, Savage Islands, and other Polynesian islets in 1901. In the year last mentioned a Royal Commission reported exhaustively against the expediency of New Zealand entering the Australian Commonwealth. In 1902 the progress of the Pacific cable brought the colony into telegraphic communication with Norfolk Island and Fiji. (W. P. R.)

Ngami, the central point of an inland water system of South Africa, once forming a small lake 20 miles long and 10 wide, but now dry and consisting merely of an expanse of reeds growing in a soft treacherous soil, below which brackish water is found at a depth of 20 feet. It is cut by $20\frac{1}{2}°$ S. and 23° E. The former feeder of the lake was the Tioghe or Taukhe river, which entered at the north-west end, but which now sends a portion at least of its waters by a channel north of the Ngami into the Botletli or Zuga river, by which the overflow of the lake was formerly carried off eastwards at the time of high water. The lowest 20 miles of the Taukhe are said to have been dry since about 1890, the districts intersected by the old river beds now growing corn in great plenty. The cessation of the river's flow was caused, according to native report, by a blocking of the channel by thousands of rafts on which the Makoba natives brought down their yearly tribute of corn. The Upper Taukhe is known successively as the Kubango and Okavango, the most remote source lying in about $12\frac{1}{2}°$ S. and $16\frac{1}{2}°$ E., on the high plateau of Bihe. The Kubango flows first south, then south-east and east, but its course is still imperfectly known. In about 18° S. and $20\frac{1}{2}°$ E. it is joined on the north bank by the Kwito, a large navigable stream rising almost as far north as the Kubango, and possibly containing more water. Its general course is south-east, but between 15° and 17° S. it flows south and even south-west. Below the Kwito the Okavango is a rapid stream with an average breadth of over 100 yards, and generally navigable as far as the Popa falls, in 21° 50′ E. In the dry season the water-level is from 4 to 20 feet below the banks, but these are overflowed during the rains. At this period some of the surplus water finds its way (in about 19° S.) by the Magwekwana to the Kwando or Linyanti (Zambezi system), to which, in Major Gibbons's opinion, the whole body of water may have once flowed. Below this point the river (now known as the Taukhe) enters a wide swamp-plain, and is broken up into various branches. The only channel by which its waters now reach the Botletli is the Tamalakane, which joins the latter in about $23\frac{1}{2}°$ E., the Botletli above this point being merely a succession of pools. Below the junction the river when visited by Dr Passarge in 1896, at the close of the dry season, had a breadth of 30 to 50 yards, though its bed reached 150 to 200 yards. The banks are 25 to 30 feet high, and form steep white walls of sand compacted with lime, behind which the dark green forest rises. The stream is fringed with reeds harbouring countless water-fowl, but the game which formerly abounded on its banks was largely destroyed by the rinderpest. The Botletli loses itself in a system of salt-pans—round or oval basins of varying size sunk to a depth of 30 to 45 feet in the sandstone, and often bounded by steep banks. The outer pans are dry for a large part of the year, the whole system being filled only at the height of the flood-season in August. (E. HE.)

Niagara, a river of North America, running northwards from Lake Erie to Lake Ontario, and carrying the discharge of all the Laurentian or Great Lakes, except Lake Ontario (see articles NIAGARA and ST LAWRENCE in the ninth edition of this work). It is navigable from its head to Chippewa, 16 miles, and from Queenston to its mouth, 6 miles. The intervening 9 miles include a series of rapids and the celebrated Falls of Niagara, where the water makes a sheer leap of 160 feet. On the right bank are Buffalo, Tonawanda, Niagara Falls, Lewiston, and Youngstown, of the state of New York; on the left bank, Chippewa, Niagara Falls, Queenston, and Niagara-on-the-Lake, of the province of Ontario. At mean stage the flow of water is 222,000 cubic feet per second, at low stage 176,000. The theoretic average

Bird's-eye Sketch of Niagara River and Gorge, from the north. *L.E.*, Lake Erie. *B*, Buffalo. *N*, Niagara Falls, N.Y. *F*, Niagara Falls, Ont. *W*, Whirlpool. *EE*, Escarpment. *L*, Lewiston. *Q*, Queenston. *D*, St Davids.

water power at the Falls equals five million horse-power, the minimum four million. Some 85,000 horse-power is already utilized, and there are extensive plans for future development. The chief part is transferred by electric methods to manufacturers and other consumers in the cities of Niagara Falls and Buffalo.

The gorge and its origin.

The river has no valley. The belt of land it crosses consists of two plains separated by a high cliff or escarpment facing towards Lake Ontario. The stream runs half its length on the upper plain, drops at the Falls into a narrow gorge through which it courses seven miles to the escarpment, and then traverses the lower plain in a deep channel. Under the lower plain are soft shales. The crest of the escarpment is a bed of limestone, nearly level, and this bed is visible in both walls of the gorge to the falls, where it is 60 feet thick. From this firm brink the cataract plunges down into a deep pool or basin hollowed from the soft shale, and the resulting agitation causes further wear of the shale and the continual undermining of the limestone, which breaks away in blocks. Thus the site of the cataract retreats up stream and the gorge is lengthened; the average rate, measured from 1842 to 1890, being between 4 and 5 feet a year. It is evident that the whole gorge has been dug out by the river, and many attempts have been made to determine the time consumed in the work.

Problem of the River's Age.—This problem is of much interest to geologists, because its solution would aid in establishing a relation between the periods and ages of geologic time and the centuries of human chronology. The great Canadian glacier, which in the Glacial period alternately crowded forward over the Great Lakes region and melted back again, so modified the face of the land by erosion and by the deposit of drift that the waters afterwards had to find new courses. The Niagara river came into existence when the waning of the glacier laid bare the western part of the Ontario basin, and the making of the gorge was then begun. If it were supposable that the lengthening of the gorge proceeded at a uniform rate, the computation of the time would be easy, but there are various modifying conditions. (1) The limestone is not equally thick all along the gorge; in one place it is 90 feet, and in several places as little as 35 feet. (2) The height of the cataract has varied from 160 feet to more than 300 feet. (3) For a short distance at the whirlpool the limestone and shale were replaced by softer material, sand, and clay. The river here touched a more ancient gorge, which had previously been concealed by drift except at the escarpment. The diagram shows the breach in the escarpment directed towards the sharp turn of the river gorge at the whirlpool. (4) The size of the river has varied. While the glacier was gradually melting the lakes underwent a complicated series of metamorphoses, and there were two separate epochs when the discharge from all the basins beyond Lake Erie followed other routes, and, during these, the Niagara drained only one-eighth of its present territory. The last mentioned is the most important of the modifying conditions, and at the same time least amenable to computation.

The parts of the gorge eroded by the full river are now marked by deep pools, the powerful cataract having dug far down into the shale. The parts eroded by the depleted river are comparatively narrow and shallow, the weaker cataract having been unable to clear away the fallen blocks of limestone. The work of the full river is illustrated by the main division of the present cataract, called the Horseshoe Fall, which wore its cliff back 220 feet in 48 years. The work of the depleted river is less adequately represented by the narrower and shallower American Fall, where 70 years of observation have discovered no change. In making two-thirds of the gorge the full river probably consumed between 5000 and 15,000 years. If the depleted river worked one-tenth as fast, the period required for the remaining third was five times as long; but the relative rate is wholly conjectural, and the ratio of one-tenth is no more plausible than one of one-hundredth. A weighing of the evidence now available indicates 25,000 years as a lower limit for plausible estimates of the age of the river, but yields no suggestion of an upper limit.

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(G. K. G.)

Niagara Falls (formerly Clifton or Suspension Bridge), a town, port of entry, and railway station of Welland county, Ontario, Canada, 40 miles south-south-east of Toronto, on the left bank of the Niagara river and opposite the falls. It is a station on the Grand Trunk, Michigan Central, and St Catharines and Niagara Central railways, and has electric railway communication with Niagara, Lewiston, and Buffalo. There are two famous bridges, viz., the Grand Trunk, the largest single-arch railway bridge extant—span 550 feet—and the road bridge, resting on the greatest steel arch in the world—840 feet span. Population (1891), 3349; (1901), 4244.

Niagara Falls, a city of Niagara county, New York, U.S.A., on the east side of the Niagara river at the falls, in the north-western part of the state, at an altitude of 571 feet. The present city was formed by the consolidation in 1892 of the former villages of Niagara Falls and Suspension Bridge. It extends along the level summit of the cliffs, from above the falls to some three miles below. The city is regularly laid out on a level site, is entered by five large railways, and is divided into four wards. The river is here crossed by three bridges, the steel arch bridge built (1897–98) on the site of the former suspension bridge near the falls, and two railway bridges about two miles farther down the river, viz., the cantilever bridge of the Michigan Central Railway and the single steel arch bridge of the Grand Trunk Railway. The first named of the three is crossed by double carriage-ways and footpaths, and by an electric tramway. Population (1890), 5502; (1892, of the present city), 12,638; (1900), 19,457.

Niam-Niam.—Former estimates of the dominant position held by the Niam-Niam, or Zandeh people, as they call themselves (*Ency. Brit.* vol. xvii. p. 473), have been more than confirmed by the researches of Junker, Casati, Bohndorff, and the Belgian and French officials in south-east Sudan. Their political ascendancy, already weakened by the incessant attacks of the Arabo-Nubian slave-hunters before the rise of the Mahdi, was no doubt broken, perhaps for ever, by the forces of the Congo Free State advancing from the Ubangi into the Welle, and thence across the Nile–Congo divide into the Bahr-el-Ghazal zeriba lands. But by these very political developments the boundaries of their ethnical domain have been greatly enlarged, and the Zandehs proper, with the kindred peoples, are now found to stretch, with interruptions, from the White Nile above the Sobat confluence to the Shari affluent of Lake Chad, and from the Bahr-el-Arab, about 10° N., nearly to the equator.

In this widespread Negroid family are now provisionally grouped the *Makarakas*, intermingled with the *Mundas*, the *Bari*, and the *Babukurs* in the north-east (Bahr-el-Ghazal); the *Krej*, *Bandas*, and *N'Sakkaras* in the north-west (Dar-Fertit, and thence to the Upper Shari); the *Bandzisi*, *Ndris*, *Togbos*, *Langwasi*, *Dakoas*, *Ngapus*, *Wia-Wias*, *Manjas*, *Awakas*, *Akungas*, and others visited by the French explorers—Crampel, Dybowski, Maister—about both slopes of the Congo–Chad water-parting. These last, who give such an enormous westward extension to the family, present much the same physical characters as the Zandehs proper, and speak dialects of the widely-diffused Ndris language, which is not Bantu, but appears to show affinities with Zandeh.

In this great division some French ethnologists are even disposed to include the Fulahs of west and central Sudan, and to substitute for the now exploded "Nuba-Fulah" a "Zandeh-Fulah" family, resulting from various secular interminglings between the true negroes and the Hamites of North Africa. Such crossings have undoubtedly been in progress since prehistoric times over an enormous area south of the Sahara (Africa: *Ethnology*), and are almost everywhere marked by certain constant characters, such as long ringletty or kinky black hair, coppery, reddish, or bronze shades of complexion, brachycephalous (round) head, often highly pronounced, and indicated outwardly by an unusually wide space between the orbits, and generally by somewhat softened negro features. But, owing to the different environments and to the different initial ratios of intermixture, the transitional forms are almost endless, so that it becomes difficult to constitute distinct ethnical groups without calling in the aid of language. Where type and speech correspond, as to a large extent is the case with most of the above-mentioned tribes, even strict systematists will be disposed to constitute separate ethnical groups, at least as working hypotheses, always allowing for the somewhat untrustworthy nature of the linguistic factor. But in the case under consideration Fulah has no kind of connexion with Zandeh speech, both forming, as far as yet known, two absolutely independent negro stock languages. Hence, at least for the present, the newly-formed Zandeh–Fulah must share the fate of Fr. Müller's Nuba–Fulah division of the Hamito-Negroid races.

Besides their speech and the above indicated physical traits, the Zandehs differ in some other respects—temperament and social usages—from the surrounding Mangbattu, Momfu, A-Barambo, A-Babua, and other Negroid peoples. The Makaraka branch especially is described by Junker as amongst the most trustworthy, industrious, and intelligent people of the Bahr-el-Ghazal, where they are very numerous in the district west of Lado. Their strength and staying-power are extraordinary, and they will carry loads of 75 ℔ poised on the head for long marches with only one or two halts during the day. They came originally from the country of the *Kibas*, north of the Welle, who are typical Niam-Niams, distinguished by their elaborate head-dresses and peculiar tattoo markings—square patterns on forehead, temples, or cheeks, an X-shaped figure in a cartouche below the chest, and various zigzag, straight, or dotted lines on the upper arm and breast. Most of the Zandeh file the incisors, the better, as they explain, to seize the foe in battle or in wrestling. From the malted grain of a species of eleusine they brew the best beer in Africa, of a sparkling brown or reddish colour, and pleasant bitter taste, derived from the stalk of the same cereal.

By tribal custom the men are all hunters; the women, who are treated with great kindness and even affection, all tillers of their fertile soil, which with little toil yields abundant crops of cereals—yams, manioc, colocasia, and Virginian tobacco (*gundli*). They are great smokers, and also passionately fond of music, gathering for hours at the concerts, at which fantastically-dressed strolling minstrels accompany their songs with stringed instruments of the guitar and mandoline types. Of the ox, horse, ass, or camel they have no knowledge, the only domestic animals being poultry, and a remarkable breed of dogs, like small wolf-hounds, with smooth red hair, twisted tail like a porker's, large ears, pointed nose, and four-clawed hind feet. These curious little "greyhounds" join in the chase with small wooden bells round the neck, and are thus soon found when lost in the woods.

At present the dismembered Zandeh empire and dependent principalities are divided up between France, which claims the "sultanates" of Rafai, Dinda, Zemio, and Tambura in the Mbomu valley, with all the peoples in Fertit and the Shari basin; the Congo State, which administers the eastern section between the Mbomu and the Upper Welle; and Great Britain, to whose share have fallen the Bari, Makarakas, and other Niam-Niam groups of the Bahr-el-Ghazal region.

See Dr W. Junker. *Travels in Africa.* English ed., vol. i., 1890.—Fr. Bohndorff. *Reisen in Central Afrika*, 1885.—G. Casati. *Ten Years in Equatoria.* English ed., 1891.

(A. H. K.)

Nicaragua, a country of Central America, lying between 10° 41′ and 15° N. and 83° 15′ and 87° 40′ W. The demarcation of the boundary towards Costa Rica was determined by arbitration under treaties of 1858 and 1896 (see Costa Rica). The climate, healthy on the uplands, is malarial on the coast and plains. The rainy season on the Pacific slope is from the middle of May to the middle of November; on the eastern coast, from June to December. The fever which prevails on the low-lying regions appears to be of a mild character, yielding to simple remedies. Observations made at San Juan (Greytown) in 1890 showed the extremes of temperature to be 89° Fahr. in September for the maximum, and 70° Fahr. in January for the minimum; the rainfall for the whole year amounted to 297 inches, the rainiest month having been July (52·5 inches), and the driest, May (4·9 inches). Earthquakes are felt at times on the Pacific slope, but in Nicaragua they are never violent, as in the neighbouring countries. The area of Nicaragua is estimated at about 49,000 square miles; the population in 1897 was 428,000. The country is for political purposes divided into twelve departments and two comarcas (or territories). The departments with their population in 1896 are given as follows:—Managua, 42,460; Masaya, 33,869; Granada, 18,938; Carazo, 18,545; Rivas, 25,883; Leon, 87,772; Chinandega, 34,614; Chontales, 40,387; Matagalpa, 29,895; Jinotega, 37 653; Nueva Segovia, 32,642; and Zelaya, 14,541. The Mosquito Reserve was, by desire of the Indian population, constituted as the department of Zelaya on 20th November 1894. The mass of the population of Nicaragua is very mixed, comprising negroes, mulattoes, *zambos*, *mestizos*, and other coloured inhabitants. The Europeans and descendants of Europeans are estimated at about 1200; the uncivilized Indians at about 30,000. The more important towns are Managua, the capital, with 27,000 inhabitants; Leon, the old capital, 45,000; Granada, 21,000; Masaya, 15,000; Chinandega, 10,000; Jinotega, 10,000; Estelí, 8500; Rivas, 6000; Bluefields, 5000; Corinto, 2500; and San Juan del Norte (Greytown), 1200. Within the republic there are altogether 110 municipalities.

Government.—Under the constitution of 11th July 1894, the Legislative Chamber consists of twenty-four members, two from each department, elected for four years by universal suffrage. The

President of the republic, chosen in a similar manner for four years, is assisted by a cabinet of five ministers, heads of Government departments. Justice is administered by a Supreme Court in two sections, one at Leon, the other at Granada, and by subordinate tribunals throughout the country.

Instruction.—Public instruction is under the care of Government, but is in a very backward condition. In 1894 there were said to be 1020 schools, with altogether 20,000 pupils. An official report of 1895, however, stated that in Leon and Granada, the most advanced of the towns, only 30 per cent. of the children were enrolled, and of these only about half learned anything, while of the whole population of school age only about 3 per cent. learned anything. There are two intermediate schools, one for boys, the other for girls, with together 51 teachers and 1441 pupils (724 boys and 717 girls). The universities for teaching law and medicine at Leon and Granada have been united. A library at Managua is supported by Government. For the year 1901 the cost of instruction was put at 491,192 pesos, or £32,740.

Defence.—Military service is obligatory. To the active army belong all citizens from eighteen to thirty-five years of age; to the reserve, those from thirty-six to forty-five; to the national guard, those from forty-six to sixty-five. The number actually serving is from 2000 to 3500. A few steamers used for police purposes are stationed on Lake Managua.

Finance.—The revenue of the republic is derived mainly from customs duties, liquor, tobacco, and slaughter taxes, railways and steamers, the postal and telegraph services, and the gunpowder monopoly. The principal spending departments are those of war and marine, internal development, and finance. The published accounts, however, present no continuous or clear view of the national receipts and disbursements. For the year 1899 the receipts amounted to 4,475,827 pesos, or (at fifteen pesos to the £) £298,388; and the expenditure to 4,577,794 pesos, or £305,186; deficit, £6798. These receipts, however, are exclusive of the proceeds of the coffee export tax mentioned below, and the expenditure is exclusive of external and various internal debt charges. For the year 1901 the revenue was estimated at £384,060, £317,480 being from taxation, and £66,580 from railways and other national services; while the expenditure was put at £383,928, of which £123,002 was for finance, £78,640 for internal development, and £66,256 for war and marine. In 1886 the republic contracted an external loan to the amount of £285,000 at 6 per cent. interest, and in 1894 the interest fell into default. In 1895 an arrangement was made for the reduction of interest, the commencement of amortization, and the creation of "coffee warrants" to be used in the payment of export duties on coffee assigned for the service of the debt. In the four years 1897-1900 the sales of these warrants amounted to 1,028,990 gold pesos, or (at 23d.) £98,610. In July 1901 the outstanding amount of the debt was £273,900. At the end of 1899 the internal debt amounted to 8,064,935 pesos, or (at fifteen to the £) £537,662.

Production.—The principal agricultural product is coffee, the yield of which increased from 4,528,300 ℔ in 1880 to 11,382,000 ℔ in 1890, 19,800,000 ℔ in 1899, and 26,400,000 ℔ in 1900. Coffee is grown principally in the Matagalpa region, on the uplands of the interior. On the Caribbean coast bananas are cultivated, and largely exported to the United States. Sugar is grown and exported in considerable quantities (1800 tons in 1901). The cocoa export is small; tobacco is grown for local use, as are also rice, beans, and other crops. Rubber is collected in the forests, and plantations have been formed from which good results are expected. The quantity of rubber exported in the year 1900 amounted to 1,097,600 ℔. Dyewoods and indigo are still shipped, but the demand for vegetable dyes has decreased. Cattle rearing is successfully pursued, live cattle and hides being important articles of export. There are about 400,000 head of cattle in the republic. In 1899 the Government sold about 52,000 acres of public land lying about 18 miles to the east of Lake Nicaragua for the purpose of colonization. The purchaser undertakes to introduce settlers from northern Europe, to import cattle for the improvement of the Nicaraguan breed, to plant rubber and vanilla trees, and to provide schools for agricultural instruction. Gold-mining is carried on in the Bluefields region, but, though the discovery of rich deposits is announced from time to time, there is no great enterprise in progress. In 1898 the gold dust and bar exports from Bluefields were of the value of £25,760; in 1899, £47,830; in 1900, £62,000.

Commerce.—The imports consist of cotton and woollen goods, wines and spirits, flour, earthenware, and provisions; the exports consist of the products already mentioned. Complete returns of the trade are not available. In 1900 the total imports amounted to the value of £703,490, and the exports to £792,203. The chief imports were cotton goods of the value of £321,000; flour, £35,000; wines and spirits, £32,000; woollen goods, £19,500; hardware, £18,300; provisions, £15,260. The chief exports were coffee, of the value of £400,000; gold and silver bullion, £74,000; rubber, £69,600; gold ore, £80,690; cattle, £45,000; mahogany, £44,000; hides, £31,500; sugar, £7343. The largest trade is with the United Kingdom, both in imports and exports; then follow, in order of value, the United States, Germany, and France. The largest and most numerous commercial firms are German, but there are also French, British, and even Chinese establishments. The immigration of Chinese is prohibited by law.

Shipping and Communications.—At Corinto, the principal port of the republic, there entered, in 1900, 200 ocean-going vessels with an aggregate tonnage of 328,622 tons. The railways, with the exception of a few short lines for local purposes, belong to the Government. Their total length in 1899 was 136 miles. The main system, connected and supplemented by steamboats on Lakes Managua and Nicaragua and the San Juan river, provides communication between Corinto on the Pacific and San Juan del Norte (Greytown) on the Atlantic. The railway is year by year extending, and several new lines are now contracted for or projected.

Nicaragua Canal.—For the construction of an interoceanic canal across Nicaragua a company obtained a concession which was ratified 15th April 1887. For the carrying out of this project the Maritime Canal Company was organized in May 1899, and incorporated by charter granted by the United States Congress. In the following year a construction company was incorporated. The proposed route of the canal begins at San Juan (Greytown), and, passing across the low coast-land to the San Juan river, follows (with the help of 3½ miles of short cuttings) the course of the river as far as Lake Nicaragua. Issuing from the west side of the lake, it passes along the valleys of the river Las Lajas and the Rio Grande to Brito, the port on the Pacific. The total length of projected waterway is 170 miles, of which 27 miles would be excavated canal. The ascent from the sea-level at each end would be made by three locks, and the summit level would have a length of 154 miles. The question whether the interoceanic canal would be constructed by this route or by the Panama route was still undecided in September 1902. (See also CANALS.)

Posts and Telegraphs.—Nicaragua joined the Postal Union in 1882. In 1896 the republic had 119 post offices; during that year 1,376,366 pieces of mail were received and 1,242,876 were delivered. The telegraph lines in 1897 had a length of 1752 miles, and were served by 83 telegraph offices.

Money and Credit.—There is one bank of issue, the London Bank of Central America, but in 1898 a concession was granted for the formation of another bank. There is, besides, an agricultural bank. The monetary unit is the silver peso, but no Nicaraguan silver pesos are coined. The current coin (of which there is little in the country) consists of Mexican and Central and South American dollars. The currency is mostly paper, notes being issued directly by the Treasury and by the bank. The outstanding Treasury notes at the beginning of 1899 amounted to 2,379,642 pesos. For their amortization there is a fund to which in 1900 the sum of 390,000 pesos, or £26,000, was paid. The notes issued by the bank must be covered to the extent of 40 per cent. by gold and silver; the actual bank reserve is stated to be from 65 to 100 per cent. of the notes issued. The metric system of weights and measures was legalized in January 1893.

History.—Few events in the recent history of Nicaragua, beyond those already noticed, require to be mentioned here. Under the administration of Chamorro, who became president in 1875, a difficulty with Germany occurred. The German Government asserted that one of its consuls had been insulted, and demanded an indemnity of $30,000 (about £2800), a demand to which Nicaragua only submitted after all her principal ports had been blockaded. The successor of President Chamorro was General Zavala, whose administration brought Nicaragua to a higher degree of prosperity than she had ever known. He was succeeded in 1883 by Dr Cárdenas, during whose presidency the attempt of General Barrios to unite the five Central American states was a cause of war between Guatemala and Honduras on one side, and Salvador, Nicaragua, and Costa Rica on the other. Cárdenas had taken command of the united Nicaraguan and Costa Rican army when Barrios died, and on 11th April 1885 a treaty of peace was signed. Don Evaristo Carazo succeeded Dr Cárdenas as president of the republic in 1887, but died when he had served a little over two years, and was succeeded by Dr Roberto Sacasa. Under Carazo's administration the boundary question between Nicaragua and Costa Rica had been settled by arbitration, the President of the United States acting as arbitrator. While Dr Sacasa was president of Nicaragua, the republics of Honduras, Salvador, and Guatemala signed a treaty, under which the United States of Central America were to be formed. The president of Nicaragua adhered to this treaty, but the National Congress refused to ratify it. President Sacasa was overthrown by a revolution in 1893, and was succeeded by a provisional government, which in its turn was deposed soon after by another uprising, at the head of which was General Zelaya. His position was regularized by the constitution of 1894, and he was re-elected president in 1898 for another term of four years. Under his government the incorporation of the Mosquito Reserve into the territory of Nicaragua took place. In 1895 occurred the Hatch incident, which led to the occupation of the port of Corinto by a British fleet. Mr Hatch, British pro-vice-consul at Bluefields, being accused of conspiracy against the Nicaraguan Government, was arrested, along with other British subjects, and expelled the country. For this action Nicaragua was required to pay an indemnity of $15,000. A serious attempt to overthrow Zelaya by force of arms was made in February 1896, but although it developed rapidly into a formidable revolution, it was crushed after several months of severe fighting. There were occasional disturbances subsequently, but none sufficient (up to September 1902) to overturn President Zelaya.

For the formation and dissolution of the Greater Republic of Central America, composed of Nicaragua, Salvador, and Honduras, see CENTRAL AMERICA.

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(W. W. R.; I. P. A. R.; C. E. A.)

Nice, capital of the department of Alpes-Maritimes, France, a winter health resort and seaport on the Mediterranean, 640 miles from Paris by rail. Its population is continually increasing, and every year fresh districts are built over. Nice now joins on the north-east the ancient episcopal town of Cimiez, in which are situated the largest and most elegantly appointed mansions (the Regina and Riviera Palace), frequented by British Royalties and rich foreigners. From east to west the town is surrounded by a girdle of beautiful towns—Carabacel, St Etienne, St Philippe, and the Beaumettes. On the east of the port lie Montboron, Riquier, and St Roch, the last partly occupied by barracks. The entrances to the port of Nice have been improved; that of the outer port is 300 feet wide, and that of the inner 220 feet. The area of the port is about 15 acres, the length of quayage available 3380 feet, the depth of water 20 feet, its trade, mostly coastal, being shared principally between French and Italian vessels, the arrivals being about 300 vessels of some 100,000 tons annually. Nice, under the command of a governor-general, is the pivot of defence of the Alpes-Maritimes; hence its girdle of forts. The French Mediterranean squadron is frequently stationed in the deep bays of Villefranche. In 1891 a monument was erected in Nice to the memory of Garibaldi, who was born here, followed in 1896 by one commemorating the union of Nice with France a century before, though the final cession did not take place till 1860 (see NICE, ninth edition of this work). The Palais de Justice was completed in 1891, the Gothic church of Notre Dame in 1890. The trade in flowers and fruit (oranges and lemons) increases in importance as the means of transit improve. In winter the railway carries them daily by the waggon-load. Population (1886), 61,484; (1896), 106,246; (1901), 125,099.

Nichol, John (1833–1894), Scottish man of letters, son of the astronomer J. P. Nichol (1804–1859), was born 8th September 1883, and educated at Glasgow and Balliol College, Oxford, where he had a brilliant career. After taking his first-class in classics, he remained at Oxford as a coach, but in 1862 he was made professor of English literature at Glasgow. He had already made a reputation as a spirited writer of both verse and prose, an acute critic, and a successful lecturer, and his influence at Glasgow was very marked. He was a frequent visitor to the United States, and in 1882 he wrote the article on American literature for the ninth edition of the *Encyclopædia Britannica*—an article which is a good example of his pungent (sometimes unduly pungent) style. He left Glasgow for London in 1889, and continued to be very active with his pen until his death on 11th October 1894, a few months after that of his wife, whom he had married in 1861. Among his best works were his drama *Hannibal* (1873), his *Byron* in the "English Men of Letters" series (1880), his *Robert Burns* (1882), and *Carlyle* (1892). A *Memoir* of Nichol, by Professor Knight, was published in 1896.

Nicholas (1841– ——), PRINCE OF MONTENEGRO AND THE BERDA, was born at the village of Niegush, the ancient home of the reigning family of Petrovitch-Niegush, on the 25th September 1841. His father, Mirko Petrovitch, a celebrated Montenegrin warrior, was elder brother to Danilo II., who left no male offspring. Since 1696, when the dignity of *vladika*, or prince-bishop, became hereditary in the Petrovitch family, the sovereign power has descended from uncle to nephew, the vladikas belonging to the order of the "black clergy" who are forbidden to marry. A change was introduced by Danilo II., who declined the episcopal office, married, and declared the principality hereditary in the direct male line. Mirko Petrovitch having resigned his claim to the throne, his son was nominated heir, and the old system of succession was thus accidentally continued. Prince Nicholas, who had been trained from infancy in martial and athletic exercises, spent a portion of his early boyhood at Trieste in the household of the Kuetitch family, to which his aunt, the Princess Darinka, wife of Danilo II., belonged. The princess was an ardent advocate of French culture, and at her suggestion the young heir of the vladikas was sent to the academy of Louis le Grand in Paris. Unlike his contemporary, King Milan of Servia, Prince Nicholas was little influenced in his tastes and habits by his Parisian education: the young mountaineer, whose keen patriotism, capability for leadership, and poetic talents early displayed themselves, showed no inclination for the pleasures of the French capital, and eagerly looked forward to returning to his native land. He was still in Paris when, in consequence of the assassination of his uncle, he was called to the throne (13th August 1860). In 1862 Montenegro was engaged in an unfortunate struggle with Turkey: the prince distinguished himself during the campaign, and on one occasion narrowly escaped with his life. In the period of peace which followed he carried out a series of military, administrative, and educational reforms. In 1867 he met the Emperor Napoleon III. at Paris, and in 1868 he undertook a journey to Russia, where he received an affectionate welcome from the Tsar, Alexander II. He afterwards visited the courts of Berlin and Vienna. His efforts to enlist the sympathies of the Russian imperial family were productive of important results for Montenegro; considerable subventions were granted by the Tsar and Tsaritsa for educational and other purposes, and supplies of arms and ammunition were sent to Cettigne. In 1871 Prince Dolgorouki arrived in Montenegro on a special mission from the Tsar, and distributed large sums of money among the people. In 1869 Prince Nicholas, whose authority was now firmly established, succeeded in preventing the impetuous mountaineers from aiding the Krivoshians in their revolt against the Austrian Government; more recently, in 1897, he checked the martial excitement caused by the outbreak of the Greco-Turkish war. In 1876 he declared war against Turkey: his military reputation was enhanced by the ensuing campaign, and still more by that of 1877–78, during which he captured Nikshitch, Antivari, and Dulcigno. The war resulted in a considerable extension of the Montenegrin frontier and the acquisition of a seaboard on the Adriatic. In 1883 Prince Nicholas visited the Sultan, with whom he has latterly maintained the most cordial relations; in 1896 he celebrated the bicentenary of the Petrovitch dynasty, and in the same year he attended the coronation of the Tsar Nicholas II., from whom in 1898 he received a gift of 30,000 rifles and 30 million cartridges; in May 1898 he visited Queen Victoria at Windsor. In 1901 he assumed the title of "Royal Highness." The descendant of a long line of warriors, gifted with a fine physique and a commanding presence, a successful military leader and a graceful poet, Prince Nicholas possesses many characteristics which awake the enthusiasm of the impressionable Servian race, while his merits as a statesman, diplomatist, administrator, and reformer have received general recognition. His system of government, which may be described as a benevolent despotism, is perhaps that which is best suited to the character of his subjects. He has done much to establish security of life and property in his dominions, to put down the vendetta and other barbarous usages, to further the progress of education, and to improve the material condition of the people. His historical dramas, poems, and ballads hold a recognized place in contemporary Slavonic literature; among them are—*Balkanska Tzaritza* and *Kniaz Arvaniti* (dramas); *Haïdana, Potini Abenserage* and *Pesnik i Vila* (poems); *Skupliene Pesme* and *Nova Kola* (miscellaneous songs). In November 1860 Prince Nicholas married Milena, daughter of the *voievode* Petar Vukotitch. Of his three sons, the eldest, Prince Danilo, married (27th July 1899) Duchess Jutta (now Militza) of Mecklenburg-Strelitz; of his six surviving daughters, Princess Militza is married to the Grand Duke Peter Nikolaievitch, Princess Stana to Duke George of Leuchtenberg, Princess Helena to King Victor Emmanuel III. of Italy, and Princess Anka to Prince Francis Joseph of Battenberg. (For the political and military history of Montenegro under Prince Nicholas see MONTENEGRO and the more recent authorities there enumerated.)

Nicholas II., EMPEROR OF RUSSIA (1868-——), eldest son and successor of Alexander III., was born at St Petersburg on the 18th of May 1868, and received the ordinary education of Russian grand dukes, under the direction of General Danilovitch, assisted by M. Pobêdonostsef and other eminent professors. Among these was an Englishman, the late Mr Charles Heath, for whom he had great respect and affection. By the death of his grandfather, Alexander II., in 1881, he became heir-apparent (Cesarevitch). Though he received, like all the heirs-apparent to the Russian throne, a certain amount of military training, his personal tastes did not lie in that direction, nor did he show any inclination for the boisterous amusements of the *jeunesse dorée* of St Petersburg. Like his father, he was nowhere happier than in the family circle, and he was particularly attached to his sister, the Grand Duchess Xenia, who was seven years younger than himself. In 1890–91 he made a tour in Greece, Egypt, India, Ceylon, and Japan, where he narrowly escaped assassination at the hands of a Japanese fanatic. On the return journey by Siberia, at Vladivostok, he turned the first sod of the eastern section of the Siberian railway, and two years afterwards (1893) he was appointed president of the imperial committee for that great undertaking. By the death of his father on 1st November 1894 he

THE TSAR NICHOLAS II.
(*From a photograph by W. and D. Downey, London.*)

became emperor, and on the 26th of that month he married Princess Alix of Hesse (a grand-daughter of Queen Victoria) to whom he had been betrothed in the presence of his father during the latter's last illness. Eighteen months later the coronation took place at Moscow with great pomp, but a gloom was thrown over the festivities by the unfortunate incident of the Khodinskoe Polye, a great open space near the city, where a popular fête had been prepared and where, from defective police arrangements, a large number of men, women, and children, roughly estimated at 2000, were crushed and trampled to death. As a rule, Nicholas II. followed in the footsteps of his father, seeking to preserve peace in foreign relations, and continuing in home affairs, though in a much milder form, the policy of centralization and Russification which had characterized the previous reign. His pacific tendencies were shown by his systematic opposition to all bellicose excitement, by his maintaining M. de Giers in the post of minister of foreign affairs, by his offering the post, on the death of that statesman, to M. de Staal, by his restraining France from dangerous adventures, by his supporting M. de Witte in his efforts to establish close commercial relations with Great Britain, and by initiating the so-called Peace Conference at The Hague. To these ought perhaps to be added the transformation of the Franco-Russian *entente cordiale* into a formal alliance, since the alliance in question might be regarded as favourable to the preservation of the *status quo* in Europe. In the internal administration he introduced by his personal influence, and without any great change in the laws, a more humane spirit towards those of his subjects who did not belong by language and tradition to the dominant nationality, and who were not members of the Eastern Orthodox Church; but he disappointed the men of liberal views by giving it to be clearly understood that he had no intention of circumscribing and weakening the autocratic power by constitutional guarantees or parliamentary institutions.

Nicholson, John (1822–1857), British colonel and brigadier-general, eldest son of Alexander Nicholson, a physician of Dublin, was born at Lisburn, Antrim, on 11th December 1822. Educated at Dungannon College, he entered the Bengal Infantry as ensign in 1839. He served in the Afghan war of 1839–42, distinguished himself in the defence of Ghazni (1842), and on its capitulation and the subsequent treachery was made a prisoner and badly treated until removed to Bamian. He escaped with the other prisoners in September 1842, on the occupation of Kabul by Sir George Pollock (medal). He served in the Sutlej campaign, and was present at the battle of Firozshah in 1845 (medal). He was then sent to Kashmir to instruct the maharaja's troops, and in 1847 was given the charge of the Sind Sagar district. On the seizure of Multan by Mulraj, Nicholson rendered great service in securing the country from Attock and in putting down rebellion. He distinguished himself at the Margalla Pass, where he was wounded. In the Punjab campaign of 1848–49 his services were invaluable in furnishing supplies and boats, and in obtaining information of the movements of the enemy, and for these and his gallantry at Chilianwala, Gujrat, and the pursuit of the Sikhs he was mentioned in despatches (medal and clasp and brevet-majority). He was appointed a deputy-commissioner of the annexed Punjab, under Sir Henry Lawrence. His frontier work was most remarkable. At Bannu, among an ignorant and bloodthirsty people, he evolved, in the course of five years, such order and respect for law that murder and highway robbery, previously rife, were unknown in the district. He so impressed his personality on the natives that he became to them a demi-god, and in Hazara a brotherhood of fakirs in 1848 instituted a religious cult for the worship of "Nikal-Seyn," which continued to flourish in spite of Nicholson's efforts to suppress it by punishment. Promoted lieutenant-colonel in 1854, he was deputy-commissioner at Peshawar when the Indian Mutiny began in 1857. He disarmed the sepoy regiment there, and pursued the Mardan mutineers to the borders of Swat. He succeeded Sir Neville Chamberlain in the command of the Punjab force, defeated the rebels at Trimmu Ghat and on the Ravi river, and joined the Delhi field force. He gained a great victory over the rebels at Najafgarh, capturing thirteen guns, and was a tower of strength during the siege and at the assault of Delhi. He led the main storming party, and, having carried the breach, fell mortally wounded in the street while leading on his men. He died a few days later, 23rd September 1857, and was buried in front of the Kashmir gate. (R. H. V.)

Nicobar Islands, a British group, consisting of twelve inhabited and seven uninhabited islands, lying in the Bay of Bengal, between Sumatra and the Andaman Islands, to which latter they are administratively appended. They have an aggregate area of about 635 square miles, Great Nicobar (*Loöng*), the largest and southernmost of any size, covering 333 square miles. Six others range in area from about 20 square miles to 62 square miles; the rest are mere islets. A careful census of the natives, taken by Mr E. H. Man in 1901, gave a total population of some 6700, at about which figure the estimates of the number of inhabitants have always stood. Car Nicobar (*Pu*), the most northerly island, with an area of 49 square miles, was by far the most densely populated, and had 3500 inhabitants, Great Nicobar containing only 450. The marine surveys of these islands are still meagre and unsatisfactory, but the whole of the Nicobars and outlying islands were surveyed topographically by the Indian Survey Department in 1886–87, when a number of maps on the scale of two inches to the mile were produced, giving an accurate coast-line. Some of the islands have mere flat, coral-covered surfaces; others, again, are hilly, the Great Nicobar rising to 2105 feet. On that island there are considerable and beautiful streams, but the others generally are badly off for fresh surface water. There is one good harbour, a magnificent land-locked shelter called Nancowry Harbour, formed by the islands of Camorta and Nancowry (both known to natives as *Nankauri*).

Geology. The Nicobars form part of a great submarine chain, of which the Andamans are a continuation. Elaborate geological reports were issued by a Danish scientific expedition in 1846 and an Austrian expedition in 1858. Dr Rink of the former found no trace of true volcanic rocks, though the chain as a whole is known for its volcanic activity, but features were not wanting to indicate considerable upheavals in the most recent periods. He considered that the islands belonged to the Tertiary age. Von Hochstetter of the Austrian expedition classified the most important formations thus: eruptive, serpentine, and gabbro; marine deposits, probably late Tertiary, consisting of sandstones, slates, clay, marls, and plastic clay; recent corals. He considered the whole group connected geologically with the great islands of the Malay Archipelago farther south. The vexed question of the presence of coal and tin in the Nicobars has so far received no decided scientific support. The white clay marls of Camorta and Nancowry have become famous as being true polycistinan marls like those of Barbados. Earthquakes of great violence were recorded in 1847 and 1881 (with tidal wave), and mild shocks were experienced in December 1899. ***Meteorology.*** It has always been held to be important to maintain a meteorological station on the Nicobars, for the purpose of supplementing the information obtained from the Andamans regarding cyclones in the Bay of Bengal. From 1869 to 1888 an observatory was properly maintained in Nancowry harbour, but after the latter year observations were recorded only in a more or less desultory way until 1897, when the station was removed to Mus in Car Nicobar. The climate is unhealthy for Europeans. The islands are exposed to both monsoons, and smooth weather is only experienced from February to April, and in October. Rain falls throughout the year, generally in sharp, heavy showers. During the five years ending 1888 the annual rainfall varied from 91 inches to 133 inches, and the number of wet days per annum from 148 to 222. The highest temperature in the shade was 98·2° F., and the lowest 64° F. ***Flora and fauna.*** Although the vegetation of the Nicobars has received much desultory attention from scientific observers, it has not been subjected to a systematic examination by the Indian Forest Department like that of the Andamans, and indeed the forests are quite inferior in economic value to those of the more northerly group; besides fruit trees—such as the cocoanut (*Cocos nucifera*), the betel-nut (*Areca catechu*), and the mellori (*Pandanus leeram*)—a thatching palm (*Nipa fruticans*) and various timber trees have some commercial value, but only one timber tree (*Myristica irya*) would be considered first-class in the Andamans. The palms of the Nicobars are, however, exceedingly graceful. Instances of the introduction of foreign economic plants are frequently mentioned in the old missionary records, and nowadays a number of familiar Asiatic fruit-trees are carefully and successfully cultivated. As with the geology and the flora, certain phases of the fauna of the islands have been extensively reported. The mammals are not numerous. In the southernmost islands are a small monkey, rats and mice, tree-shrews (*Cladobates nic.*), bats, and flying-foxes, but it is doubtful if the "wild" pig is indigenous; cattle, when introduced and left, have speedily become "wild." There are many kinds of birds, notably the megapod (*Megapodius nic.*), the edible-nest-building swift (*Collocalia nidifica*), the hackled and pied pigeons (*Calœnas nic.* and *Carpophaga bicolor*), a paroquet (*Palæornis caniceps*), and an oriole (*Oriolus macrourus*). Fowls, snipe, and teal thrive after importation or migration. Reptiles—snakes, lizards, and chameleons, crocodiles, turtles, and an enormous variant of the edible Indian crab—are numerous; butterflies and insects, the latter very troublesome, have not yet been systematically collected. The fresh-water fish are reported to be of the types found in Sumatra.

Natives. The Nicobarese may be best described as a Far Eastern race, having generally the characteristics of the less civilized tribes of the Malay Peninsula and the south-eastern portion of the Asiatic continent, and speaking varieties of the Mon-Annam group of languages, though the several dialects that prevail are mutually unintelligible. Their figure is not graceful, and, owing to their habit of dilating the lips by betel-chewing, the adults of both sexes are often repulsive in appearance. Though short according to our standards (average height, man, 5 feet 3¾ inches; woman, 5 feet), the Nicobarese are a fine, well-developed race, and live to 70 or 80 years of age. Their mental capacity is considerable, though there is a great difference between the sluggish inhabitant of Great Nicobar and the keen trader of Car Nicobar. The religion is an undisguised animism, and all their very frequent and elaborate ceremonies and festivals are aimed at exorcising and scaring spirits. It has so far proved ineradicable. Though for a very long time they were callous wreckers and pirates, and then very cruel, and though they show great want of feeling in the "devil murders"—ceremonial murders of one of themselves for grave offences against the community, which are now being gradually put down—still on the whole the Nicobarese are a quiet, inoffensive people, friendly to each other, and not quarrelsome, and by inclination friendly towards and not dangerous to foreigners. The old charge of cannibalism may be generally said to be quite untrue. Tribes can hardly be distinguished, but there are distinctions, chiefly territorial. All the differences observed in the several kinds of Nicobarese may with some confidence be referred to habitat and the physical difficulties of communication. Such government as there is, is by the village; but the village chiefs have not usually much power, though such authority as they have has always been maintained by the foreign Powers who have possessed the islands. The clothing, when not a caricature of European dress, is of the scantiest, and the waggling tags in which the loin-cloths are tied behind early gave rise to fanciful stories that the inhabitants were naked and tailed. The houses are good, and often of considerable size. The natives are skilful with their lands, and though they never cultivate cereals, exercise some care and knowledge over the cocoanut and tobacco, and have had much success with the foreign fruits and vegetables introduced by the missionaries. The staple article of trade has always been the ubiquitous cocoanut, of which it is computed that 15 million are produced annually, 10 million being taken by the people, and 5 million exported about equally from Car Nicobar and the rest of the islands. The usual cheap European goods are imported, the foreign trade being carried on with the native traders of the neighbouring Asiatic countries. There is an old-established internal trade, chiefly between the other islands and Chowra for pots (which are only made there) and racing and other canoes.

History. The situation of the Nicobars along the line of a very ancient trade route has caused them to be reported by traders and seafarers through all historical times. In the 17th century the islands began to attract the attention of missionaries. At various times France, Denmark, Austria, and Great Britain all had more or less shadowy rights to the islands, the Danes being the most persistent in their efforts to occupy the group, until in 1869 they relinquished their claims in favour of the British, who at once began to put down the piracies of the islanders, and established a penal settlement, numbering in all about 350 persons, in Nancowry harbour. The health of the convicts was always bad, though it improved with length of residence and the adoption of better sanitary measures; and an attempt to found a Chinese colony having failed in 1884 through mismanagement, the settlement was withdrawn in 1888. At present there are maintained native agencies at Nancowry Harbour and on Car Nicobar, both of which places are gazetted ports. At the latter is a Church of England mission station (the only one the missioners connected with which have not led a miserable existence) under a native Indian catechist attached to the diocese of Rangoon.

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Nicosia, the capital of Cyprus. Its earliest name was Ledra, but Leucos, son of Ptolemy Soter (280 B.C.), is said to have restored it and changed its name to Leuteon, Leucotheon, or Levcosia. One mile south-west of the town lies the very large Bronze-Age necropolis known as Hagia Paraskevi, which has been repeatedly explored with valuable results. Population in 1881, 11,536 (Moslem, 5393; Christian, 6143); in 1901, 14,752 (Moslem, 6013; Christian, 8739). The circuit of the city was reduced in 1567, under the direction of the Venetian engineer G. Savorgnano, from nine miles to three; eighty churches and a number of fine houses were sacrificed. The new walls were given a circular shape, with eleven bastions and three gates. Water is supplied by two aqueducts. Government House, the residence of the High Commissioner, the Government offices, hospital, central prison, and the new English church are without the walls. The fosse has been planted, and part of it used as an experimental garden. Carriage roads have been completed to Kyrenia, Kythraia, Famagusta, Larnaca, Limasol, and Morphou. Within the city something has been done towards widening and repairing the streets. The principal monuments of the Lusignan period are the fine cathedral church of St Sophia, an edifice of French Gothic, at once solid and elegant (the towers were never completed); the church of St Catherine, "a perfect and finished type of southern Gothic architecture of the last years of the 14th century" (both these are now mosques); and the church of St Nicolas of the English (now a grain store), built for the order of the Knights of St Thomas of Acre (Bp. Stubbs, *Lectures on Mediæval and Modern History*, Lect. viii. p. 182, Oxford, 1886). A gateway of no great importance is nearly all that remains of the palace last used by the Venetian *proveditori.* It dates from the end of the 15th century. There is a museum, with a valuable catalogue. The chief industries are tanning and hand weaving, both silk and cotton.

Nicotera, Giovanni (1828–1894), Italian patriot and politician, was born at San Biagio on 9th September 1828. Early affiliated to the Giovane Italia, he was among the combatants at Naples in May 1848, and at San Pancrazio with Garibaldi during the defence of Rome. After the fall of Rome he fled to Piedmont, where he organized the expedition of Sapri in 1857, but shortly after landing was defeated and severely wounded by the Bourbon troops. Condemned to death, but reprieved through the intervention of the British minister, he remained a prisoner at Favignana until 1860, when he joined Garibaldi at Palermo. Sent by Garibaldi to Tuscany, he attempted to invade the Papal States with a volunteer brigade, but his followers were disarmed and disbanded by Ricasoli and Cavour. In 1862 he was with Garibaldi at Aspromonte; in 1866 he commanded a volunteer brigade against Austria; in 1867 he invaded the Papal States from the south, but the defeat of Garibaldi at Mentana put an end to his enterprise. His parliamentary career dated from 1860. During the first ten years he engaged in violent opposition, but from 1870 onwards joined in supporting the military reforms of Ricotti. Upon the advent of the Left in 1876, Nicotera assumed the portfolio of the Interior, and governed with remarkable firmness. Obliged to resign in December 1877, he joined Crispi, Cairoli, Zanardelli, and Baccarini in forming the "Pentarchy" in opposition to Depretis, but only returned to power, thirteen years later, as Minister of the Interior in the Rudini cabinet of 1891. On this occasion he restored the system of uninominal constituencies, resisted the Socialist May Day agitation, and pressed, though in vain, for the adoption of drastic measures against the false bank-notes put in circulation by the Roman Bank. He fell with the Rudini cabinet in May 1892, and died at Vico Equense on 13th June 1894. (H. W. S.)

Niemes (Czech, *Mimoň*), a town in the government district of Böhmisch-Leipa, North Bohemia, Austria, on the Polzen river. There are manufactures of cloth, linen, and cotton stuffs, bentwood furniture, chemicals, and pyroligneous vinegar. Population (1890), 5598; (1900), 6024.

Nietzsche, Friedrich Wilhelm (1844–1900), German philosopher, was the son of the pastor at Röcken, near Leipzig, where he was born on 15th October 1844. He was educated at Schulpforta, and studied the classics at the universities of Bonn and Leipzig. In 1869, while still an undergraduate, he was, on F. W. Ritschl's recommendation, appointed to an extraordinary professorship of classical philology in the University of Basel, and rapidly promoted to an ordinary professorship. Here he almost immediately began a brilliant literary activity, which gradually assumed a more and more philosophical character. In 1876 eye (and brain) trouble caused him to obtain sick leave, and finally, in 1879, to be pensioned. For the next ten years he lived in various health resorts, in considerable suffering (he declares that the year contained for him 200 days of pure pain), but dashing off, at high pressure, the brilliant essays on which his fame rests. Towards the end of 1888, after recovering from an earlier attack, he was pronounced hopelessly insane, and in this condition he remained until he died on 25th August 1900. Nietzsche's writings must be understood in their relation to these circumstances of his life, and as the outcome of a violent revolt against them on the part of an intensely emotional and nervous temperament. His philosophy, consequently, is neither systematic in itself nor expounded in systematic form. It is made up of a number of points of view which successively appeared acceptable to a personality whose self-appreciation verges more and more upon the insane, and exhibits neither consecutiveness nor consistency. Its natural form is the aphorism, and to this and to its epigrammatic brilliance, vigour, and uncompromising revolt against all conventions in science and conduct it owes its persuasiveness. Revolt against the whole civilized environment in which he was brought up is the keynote of Nietzsche's literary career. His revolt against Christian faith and morals turns him into a proudly atheistic "free-thinker," and preacher of a new "master" morality, which transposes the current valuations, deposes the "Christian virtues," and incites the "over-man" ruthlessly to trample under foot the servile herd of the weak, degenerate, and poor in spirit. His revolt against the theory of State supremacy turns him into an anarchist and individualist; his revolt against modern democracy into an aristocrat. His revolt against conventional culture leads him to attack D. F. Strauss as the typical "Philistine of culture"; his revolt against the fashion of pessimism to demand a new and more robust affirmation of life, not merely *although*, but *because*, it is painful. Indeed, his very love of life may itself be regarded as an indignant revolt against the toils that were inexorably closing in around him. He directs this spirit of revolt also against the sources of his own inspiration; he turns bitterly against Wagner, whose intimate friend and enthusiastic admirer he had been, and denounces him as the musician of decadent emotionalism; he rejects his "educator" Schopenhauer's pessimism, and transforms his will to live into a "Will to Power." Nevertheless his reaction does not in this case really carry him beyond the ground of Schopenhauerian philosophy, and his own may perhaps be most truly regarded as the paradoxical development of an inverted Schopenhauerism. Other influences which may be traced in his writings are those of modern naturalism and of a somewhat misinterpreted Darwinism ("strength" is generally interpreted as physical endowment, but it has sometimes to be reluctantly acknowledged that the physically feeble, by their combination and cunning, prove stronger than the "strong"). His writings in their chronological order are as follows, those so far translated into English being marked with an asterisk:—*Die Geburt der Tragödie aus dem Geiste der Musik*, 1872; *Unzeitgemässe Betrachtungen*, 1873–76 (*Strauss—Vom Nutzen u. Nachtheil der Historie für das Leben—Schopenhauer als Erzieher—Richard Wagner in Bayreuth*); *Menschliches, Allzumenschliches*, 1876–80; *Morgenröthe*, 1881; *D. fröhliche Wissenschaft*, 1882; **Also sprach Zarathustra*, 1883–84; *Jenseits von Gut u. Böse*, 1886; **Zur Genealogie der Moral*, 1887; **Der Fall Wagner*, 1888; **Götzendämmerung*, 1888; **Nietzsche contra Wagner*, **Der Antichrist*, and **Poems* first appeared in the complete edition of his works, which also contains the notes for *Wille zur Macht*, in which Nietzsche had intended to give a more systematic account of his doctrine (1895–1901). His biography, by his sister, Elizabeth Förster-Nietzsche, is in course of publication (vol. i., 1895). (F. C. S. S.)

Nièvre, a department in the centre of France, traversed by the mountains of Morvan and watered by the Loire, the Allier, the Nièvre, and the Yonne.

Area, 2659 square miles. The population, 347,576 in 1881, had decreased to 319,506 in 1901. Births in 1899, 5921, of which 279 were illegitimate; deaths, 6473; marriages, 2380. There were in 1896, 702 schools, with 53,000 pupils, and 5 per cent. of the population was illiterate. The area under cultivation in 1896 measured 1,593,150 square miles, of which 795,340 acres were plough-land and 27,170 acres vineyards. The land in wheat in 1899 yielded the value of £1,008,000; barley, £96,000; oats, £433,000; vines, £132,000; potatoes, £304,000; mangold-wurzel, £123,000; green crops (trefoil, lucern, and sainfoin), £309,000; natural pastures and grass lands, £957,000. In 1899 there were in the department 26,230 horses, 195,369 cattle, 147,790 sheep, and 76,570 pigs. In 1898 Nièvre mined 192,000 metric tons of coal, valued at £92,000. It has also some iron mines. The arrondissement of Nevers (Decize, &c.) has important industries in metals, producing in 1898, 5800 metric tons of iron and 19,200 tons of steel, of the total value of £245,000. There is a brisk industry in pottery. Distillation produced (1899) only some 28,000 gallons of alcohol. Nevers, the capital, had 25,116 inhabitants in 1901.

Nigdeh, the chief town of a sanjak of the same name in the Konia vilayet of Asia Minor, situated on the Kaisaríeh–Karaman road. It is remarkable for the beauty of its buildings, dating from the Seljúk period. The population of 20,000 includes large Greek and small Armenian communities.

Niger, a great river of West Africa, inferior only to the Congo and Nile among the rivers of the continent. Rising within 150 miles of the sea in the outer mountainous zone of the western limb of Africa, it traverses the interior plateaux in a vast curve, flowing north-east, east, and south-east, until it finally enters the Gulf of Guinea through an immense delta. About 250 miles from its mouth it is joined by its great tributary, the Benue, coming from the east from the mountainous region of Adamawa. The source of the Niger, as fixed by the Anglo-French boundary commission in 1896, lies in 9′ 5° N. and 10′ 46° W., and the most northerly point of the great bend in about 17° N., this part of the river's course having been shifted considerably to the south as a result of recent surveys. The area of the Niger basin, excluding the arid regions with a slope towards the stream, has been calculated by Dr Bludau at 584,000 square miles.

The additions to our knowledge of the Niger during the last two decades of the 19th century were largely the work of French officers engaged in the extension of French influence throughout the western Sudan. From 1880 onwards Colonel (afterwards General) Gallieni took a leading part in the operations on the upper river, where in 1883 a small gunboat, the *Niger*, was launched for the protection of the newly-established French posts. In 1885 a first voyage was made by Captain Delanneau past the ruins of Sansandig, as far as Diafarabe, at the junction of the backwater which flows past the town of Jenne. Below Sansandig the stream was found to be split up into a number of channels, while beyond Diafarabe the banks became swampy and treeless. In 1887 the gunboat made a more extended voyage, reaching the port of Timbuktu, and correcting the mapping of the river down to that point. After the occupation of Timbuktu in 1893–94, surveys made in the surrounding region revealed the existence of a series of lakes and backwaters, chiefly on the left of the main stream, with which they are connected by channels conveying the water in one direction or the other according to the season. At high water most of these are united into one general inundation. The largest lake, Faguibini, is nearly 70 miles long, has high shores, and reaches a considerable depth. In 1894–95 attention was directed to the middle and lower Niger, to which several expeditions started from the coast of Guinea, the result being the survey of the portion of the river below Say never before visited by Europeans. Say was reached early in 1895 by Captain Decœur (French), coming from Dahomey, and by Dr Gruner (German), coming from Togoland, the latter afterwards following the course of the stream down to its mouth. In the same year Captain Toutée (French) ascended the river past the Bussa rapids (the scene of Mungo Park's death) and Say, to a point within the radius of influence of Timbuktu. During the subsequent descent the rapids at Bussa were only passed with the greatest difficulty. A still more important expedition was that of Lieutenant Hourst, who, starting from Timbuktu in January 1896, navigated the whole course of the Niger from that point to its mouth, executing a careful survey of the river and the various obstructions to navigation. These were found to occur in two principal sections—the one commencing at Ansongo, in the territory of the Kel-es-Suk Tuareg, and extending almost to Say, the other beginning below the town of Bussa. In both of these sections the river flows through several rocky passes, the current attaining a tremendous velocity. Rapids do not entirely cease until a little above Rabba. A voyage made in 1897 by Lieutenant de Chevigné showed that at low water the section between Timbuktu and Ansongo presents great difficulties, but the voyage from Timbuktu to Say was again successfully accomplished in 1899 by Captain Granderye. In 1901 Captain Leufaut ascended the river with a flotilla from its mouth to Say, experiencing great difficulties in the passage of the rapids.

The delta of the Niger, though still imperfectly known, has been partially surveyed since it became British territory by various ship captains, officials of the Royal Niger Company, and others, including Sir Harry Johnston, formerly British consul for the Oil Rivers. East of the Nun, or the main mouth of the Niger, the estuaries known as the Brass, Sombrero, New Calabar, Bonny, Opobo, &c. (with the exception, perhaps, of the first-named), seem to derive most of their water from independent streams such as the Orashi, rising in about 6° N., which is, however, linked with the Niger by the Onita creek in 5½° N. Behind the town of Okrika, some 30 miles up the Bonny river, the swampy ground gives place to firm land, partially forest-clad. West of the Nun all the estuaries up to the Forcados, and possibly the next beyond, the Escravos, seem to be true mouths of the great river, while the Benin river, though linked to the others by transverse channels, may be more properly regarded as an independent stream. In this direction the largest mouth is the Forcados, the main outlet of the Wari branch of the Niger, a noble stream with a safe and relatively deep bar. The other western mouths, most of which are still very imperfectly known, have as a rule shallow and difficult bars.

In addition to the main stream, almost the whole of the Niger basin has been made known by recent exploration. The journeys of the German traveller G. A. Krause (north from the Gold Coast, 1886–87) and the French Captain Binger (Senegal to Ivory Coast, 1887–89) first defined its southern limits by revealing the unexpected northward extension of the basins of the Guinea coast streams, especially the Volta and Komoe, a fact which explained the absence of important tributaries within the Niger bend. This was crossed for the first time, in its fullest extent, by Monteil (French) in 1890–91, but has since been traversed in all directions by French and other travellers. At the eastern end of the basin much light has been thrown on the system of the Benue, the only really important tributary, apart from the right-bank affluents of the upper Niger. The region of the Benue sources was first explored by E. R. Flegel (1882–84), who traversed the whole southern basin of the river and reached the important town of Ngaundere. Other German travellers—Zintgraff, Morgen, Uechtritz and Passarge, &c., —added to our knowledge of the southern tributaries, the Tarabba, Donga, and others, which in the rains bring down a large body of water from the highlands of southern Adamawa. British travellers who have done work in the same region are Messrs Wallace, Moseley, and Hewby. The Benue itself was ascended to 13½° E., and its tributary the Kebbi to the Bifara marshes, by Colonel (afterwards Sir Claude) Macdonald in 1889, further progress towards the Tuburi marsh, by which a connexion with the Shari system is supposed to exist, being prevented by the shallowness of the water. The upper basin of the Benue was also traversed by the French expeditions of Mizon (1892) and Maistre (1892–93), the latter passing to the south of the Tuburi marsh, without, however, definitely settling the hydrographical question connected with it. Above the Kebbi a considerable stretch of the Benue has not been visited. At this part the stream flows in a curve from the south-west, its source lying in the latter direction, in about 7° 40′ N. and 13° 15′ E. The Benue, though exceptionally free from obstruction by rapids, falls very low in the dry season, and for seven to eight months is almost useless for navigation.

Politically, the main stream of the Niger is divided between Great Britain and France, the former holding, in the protectorate of Nigeria (see below), the lower course of the river as far as a point just above Ilo, in about 11° 40′ N., and the latter the whole middle and upper course. The Benue falls within British territory up to a point three miles below the mouth of the Faro, in about 13° 8′ E., the head streams beyond that point lying within the German territory of Cameroon.

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ibid., September 1895.—MOCKLER-FERRYMAN. *Up the Niger.* London, 1892.—BINDLOSS. *In the Niger Country.* London, 1898. (E. HE.)

Nigeria, a British protectorate occupying the whole lower basin of the Niger, with adjoining territories up to Lake Chad.

History. The coast-line had long been a field of British commerce, but no British political rights were asserted anywhere in Nigeria until 1884, when the annexation of Cameroon by Germany drew the attention of the Government to the complete insecurity of British interests in those regions. Early in 1884 the first political treaties with native chiefs on the banks of the Niger were concluded by a British company which had foreseen and prepared for the coming general rush for the partition of the continent. It had been founded for this work by Captain Goldie Taubman (afterwards the Right Hon. Sir George Taubman Goldie, K.C.M.G.) as early as 1879, under the name of the United African Company. Finding its capital too small to obtain the desired royal charter, it had expanded in 1882 into the National African Company, with a capital of £1,000,000 sterling. Just before the West African Conference at Berlin in 1884, it had completed the purchase of all French interests in the basin of the lower Niger, enabling the British ambassador to declare that the British flag was alone represented in those regions. In 1886 it at last received a royal charter, which recognized the sovereign and other administrative rights it had obtained (or might obtain) by treaties with native sultans, emirs, and chiefs. Its name was then changed to "The Royal Niger Company." The total number of these political treaties exceeded 400, and covered territory extending from the Gulf of Guinea to the Sahara. Of the coast-line of Nigeria, about one-half only was within the Royal Niger Company's jurisdiction. The remaining half—at the chief ports of which treaties had been made by Consul Hewitt in 1884 for the Imperial Government—was administered by Imperial authorities, first as the "Oil Rivers Protectorate," and after May 1893 as the "Niger Coast Protectorate." After many years of struggle between the Niger Company and German agents, final recognition of British rights was obtained from Germany by the agreement of 1893, which defined the south-east frontier, running roughly north-east from the Rio del Rey to Lake Chad. An agreement with France in 1890 fixed the northern frontier of the company as a line running from Say on the Niger to Barua on Lake Chad, but left undecided the frontier west of the Niger. This was keenly contested between the Niger Company and the French colonial agents, until the agreement of 1898, which fixed the frontier on the right bank of the Niger near Ilo, the northern frontier of the company being also modified so as to give to France the left bank below Say, and also a rectangular block, including the important town of Zinder. Two small enclaves on the lower river were also assigned to France—the one on the south bank of the Forcados estuary, the other on the right bank of the Niger in about $9\frac{1}{2}°$ N. They were occupied in 1901. The sovereign rights of the Niger Company were transferred to the British Crown on 1st January 1900, and the whole territory, including the coast protectorate, became the protectorate of Nigeria, divided into a northern and southern government, each of which is administered by a high commissioner appointed by the Colonial Office. (See also CHARTERED COMPANIES.)

Physical features. Physically, Nigeria consists of a series of zones parallel to the coast-line. The swampy delta region, traversed by innumerable interlacing creeks and broad placid channels fringed with monotonous mangrove forest, gives place some 40 miles from the coast to an undulating forest-clad country, which in turn yields near the confluence of the Niger and Benue to a zone of hills, bare in parts, marking the outer margin of the interior plateau. This, which extends north with generally similar features through the remainder of British territory, broken only by the valleys of the two great rivers, does not attain an elevation approaching that of the plateaux of the southern half of the continent, the culminating point (apart from particular mountain districts), situated in about 10° N., reaching a height of 2500 feet only. The valleys of the Niger and Benue, especially the latter, are very much lower, the town of Yola on the Benue, some 750 miles from the sea, lying at an altitude of little over 600 feet. The surface is generally undulating, with isolated hills of granite and sandstone often rising abruptly from the plain. It is clothed largely with thin forest, but becomes more open to the north until the arid steppes bordering the Sahara are reached. The most mountainous districts are northern Bauchi (a little north of 10°), where heights of 6000 to 7000 feet occur; parts of Muri, along the north bank of the Benue; and the southern border of the Benue basin, where the hills (consisting of ironstone, quartz, and granite) appear rich in minerals.

The climate of the coast-lands is moist and hot, and extremely unhealthy, malarial fevers being unusually prevalent and deadly. Inland the mean temperature of the year is high, and at the time when the "harmattan" blows from the northern deserts, noon temperatures considerably over 100° Fahr. are recorded. A great part of the year (eight months in parts) is dry, the rains being limited to the late summer. Though unfavourable for the permanent residence of white men, the interior is much less deadly than the coast-lands. In the latter, as far inland as $6\frac{1}{2}°–7\frac{1}{2}°$ N., the oil-palm (*Elæis guineensis*) is the most noteworthy tree; bananas are largely grown, and, with yams, &c., form an important article of food. Rubber, with many kinds of valuable timber, occurs throughout the inland forest zone. The Benue valley and the plains of northern Nigeria are largely cultivated, producing abundance of guinea corn (millet), maize, wheat, cassava, rice, onions, cotton, indigo, peas and beans, sweet potatoes, ground nuts, &c. Various economic trees, including the shea-butter tree (*Bassia Parkii*), the locust-tree, gambier (used in tanning), tamarind, &c., are allowed to grow in the fields. The last-named supports silk-worms in large quantities, the silk being much valued.

Population. The inhabitants of Nigeria are distributed in accordance with the physical features, the forest-clad coast-lands being peopled by pure negroes, some of the tribes being given, at least in the past, to cannibalism and other revolting practices, while others are harmless and peaceable. The interior possesses a mixed population, a negro substratum having been modified by contact with the northern races of the continent, and by them converted to Islam, which forms, however, but a thin veneer. The most important race in northern Nigeria is that of the Hausas, who have been called the Parsees of West Africa for their enterprise and industry. They are keen traders, their caravans ranging from the Mediterranean to the Gulf of Guinea. They are physically well developed, capable of great endurance, and make excellent soldiers. The ruling race of the Hausa States, however, is the Fulah or Fulani, which forms a separate caste of cattle-rearers, but constitutes probably less than a sixth of the total population, the pure-blooded Hausas making up a third, while the remainder consists of slaves chiefly recruited from the pagan races to the south-east. Towns of 10,000 to 30,000 inhabitants are met with about every 50 miles in some parts, and occasional cities of 60,000 to 100,000. The total population of the Hausa States alone has been estimated at from 15 to 20 millions. The nominal sovereign of the Fulah empire is the Sultan of Sokoto, whose power has, however, much declined of late years, many of the subordinate sultans having become almost independent.

The capital is now *Wurnu*, some 25 miles north-east of *Sokoto*, the former capital, which has been abandoned for political reasons. Wurnu is a small town of 6000 inhabitants, not to be compared with the other great cities of the empire. Of these the most important is *Kano*, the great emporium of trade for the central Sudan, where Tuareg and Arab from the north meet merchants from the Niger, Lake Chad, and the far southern regions. The average daily attendance at the market has been estimated at 25,000 to 30,000. Kano produces an immense amount of cotton cloth, and is the great centre of the trade in kola nuts, which are imported from behind the Gold

Coast. Other important towns, more or less independent of the central authority, are *Katsena*, *Zaria*, *Bauchi* or *Yakoba* (population, 50,000), *Nasarawa*, *Muri*, and *Yola* on the Benue, the last the chief centre of the province of Adamawa. In the extreme east, between the Benue and Lake Chad, the state of *Belda* has acquired importance of late years under Hayatu, a Moslem propagandist of the ruling family of Sokoto. Several of the mountainous districts, especially south of the Benue, are inhabited by pagan negro tribes. Immediately east of the Niger is the semi-subordinate kingdom of *Gandu*, with the chief town of the same name, and south of it the small states of Yauri and Nupe. Nupe extends south across the Niger, between 8° and 9° N. Its capital is Bida, a large walled town of much importance as a centre of trade and of the manufacture of leather goods and glass. It was taken by the Niger Company's forces in 1897. West of the Niger lies the negro kingdom of *Borgu* (under the king of Bussa), where, however, the Fulahs have gained a footing at *Gomba*. The bulk of the inhabitants are known as Baribas. Farther south on this side Nigeria includes the northern part of the Yoruba countries, with the important town of *Ilorin*, captured by the Niger Company's forces in 1897. *Bornu*, west of Lake Chad, inhabited by the Kanuri, another mixed race, though likewise part of British Nigeria, has for some time been in an unsettled state, firstly through the invasion of the ex-slave Rabah (*q.v.*), and since 1899 through the French military operations against Rabah and his son Fadel Allah, both of whom lost their lives in battle.

Administration.

Since its transfer to the British Crown Nigeria has been divided for administrative purposes into the two governments of northern and southern Nigeria, the dividing line running east and west in about 7° 10′ N., crossing the Niger a little above Idda. Southern Nigeria thus includes an area many times larger than the old Niger Coast Protectorate. The administrative centre is at *Asaba*, above the head of the delta, which was the old civil capital of the whole territory under the Niger Company. It is the seat of the supreme court, and has various public buildings, including the central gaol. On the opposite bank of the Niger is *Onitsha*, where are both Protestant and Roman Catholic mission stations. The principal port of entry for the Niger is *Akassa*, on the main mouth of the river, which under the former régime formed part of the Company's territory. It possesses a slip for the repairing of ships and important engineering workshops. Other trading ports of importance are *Old Calabar*, *Opobo*, *Bonny*, *New Calabar*, and *Brass* to the east; and *Warri*, *Burutti*, *Sapele*, and *Benin* to the west, of the main Niger mouth. Old Calabar, known also as Duke Town (population about 40,000), lies at the head of a broad tidal estuary unconnected with the Niger system, but carrying off the water of the Old Calabar or Cross river, which rises in German territory in about 10½° E. The chief exports from all these ports are palm-oil and kernels. Rubber, ebony, cacao, and coffee also figure in small quantities among the exports from the coast region, and those of the interior which pass out by the Niger mouth include ivory, indigo, gums, camwood, and hides. The total exports of southern Nigeria were valued at £774,648 in 1898–99, and the imports (in which the principal item was cotton goods) at £732,640. The Church Missionary Society has long been active on the Lower Niger, and has stations at most of the chief centres; while two other British Protestant societies and two French Roman Catholic societies are also at work.

In northern Nigeria the chief British stations are *Lokoja* (military centre under the Royal Niger Company), *Egga*, *Rabba*, and *Bussa*, all on the Niger; and *Loko* (port of Nasarawa) and *Ibi* on the Benue, the latter the company's military headquarters on that river. Under the administration of Sir F. Lugard good progress has been made in the pacification of the country, and British influence has been established at several of the Hausa towns; while Yola, the capital of Adamawa, was taken by a force under Colonel Morland in 1901. A site for the headquarters of the Government has been chosen near the left bank of the Kaduna river, 9 miles from Wushishi, the limit of navigation, with which it has been connected by a steam tramway. The portion of the territory brought under British control had in May 1901 been formed into nine provinces, each under a Resident, while others were about to be established. Northern Nigeria, especially the Hausa States, is an unusually promising field for commercial enterprise, the principal products being indigo, gum-arabic, kola-nuts, ivory (brought from the south by caravans from the marts of Tibati and Ngaundere, and from the shores of Lake Chad), kino, hides, gutta-percha, and rice. The military force of northern Nigeria consists of about 2500 native infantry, with artillery, engineers, and other details, officered by British officers; the military force of southern Nigeria consists of about 800 native infantry, also under British officers. In 1898–99 the total revenue of southern Nigeria (then the Niger Coast Protectorate) was £169,568, and expenditure £146,752.

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Nightingale, Florence (1820–——), younger daughter of William Edward Nightingale of Embley Park, Hampshire, and Lea Hurst, Derbyshire, was born at Florence, 15th May 1820, and named after that city, but her childhood was spent in England, chiefly in Derbyshire.

FLORENCE NIGHTINGALE.
(From a photograph by the London Stereoscopic Co.)

From her earliest years her strong love of nature and animals manifested itself. Her games, too, were characteristic, for her great delight was to nurse and bandage her dolls. Her first living patient was a shepherd's dog. From tending animals she passed to human beings, and wherever there was sorrow or suffering she was sure to be found. Her most ardent desire was to use her talents for the benefit of humanity. She had a natural shrinking from society; and though her social position necessitated her presentation at Court, her first season in town was spent in examining into the working of hospitals, reformatories, and other charitable institutions. This was followed by a tour of inspection of foreign hospitals. At that time England was sadly behind-hand in matters of nursing and sanitation, and Miss Nightingale, who desired to obtain the best possible teaching for herself, went through a course of training in the Institute of Protestant Deaconesses at Kaiserswerth. She remained there six months, learning every detail of hospital management with a thoroughness rarely equalled. Miss Nightingale neglected nothing that could make her proficient in her self-chosen task. From Kaiserswerth she went to Paris, where she studied the system of nursing and management in the hospitals under the charge of the sisters of St Vincent de Paul. After her return to England she devoted herself to reorganizing the Governesses' Sanatorium in Harley Street (now the Home for Gentlewomen during Temporary Illness), which was at that time badly managed and in great need of funds. Miss Nightingale grudged neither time nor money to this work, and she had the satisfaction of placing it on a thoroughly satisfactory basis.

In the year 1854 England was stirred to its depths by the report of the sufferings of the sick and wounded in the Crimea. There was an utter absence of the commonest preparations to carry out the first and simplest demands in a place set apart to receive the sick and wounded of a large army. The condition of the large barrack-hospital at Scutari was deplorable. A Royal Commission of Inquiry was appointed, a Patriotic Fund opened, and money flowed in fast. To Miss Nightingale this proved the trumpet-call of duty. She wrote to Sidney Herbert, Secretary at War, and offered her services. Her letter crossed with one from him inviting her to proceed to the Crimea. She set out on the 24th October with a staff of thirty-seven nurses, partly volunteers, partly professionals trained in hospitals. They reached Scutari on 4th November, in time to receive the Balaclava wounded. A day or two later these were joined by 600 from Inkerman. The story of Miss Nightingale's labours at Scutari is one of the brightest pages in English annals. She gave herself, body and soul, to the work. She would stand for twenty hours at a stretch to see the wounded accommodated. She regularly took her place in the operation-room, to hearten the sufferers by her presence and sympathy, and at night she would make her solitary round of the wards, lamp in hand, stopping here and there to speak a kindly word to some patient. Soon she had 10,000 men under her charge, and the general superintendence of all the hospitals on the Bosphorus. Gradually the effects of the measures adopted were seen in a lowered death-rate. In February 1855 it was as high as 42 per cent., before many months it had sunk to 2. For a time Miss Nightingale was herself prostrated with fever, but she refused to leave her post, and remained at Scutari till Turkey was evacuated by the British in July 1856. The enthusiasm aroused in England by Miss Nightingale's labours was indescribable. A man-of-war was ordered to bring her home, and London prepared to give her a triumphant reception; but she returned quietly in a French ship, crossed to England, and escaped to her country home before the news of her return could leak out. The experiences of those terrible months permanently affected Miss Nightingale's health, but the quiet life she afterwards led was full of usefulness. With the £50,000 raised in recognition of her services she founded the Nightingale Home for training nurses at St Thomas's and King's College Hospitals. She also turned her attention to the question of army sanitary reform and army hospitals, and to the work of the Army Medical College at Chatham. In 1858 she published her *Notes on Nursing*, which gave an enormous stimulus to the study of this subject in England. According to Miss Nightingale, nursing ought to signify the proper use of fresh air, light, warmth, cleanliness, quiet, and the selection and administration of diet—all at the least expense of vital force to the patient.

Miss Nightingale followed with interest all the later improvements in sanitation, and was frequently consulted about hospital plans both at home and abroad. She has written on sanitation in India, children's hospitals, lying-in hospitals, and other cognate subjects. With the help of the County Council Technical Instruction Committee she organized in 1892 a health crusade in Buckinghamshire. Teachers were sent round among the cottagers to give practical advice on such points as ventilation, drainage, disinfectants, cleanliness, &c., a plan which, if widely carried out, would bring the most valuable knowledge to every home in England. She is understood to have drawn up a confidential report for the Government on the working of the Army Medical Corps in the Crimea, and to have been officially consulted during the American Civil War and the Franco-German war. She is the subject of a beautiful poem by Longfellow, "Santa Filomena," and the popular estimate of her character and mission was summed up in a particularly felicitous anagram, *Flit on, cheering angel.*

Nigra, Costantino (1827——), Count, Italian diplomatist and knight of the Annunziata, was born at Villa Castelnuovo in the province of Ivrea on 12th June 1827. During the war of 1848 he interrupted his studies to take up arms against Austria, and on the conclusion of peace entered the Piedmontese Foreign Office. He accompanied Victor Emmanuel and Cavour to London in 1855, and a year later was chosen by Cavour as secretary in the negotiations for the Franco-Italian alliance of 1859. During the war of that year Nigra was attached to the French headquarters, and after the peace of Villafranca was sent as minister plenipotentiary to Paris. Except for a brief period in 1860–61, when the Piedmontese occupation of the Marches and Umbria caused a breach in Franco-Italian relations, Nigra remained Italian representative in Paris until the fall of the Right in 1876. During this long period the influence possessed by him at the Imperial Court enabled him to render invaluable service to his country, especially in regard to the September Convention, the Italo-Prussian alliance against Austria in 1866, and the French expedition to Rome in 1867. During the Franco-Prussian war Nigra was of material assistance to the French imperial family, but nevertheless succeeded in maintaining, in his dealings with the Republican Government, the same influence as he had wielded under the Empire. Upon the advent of the Left in 1876, he was transferred to St Petersburg, and in 1882 to London, where he actively seconded the Anglophil policy of Mancini. Upon the fall of Mancini he was appointed ambassador at Vienna in succession to Count di Robilant, the duties of which difficult post he discharged with great tact and skill, the exceptional value of his diplomatic services being recognized even by former political opponents. In 1882 he was created count by King Humbert, and in December 1890 was appointed a member of the Italian Senate.

Nihilism may be roughly defined as the Russian form of revolutionary Socialism, which had at first an academical character, and rapidly developed into an anarchist revolutionary movement. It originated in the early years of the reign of Alexander II., and the term was first used by Turguenief in his celebrated novel, *Fathers and Children*, published in 1862. Among the students of the universities and the higher technical schools Turguenief had noticed a new and strikingly original type—young men and women in slovenly attire, who called in question and ridiculed the generally received convictions and respectable conventionalities of social life, and who talked of reorganizing society on strictly scientific principles. They reversed the traditional order of things even in trivial matters of external appearance, the males allowing the hair to grow long and the female adepts cutting it short, and adding sometimes the additional badge of blue spectacles. Their appearance, manners, and conversation were apt to shock ordinary people, but to this they were profoundly indifferent, for they had raised themselves above the level of so-called public opinion, despised Philistine respectability, and rather liked to scandalize people still under the influence of what they considered antiquated prejudices. For æsthetic culture, sentimentalism, and refinement of every kind they had a profound and undisguised contempt. Professing extreme utilitarianism and delighting in paradox, they were ready to declare that a shoemaker who distinguished himself in his craft was a greater man than a Shakespeare or a Goethe, because humanity had more need of shoes than of poetry. Thanks to Turguenief, these young persons came to be known in common parlance as "Nihilists," though they never ceased to protest against the term as a calumnious nickname. According to their own account, they were simply earnest students who desired reasonable reforms, and the peculiarities in their appearance and manner arose simply from an excusable neglect of trivialities in view of graver interests. In reality, whatever name we may apply to them, they were the extreme representatives of a curious moral awakening and an important intellectual movement among the Russian educated classes (see the article ALEXANDER II., vol. xxv. p. 258). In material and moral progress Russia had remained behind the other European nations, and the educated classes felt, after the humiliation of the Crimean war, that the reactionary régime of the Emperor Nicholas must be replaced by a series of drastic reforms. With the impulsiveness of youth and the recklessness of inexperience, the students went in this direction much farther than their elders, and their reforming zeal naturally took an academic, pseudo-scientific form. Having learned the rudiments of positivism, they conceived the idea that Russia had outlived the religious and metaphysical stages of human development, and was ready to enter on the positivist stage. She ought, therefore, to throw aside all religious and metaphysical conceptions, and to regulate her intellectual, social, and political life by the pure light of natural science. Among the antiquated institutions which had to be abolished as obstructions to real progress were religion, family life, private property, and centralized administration. Religion was to be replaced by the exact sciences, family life by free love, private property by collectivism, and centralized administration by a federation of independent communes. Such doctrines could not, of course, be preached openly under a paternal, despotic government, but the press censure had become so permeated with the prevailing spirit of enthusiastic liberalism, that they could be artfully disseminated under the disguise of literary criticism and fiction, and the public very soon learned the art of reading between the lines. The work which had perhaps the greatest influence in popularizing the doctrines was a novel called *Shto Dyelati?* (What is to be done?), written in prison by Tchernishefski, one of the academic leaders of the movement, and published with the sanction of the authorities!

Since the time of Peter the Great, Russia had been subjected to a wonderful series of administrative and social transformations, and it seemed to many people quite natural that another great transformation might be effected with the consent and co-operation of the autocratic power. The doctrines spread, therefore, with marvellous rapidity. In the winter of 1861–62 a high official wrote to a friend who had been absent from Russia for a few months: "If you returned now you would be astonished at the progress which the opposition—one might say, the revolutionary party—has made. . . . The revolutionary ideas have taken possession of all classes, all ages, all professions, and they are publicly expressed in the streets, in the barracks, and in the Government offices. I believe the police itself is carried away by them." Certainly the Government was under the influence of the prevailing enthusiasm for reform, for it liberated all the serfs, endowed them liberally with arable land, and made their democratic communal institutions independent of the landed proprietors; and it was preparing other important reforms in a similar spirit, including the extension of self-government in the rural districts and the towns, and the reorganization of the antiquated judicial system and procedure according to the modern principles adopted in western Europe.

The programme of the Government was extensive enough and liberal enough to satisfy, for the moment at least, all reasonable reformers, but the well-intentioned, self-confident young people to whom the term Nihilists was applied were not reasonable. They wanted an immediate, thorough-going transformation of the existing order of things according to the most advanced socialistic principles, and in their youthful, reckless impatience they determined to undertake the work themselves, independently of and in opposition to the Government. As they had no means of seizing the central power, they adopted the method of endeavouring to bring about the desired political, social, and economic changes by converting the masses to their views. They began, therefore, a propaganda among the working population of the towns and the rural population in the villages. The propagandists were recruited chiefly from the faculty of physical science in the universities, from the Technological Institute, and from the medical schools, and a female contingent was supplied by the midwifery classes of the Medico-Surgical Academy. Those of each locality were personally known to each other, but there was no attempt to establish among them hierarchical distinctions or discipline. Each individual had entire freedom as to the kind and means of propaganda to be employed. Some disguised themselves as artisans or ordinary labourers, and sought to convert their uneducated fellow-workmen in the industrial centres, whilst others settled in the villages as school-teachers, and endeavoured to stir up disaffection among the recently emancipated peasantry by telling them that the Tsar intended they should have all the land, and that his benevolent intentions had been frustrated by the selfish landed proprietors and the dishonest officials. Landed proprietors and officials, it was suggested, should be got rid of, and then the peasants would have arable, pastoral, and forest land in abundance, and would not require to pay any taxes. To persons of a certain education the agitators sought to prove that the general economic situation was desperate, that it was the duty of every conscientious citizen to help the people in such a dilemma, and that the first step towards the attainment of this devoutly to be wished consummation was the limitation or destruction of the uncontrolled supreme power. On the whole the agitators had very little success, and not a few of them fell into the hands of the police, several of them being denounced to the authorities by the persons in whose interest they professed to be acting; but the great majority of them were so obstinate and so ready to make any personal sacrifices, that the arrest and punishment of some of their number did not deter others from continuing the work. Between 1861 and 1864 there were no less than twenty political trials, with the result that most of the accused were condemned to imprisonment, or to compulsory residence in small provincial towns under police supervision.

The activity of the police naturally produced an ever-increasing hostility to the Government, and in 1866 this feeling took a practical form in an attempt on the part of an obscure individual called Karakozof to assassinate the emperor. The attempt failed, and the judicial inquiry proved that it was the work of merely a few individuals, but it showed the dangerous character of the movement, and it induced the authorities to take more energetic measures. For the next four years there was an apparent lull, during which only one political trial took place, but it was subsequently proved that the Nihilists during this time were by no means inactive. An energetic agitator called Netchaief organized in 1869 a secret association under the title of the Society for the Liberation of the People, and when he suspected of treachery one of the members he caused him to be assassinated. This crime led to the arrest of some members of the society, but their punishment had very little deterrent effect on the Nihilists in general, for during the next few years there was a recrudescence of the propaganda among the labouring classes. Independent circles were created and provided with secret printing-presses in many of the leading provincial towns—notably in Moscow, Nijni-Novgorod, Penza, Samara, Saratof, Kharkof, Kief, Odessa, Rostof-on-the-Don, and Taganrog; and closer relations were established with the revolutionary Socialists in western Europe, especially with the followers of Bakounine, who considered that a great popular rising should be brought about in Russia as soon as possible. Bakounine's views did not, it is true, obtain unanimous acceptance. Some of the Nihilists maintained that things were not yet ripe for a rising of the masses, that the pacific propaganda must be continued for a considerable time, and that before attempting to overthrow the existing social organization some idea should be formed as to the order of things which should take its place. The majority, however, were too impatient for action to listen to such counsels of prudence, and when they encountered opposition on the part of the Government they urged the necessity of retaliating by acts of terrorism. In a brochure issued in 1874 one of the most influential leaders (Tkatchef) explained that the object of the revolutionary party should be, not the preparation of revolution in general, but the realization of it at the earliest possible moment, that it was a mistake to attach great importance to questions of future social organization, and that all the energies of the party should be devoted to "a struggle with the Government and the established order of things, a struggle to the last drop of blood and to the last breath." In accordance with the fashionable doctrine of evolution, the reconstruction of society on the *tabula rasa* might be left, it was thought, to the spontaneous action of natural forces, or, to use a Baconian phrase, to *natura naturans*.

To this and similar declarations of irreconcilable hostility the Government replied by numerous arrests, and in the winter of 1877–78 no less than 193 agitators, selected from 2000 arrested on suspicion, were tried publicly in St Petersburg by a tribunal specially constituted for the purpose. Nearly all of them were condemned to imprisonment or exile, and the revolutionary organization in the northern provinces was thereby momentarily paralysed, but a few energetic leaders who had escaped arrest reorganized their scattered forces and began the work anew. They constituted themselves into a secret executive committee, which endeavoured to keep in touch with, and partially direct, the independent groups in the provincial towns. Though they never succeeded in creating an efficient centralized administration, they contrived to give to the movement the appearance of united action by assuming the responsibility for terrorist crimes committed by persons who were in reality not acting under their orders. During the years 1878, 1879, and 1880 these terrorist crimes were of frequent occurrence. General Trepof, prefect of St Petersburg, was shot by Vera Zasulitch under pretence of presenting a petition to him; General Mezentsof, chief of the political police, was assassinated in broad daylight in one of the principal streets of St Petersburg, and an attempt was afterwards made on the life of his successor, General Drenteln; Prince Krapotkin, governor of the province of Kharkof, was assassinated for having introduced stricter prison discipline with regard to political prisoners; a murderous attack was made on the emperor in front of the Winter Palace by an ex-student called Solovieff; repeated attempts were made to blow up the train conveying the Imperial family from the Crimea to St Petersburg; and a dynamite explosion, by which ten people were killed and thirty-four wounded, took place in the Winter Palace, the Imperial family owing their escape to the accident of not sitting down to dinner punctually at the usual hour. Assassination was used also by the agitators against confederates suspected of giving information to the police, and a number of gendarmes were murdered when effecting arrests. After each of these crimes a proclamation was issued by the executive committee explaining the motives and accepting the responsibility.

When repressive measures and the efforts of the police were found insufficient to cope with the evil, Alexander II. determined to try a new system. Count Loris Melikof was entrusted with semi-dictatorial powers, relaxed the severity of the police régime, and endeavoured to obtain the support of all loyal Liberals by holding out the prospect of a series of reforms in a liberal sense. His conciliatory methods failed signally, and were repaid by an attack on his life. A semblance of parliamentary institutions was not what the Anarchists wanted. They simply redoubled their activity, and hatched a plot for the assassination of the emperor. In March 1881 the plot was successful. Alexander II., when driving in St Petersburg, was mortally wounded by the explosion of small bombs, and died almost as soon as he had reached the Winter Palace. On the following day the executive committee issued a bombastic proclamation, in which it declared triumphantly that the Tsar had been condemned to death by a secret tribunal on 26th August 1879, and that two years of effort and painful losses had at last been crowned with success.

These facts put an end to the policy of killing Anarchism by kindness, and one of the first acts of the new reign was a manifesto in which Alexander III. announced very plainly that he had no intention of limiting the autocratic power, or making concessions of any kind to the revolutionary party. The subsequent history of the movement presents little that is interesting or original, merely a continual but gradually subsiding effort to provoke local disturbances with a view to bringing about sooner or later a general rising of the masses and the overthrow not only of the Government, but also of the existing social and economic régime. A serious manifestation on the part of the terrorists took the shape of a plot to assassinate the emperor by bombs in the streets of St Petersburg in March 1887. It was the work of a very small group, the members of which were being watched by the police, and were all arrested on the day when the crime was to be perpetrated. The movement afterwards showed occasionally signs of revival. In 1901, for example, there were troubles in the universities, and in 1902 there were serious disturbances among the peasantry in some of the central rural districts; and the assassination of M. Sipiaguine, the Minister of the Interior, was a disquieting incident; but the revolutionary aspirations no longer received sympathy and support from any large section of the educated classes. The illusions and enthusiasm which produced Nihilism in the young generation during the early years of the reign of Alexander II. had been shattered and dispelled by experience, and many of those who formerly dreamed of bringing about at once by revolutionary methods a social millenium became quiet, respectable members of society in the various spheres of ordinary practical life.

The following criminal statistics of the movement during six and a half years of its greatest activity (from 1st July 1881 to 1st January 1888) are taken from unpublished official records:—

Number of affairs examined in the police department	1500
Number of persons punished	3046

These 3046 punishments may be divided into the following categories:—

Death	20
Penal servitude	128
Exile in Siberia	681
Exile under police supervision in European Russia	1500
Lesser punishments	717
	3046

From the beginning of the movement up to 1902 the number of Anarchists condemned to death and executed was forty-eight, and the number of persons assassinated by the Anarchists was thirty-nine. There is no reason to suspect the accuracy of these statistics, for they were not intended for publication. They are taken from a confidential memorandum presented to the emperor. (D. M. W.)

Niigata, capital of the province of Echigo, Japan, with a population of 53,366, as against 46,393 in 1889. It was originally chosen as one of the five open ports —Nagasaki, Kobe, Yokohama, Niigata, and Hakodate —but it failed, chiefly owing to a bar which prevents the entry of vessels of any size. The town has been brought within the railway circuit, and it is possible that it may become important, as Echigo promises to yield large quantities of kerosene, and efforts are in progress to develop that enterprise. The foreign trade is entirely in the hands of Japanese merchants, and amounted to only £13,459 in 1899, namely, exports £12,743, and imports £716.

Nijar, a town of Spain, in the province of Almeria. It lies in a plain well watered by small streams, and fertile, that produces abundantly wheat, olives, almonds, esparto grass, and fruit. There are lead, iron, manganese, and phosphorite beds in the neighbourhood, and in the town manufactures of fine porcelain and woollen and cotton stuffs are carried on. The streets are regular, and in general contain modern houses, but there are no public buildings worth notice except the massive parish church. The population was 11,568 in 1897.

Nijni-Novgorod, a province of middle Russia, bounded on the W. by Vladimir, on the N. by Kostroma and Vyatka, on the E. by Kazañ and Simbirsk, and on the S. by Penza and Tamboff. It is intersected by the Volga and the Oka, at the junction of which the town of Nijni-Novgorod has grown up. The area of the province is 19,797 square miles. Besides the Carboniferous, Permian, and Triassic deposits ("variegated marls"), Jurassic deposits are found in patches, chiefly in the south-east, as also in the south-west and north. They are covered with Cretaceous black clays and sandstones. Thick layers of Tertiary sands, containing petrified wood, are found in the Ardatoff district, and the whole is overlain with Glacial deposits, sandy gravels, and clays.

The soil has been carefully investigated by Prof. Dokuchaeff. Black earth, known as the "black earth of the plateau," prevails on the high plains between the river valleys in the south-east; the "valley black earth," even more fertile than the former, covers the gently-sloping portions of the territory, also in the south-east. More or less sandy clays are met with elsewhere, and there are also large patches of sand. Forests cover all the territory to the north of the Volga and the Oka, as also in the west and along the Alatyr river in the south. Iron ores (brown and spherosideritic), alabaster, limestone, sand (used for glass), and phosphorites are the chief useful minerals. There are also extensive deposits of peat. The population increased from 1,376,000 in 1880 to 1,600,304 in 1897; of these 841,245 were women, and 140,347 lived in towns. The population was thus distributed in 1896:—10,875 nobles, 14,920 clergy, 6368 merchants, 53,585 artisans, 1,430,165 peasants, and 141,433 military. Of the total number 1,525,735 were Orthodox or Old Believers, 75,848 Raskolniks (Nonconformists), 1115 Catholics, 723 Protestants, 51,236 Mussulmans, and 3388 Jews. Both the birth-rate (53 in 1000) and the death-rate (42 in 1000) are high. A little over 92 per cent. of the area is available for agriculture, and of this 59 per cent. is owned by noblemen and 16 per cent. only by the peasantry, the remainder being owned by merchants and others. Of the cultivable land owned by the peasantry 55 per cent. is under crops, but of similar land owned by noblemen only 30 per cent. is cultivated. The annual average yield of the principal crops in 1894-99 was—wheat, 7,643,000 cwt.; rye, 7,871,000 cwt.; oats, 2,369,600 cwt. In some years the crops are quite insufficient for the population. The *zemstvo* of Nijni-Novgorod supports an agricultural school, an experimental farm, and an agency for the purchase of improved seeds and machinery. There is good gardening in some of the towns, but the cattle-breeding is inferior, as many as 41 per cent. of the peasant families having no horses, and 24 per cent. no cows. In 1896 there were 215,120 horses, 281,180 cattle, and 259,860 sheep in the province. The domestic trades are widely practised, 70 per cent. of the male working population among the peasants earning their livelihood in this way (122,570 persons), as well as by shipping (95,760). The last named represents a very large industry; no fewer than 9311 vessels (565,000 tons, valued at 17 million roubles) were loaded, and 8690 vessels (1,360,000 tons, 30 million roubles) unloaded in 1896. To these must be added 1800 rafts. The factories are steadily developing: iron, machinery, and crockery works, tanneries, shipbuilding yards, saw-mills, and distilleries are the chief of them, but their aggregate production is only worth £2,206,500 annually, and they employ only some 18,000 persons. Education, owing to the efforts of the *zemstvo*, is in a better condition than in many other provinces. There are 29 schools for secondary education (gymnasia, technical schools), and the total number of schools in 1895 was 1044, with an attendance of 38,104 boys and 9440 girls. A society for primary education supplies the village schools with libraries (330,000 copies distributed in ten years), and organizes lectures in the villages. The chief towns of the 11 districts into which the government is divided are: Nijni-Novgorod (95,124), Ardatoff (3538), Arzamas (10,591), Balakhna (5037), Gorbatoff (3950), Knyaghinin (2962), Lukoyanoff (2113), Makarieff (1443), Semenoff (3748), Sergach (1726), and Vasilsursk (3729). Other towns of importance are Pavlovo (7414) and Vorsma (3413), centres of cutlery manufacture, and Pochinki (9894). (P. A. K.)

Nijni-Novgorod, or simply Nijniy, capital of the above government, 276 miles by rail east of Moscow, at the confluence of the Oka with the Volga. It is a city of steadily growing importance both as a commercial centre for Russia and as an intellectual centre for east Russia. Population (1897), 95,124, increasing to nearly 200,000 during the great annual fair. Nijni-Novgorod has 14 secondary schools (gymnasia, technical and professional schools, cadet schools, &c.) and 36 primary schools, in which an aggregate of about 7000 pupils are taught; 15 libraries, mostly free, one (municipal) being of special value; several museums, historical, art, archæological, natural sciences; and a number of philanthropic institutions. The fair is still a prominent factor in the internal trade of the empire. Several buildings have been erected for the purposes of the fair—the house of the committee, with "passages" lined with shops; banks, a theatre, a circus, a new semicircular canal and a second floating bridge, underground galleries, a water-supply, an electrical tramway, temperance tea-shops and restaurants kept by the Society of Tradesmen, and so on. The value of goods brought to the fair has, however, steadily declined from 246,000,000 roubles in 1881 to 176,557,573 in 1896; but the amount of trade operations concluded at the fair greatly exceeds these figures. The total amount of business done was put at 416,000,000 roubles in 1894, of which 161,000,000 only represented the value of goods sold, while 254,000,000 was the return of four banks, excluding, however, the principal bank (the State Bank) and one private bank. It is, however, certain that the facilities offered to Siberian merchants, by the Siberian Railway, for dealing directly with Moscow, will lead to a further decrease of business at the fair.

Authorities.—Excellent guides to Nijni-Novgorod and its fair were published in connexion with the Exhibition of 1896. See also the *Pamyatnaya Knizhka* of the Government, published every year. Excellent works dealing with the province have been published by A. Gatsissky (*Nizhegorodskiy Sbornik*, 10 vols.); the Committee of Archives (*Trudy*, 16 vols.); the *Zemstvo* (*Materialy*, for the valuation of the lands; Natural History part, 14 vols.; Economical part, 6 vols.); V. Vinogradoff's *Nizhegorodskiy Kalendar*, illustrated. (P. A. K.)

Nikolaeff, a seaport and the chief naval station of Russia on the Black Sea, at the head of the estuary of the Bug, 41 miles north-west of Kherson. Its population, which was 35,000 in 1881 and 77,210 in 1891, reached 92,060 in 1897, and its importance both as an industrial centre and as a commercial port has been steadily growing. Since 1893 it has been the chief port for the Russian voluntary fleet, which transports to Vladivostok all the materials necessary for the Usuri and the Manchurian railways. Its steam flour-mills, iron and machinery works, saw-mills, soap, tobacco, vinegar, carriage and agricultural machinery works show yearly returns of approximately £4,000,000, to which the Admiralty works must be added. Every year no less than 3,000,000 tons of goods are brought by rail, and 100,000 tons by the coasting trade. The port is visited annually by an average of 160 vessels engaged in foreign trade and 750 coasting vessels. The foreign exports amount to from 1,150,000 tons, chiefly of grain (815,000 tons), flour, linseed, hempseed, and sugar (16,200 tons) to 1,450,000 tons (grain, 1,170,000 tons). The foreign imports are small (25,000 tons), and consist chiefly of coal, metals, and some machinery. Navigation is maintained during the whole winter by the aid of a powerful ice-breaker.

Nikolaistad. See Vasa.

Nikolsburg (Czech, *Mikulov*), the chief town of a government district in southern Moravia, at the foot of the Polau Mountains near the border of Upper Austria. It is best known from the preliminary treaty of peace concluded there on the 26th July 1866 between the Prussians and Austrians. The château of the Dietrichstein family contains an extensive library, with some valuable MSS. and block-books. The Heiliger Berg, in the immediate vicinity, has sixteen chapels, and a church in the Byzantine style. The principal resources of the inhabitants (in 1890, 8210; in 1900, 8091) are viticulture, the manufacture of cloth, and trade in lime and limestone.

Nile, the longest river of Africa, and second in length of all the rivers of the globe, draining a vast area in north-east Africa, from the East African lake plateau to the shores of the Mediterranean. Although probably falling short of the length of the Mississippi-Missouri (4194 miles according to the estimate of General Tillo), when the windings of the stream are taken into account the Nile is at the head of all rivers as regards the length of its basin, which extends through 35 degrees of latitude, or 2450 miles in a direct line; while measured along its major curves its course has a similar pre-eminence. The length along the minor windings has not yet been accurately determined, but a moderate estimate puts it at 4000 miles.

Area.

The area of the Nile basin is reckoned by Dr A. Bludau at 1,082,000 square miles, on the assumption, since shown to be fairly correct, that the southern branches of the Sobat extend to the neighbourhood of Lake Rudolf. This falls considerably short of the area of the Congo basin (1,425,000 square miles), the lesser extent being due to the fact that, though of so great a length, the Nile basin is reduced to a minimum width during the passage of the river across the Sahara. The limits of the basin can now be laid down with an approximation to accuracy. The most southerly extremity has been found to be south-west, not south, of Victoria Nyanza, the streams draining the steppes in the latter direction, between 3½° and 5° S., having been proved to enter an independent lake, and to form no part of the Nile basin. No streams of any importance enter the south side of Lake Victoria, and the country drained to it by temporary water-courses does not extend farther than about 3½°. Farther west, however, the southernmost feeders of the Kagera river rise as far south as 3° 50′ and 30° E. From this point northwards the western limit of the basin runs first in the close vicinity of the eastern wall of the great central rift valley, where it is formed by considerable ranges of mountains; then crossing that valley by the line of the Kirunga volcanoes, it follows the western wall of the valley to a point near the north end of Albert Nyanza. It then turns north-west, embracing the wide area watered by the Bahr-el-Ghazal and its tributaries, until about 9° N. and 23° E., whence it runs north and north-east till it approaches the Nile itself on the southern verge of the Sahara. It is a matter of uncertainty whether the Wadi Melk, which in its upper course carries down water at certain seasons from the highlands of Darfur, should be ascribed to the Nile basin or not.

East of Victoria Nyanza the limit of the Nile basin runs along the high plateaux (8000–9000 feet) west of the East African rift valley, until on reaching 1° N. it veers somewhat to the west towards Mount Elgon, which on the north-east sends its waters towards Lake Rudolf. North of Mount Elgon it probably runs between 34½° and 36° E. to 9° N., where it veers suddenly eastwards to enclose the greater part of the Abyssinian highlands. Beyond 15° N. it keeps generally near the west shore of the Red Sea, except where diverted to the west by the basin of the Khor Baraka.

The Nile basin includes a variety of zones succeeding each other from south to north, and differing in elevation, climate, and natural productions. The southernmost zone, ending in about 2°–4° N., belongs to the elevated lake plateau of eastern Africa, and here the altitude is generally over 3500 feet, while extensive areas in the east and west exceed 5000 feet. The most sudden fall northwards occurs about 2° N., and beyond 4° the central valley is generally below 1500 feet, though to the east the Abyssinian highlands form another very elevated region. It is the high lake plateau which supplies the chief volume of water to the White Nile, just as the highlands of Abyssinia are the source of the supply of the Blue Nile. Coming in part, however, from this same elevated region, the Sobat contributes an appreciable amount to the total volume of the Nile. Within the Nile basin the most rainy portions of the lake plateau (where alone a rainfall occurs comparable to that of the West African basin—60 inches and over) lie along the eastern edge of the central rift valley, and to the east and north-east of Victoria Nyanza. Through the Kagera and Semliki the former region affords the greater part of the water-supply of the great lakes, while the rainy region to the east, especially that around Mount Elgon, also helps to feed Victoria Nyanza through the Nzoia river. Elsewhere on the lake plateau and along the southern watershed of the Bahr-el-Ghazal the rainfall probably reaches 40 inches a year, gradually diminishing, however, apart from isolated districts to the north-east of a line running from Mount Elgon to the western extremity of the Bahr-el-Ghazal system.

Source and feeders.

The controversy as to the true source of the Nile has continued to engage the attention of travellers and writers, some holding that nothing but Victoria Nyanza, the gathering-ground of the rain and rivers of three-fourths of the upper basin, can be considered the source of the Nile proper, while others seek to bestow the honour on some one ultimate streamlet. If the source be considered—somewhat unscientifically, but in accordance with general usage—to signify the most remote headstream (measured by the windings of the river) there is no doubt that the distinction belongs to one of the upper branches of the Kagera. Among the feeders of Victoria

Nyanza this is by far the most important, both for length of course and volume of water carried, coming as it does from the region of greatest rainfall round Lake Victoria. Three chief branches unite to form the Kagera, and of these the most important for the volume of water carried is said to be the Nyavarongo, explored by the German traveller Dr Kandt in 1898. Its sources appear to lie in about 2° 30′ S., at an elevation of some 7000 feet, in a picturesque and bracing mountain region immediately east of the central rift valley. It first flows north to about 1° 40′ S., then turning in a sharp bend east and south, and on again reaching 2° 30′ joining the Akanyaru in a swamp or small lake in 30° 30′ E. The Akanyaru, which comes from the south-west, has been sometimes considered the larger stream, but in Dr Kandt's opinion it carries decidedly less water, while its course is shorter than that of the Nyavarongo. The combined stream retains the direction of the Akanyaru, flowing in a swampy valley and joining a little west of 31° E. the third branch of the Kagera, the Ruvuvu, coming from the south. The source of this river was placed by Baumann (1892) in about 3° S., but according to Dècle (1900) it derives its main water-supply from a range running east from the vicinity of Lake Tanganyika in about 3° 50′ S. The combined stream of the Kagera flows north and north-west in a level valley strewn with small lakes until almost 1° S., when it turns east, and finally empties itself into Victoria Nyanza just north of 1°, the mouth forming a small projecting delta. Its lower course would be navigable for small steamers. All the other feeders of Victoria Nyanza are small rivers, many carrying water at one time of the year only, the largest being probably the Nzoia, which enters on the north-east from the plateaux south of Mount Elgon.

After leaving the lake at Ripon Falls, the Nile enters a smaller lake of irregular outline, running mainly east and west in 1½° N., and known as Choga (formerly Kioja or Ibrahim). Eastwards the lake breaks up into several long arms, which appear to receive the waters of other lakes lying on the plain west of Mount Elgon. One of these, which has been named Lake Salisbury, lies in 1° 40′ N. and 34° E.; another, Mpologoma, south-south-east of the first. Lake Choga also receives a broad lacustrine river, the Seziwa, from the south, while still another lake is said to be connected with it in the north. The altitude of Choga is given as 3320 feet, so that between its western end and Albert Nyanza—a distance of 130 miles—the Nile falls over 1200 feet, chiefly during the second half of the distance, which is occupied by the Karuma Rapids and Murchison Falls. At Mruli, a little below Choga, the river is 900 yards wide, and at Foweira, at the head of the rapids, 500 yards.

Albert and Albert Edward Nyanzas, lying in the central rift valley, form the western source-reservoirs of the Nile, the latter fed mainly by streams descending the eastern slopes of the Ruwenzori range, in the rainy district of Toru. The two lakes are united by the Semliki river (known also as Isango and Itiri), which traverses the level plain—in part forested, in part swampy—between them, receiving countless streams from the western slopes of Ruwenzori. These streams are so charged with sediment that the deposits from the Semliki have filled up a large part of the south end of Lake Albert. The Semliki is a rapid stream running in a winding course between high banks of alluvium, and falling about 1000 feet in a distance of 130 miles. In its upper course the Semliki is 60 yards wide and 1½ to 3 feet deep, but at 30 miles from its mouth it has become a deep stream 100 yards wide. Besides the Semliki, Albert Nyanza has no important feeder.

Between its exit from Albert Nyanza (2100 feet above the sea) and the swamp region which begins in about 6° 20′ N., at an altitude of 1450 feet, the Nile receives no important tributary but the Asua, which joins from the east in 3° 50′ N., and even this has little water in the dry season. Its source-region, first explored by the Macdonald expedition in 1898, lies on the western versant of the Karamojo plateau, and among the mountain ranges which run off from that plateau to the north-west, the most remote head-stream running originally due south, and forming, with others, the small Lake Kirkpatrick in 2° 20′ S. and 34° E. The total length of the Asua is over 300 miles. Just below the old Egyptian fort of Bor in 6° 20′ N., an arm was found by Mr Grogan (1899) to diverge from the Bahr-el-Jebel, running more or less parallel with the latter on the eastern edge of the swamps, among which it seems to lose itself near the lower junction of the Bahr-el-Zaraf. Near the Bahr-el-Zaraf divergence a considerable stream enters from the east, but its course is unknown. Owing to the renewed obstruction of the Nile by "sudd" (*q.v.*), which, during the time that this region was closed to Europeans in 1884 by the Mahdist revolt, acquired an unusual density, the Nile water seems to have spread over an unusually large area, the channel being therefore less defined. In 1899 the Bahr-el-Jebel was totally obstructed, and only after weeks of laborious labour was navigation opened by Major Peake in May 1900. The whole channel of the White Nile was finally cleared of sudd in 1901.

Recent additions to our knowledge of the Bahr-el-Ghazal system, west of the Bahr-el-Jebel, have been mainly of the character of filling in of details respecting streams previously known. The valuable results of Dr Junker's surveys, published in Germany in 1889, still supply our most complete account of the system. Later surveys have been made by French travellers arriving from the Congo basin, especially by Major Marchand, who during his journey across the continent explored the course of the Swe or Jur, and threw light on the relationship of the Bahr-el-Homr and Bahr-el-Arab with the rest of the system. The system of the Sobat, the next important Nile tributary, was, on the contrary, first brought to light within the last decade of the 19th century by the explorations of Bottego, de Bonchamps, Michel, Wellby, Austin, and others. The most important upper branch is the Baro, which, with its many tributaries, descends the western slopes of the Abyssinian highlands, flowing in a course slightly north of west. Rising in about 36° 10′ E. and 7° 50′ N., at an altitude of 6000 to 7000 feet, the Baro has first the character of a torrent descending the plateau escarpment between rocky walls, with a drop of 3000 feet in 45 miles. Some 25 miles after reaching the plains its course becomes free from rocks, and the river is navigable to its mouth, being barred at one spot only at extreme low water. In 32° 40′ E. the Baro is joined by the Pibor or Ajubba, formed by the junction of various streams coming from the south and south-east, and having their sources on the western slopes of the Kaffa plateau. The whole region of the lower Pibor and Baro is one of swamps, almost impassable even in the dry season. At its junction with the Baro to form the Sobat the Pibor is over 100 yards wide, with a depth of 8 feet and a speed of 2·3 feet per second. The Blue Nile and the Atbara tributaries are described under ABYSSINIA.

On the main stream of the Nile the most valuable results are to be expected from the trigonometrical surveys inaugurated by Colonel Talbot. The telegraphic determination of the longitude of Omdurman (32° 29′ 42″ E.), and of other points, both on the White and Blue rivers, has supplied for the first time a trustworthy basis for the mapping of the upper river, showing that previously accepted positions require considerable shifting. On the Lower Nile a most important work is the construction of the great dam at Assuan, which will raise the level of the Nile for 140 miles above the First Cataract, and enormously increase the water-supply available for irrigation in Egypt. Schemes have been set on foot for the improvement of the White Nile channel by means of embankments, and for the storage of its water-supply, and that of the Blue Nile, in reservoirs (see Sir W. Garstin's Report, "Egypt," No. 2, 1901). A measure of scientific interest, but also of some practical importance, is the execution of a fish-survey of the waters of the Nile, chiefly due to the advocacy of the late Dr John Anderson.

Political relations.

The political relations in the Nile valley have of late years been subject to many vicissitudes. After the abandonment, in 1888, of the old Equatorial Province administered by Emin Pasha, the whole course of the river from the frontiers of Egypt to the neighbourhood of Albert Nyanza was for a time dominated by the Dervish power. After the establishment of a British protectorate in Uganda, British posts were pushed down the stream from the great lakes, while the Belgians also established themselves on the west bank in the territory leased to King Leopold in 1894 by Great Britain, from Lake Albert to 5° 30′ N. British posts exist at Mruli, Foweira, and Fajau, between Lake Choga and Albert Nyanza, and at Wadelai, Afuddu, and Fort Berkeley, between the latter lake and 50° N. Of these, Wadelai, the only healthy station in the river valley, is opposite the old Egyptian station of the same name which lay on the west bank. Afuddu lies nearly opposite the old Egyptian post of Dufile (now in Belgian territory), on a spot originally chosen by Sir S. Baker as the site of the capital of the Upper Nile province; while Fort Berkeley occupies the site of the old Bedden. The chief Belgian posts are at Old Wadelai, Dufile, Labore, Rejaf, Lado, and at Kero, on the frontier of the leased territory in 5° 30′ N. Lado, in Gordon's time the capital of the Equatorial Province, has sometimes given its name to the whole Belgian territory on the Upper Nile. For the Anglo-Egyptian stations established on the Nile above Khartum since the overthrow of the Dervish power, see SUDAN.

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Niles, a city of Trumbull county, Ohio, U.S.A., on the Mahoning river and several railway lines, in the north-eastern part of the state. Population (1890), 4289; (1900), 7468.

Nilgiris, The, or Neelgherries (=Blue Mountains), a range of hills in southern India, which gives its name to a district of the Madras Presidency. The Nilgiris are really a plateau rather than a range, rising abruptly from the plains on most sides, with a general elevation of about 6500 feet above the sea.

The district of the Nilgiris is by far the smallest in Madras. Area, 957 square miles. Population (1881), 91,034; (1891), 99,797; (1901), 111,449, showing an increase of nearly 10 per cent. between 1881 and 1891, and of 11·7 per cent. between 1891 and 1901; average density, 116 persons per square mile, being the lowest in the Presidency. Of the total population in 1891 Europeans numbered 1790, Eurasians, 1236, and native Christians, 8600. The land revenue and rates in 1897–98 were Rs.1,73,347, the incidence of assessment being 11 annas per acre; number of police, 186; boys at school (1896–97), 3402, being 40 per cent. of the male population of school-going age; girls at school, 925, being 14 per cent. Registered death-rate (1897), 25·5 per thousand. In 1897–98, out of a cultivated area of 69,956 acres, food crops covered only 26,343, while 26,520 were under coffee, 6867 under tea, and 5097 under cinchona. The Government cinchona factory turned out 5092 ℔ of quinine and 6389 ℔ of febrifuge. The export of tea from Madras in 1897–98, practically all of which came from the Nilgiris, was 3.441,840 ℔, valued at Rs.25,77,800. The approach from the plains is by the branch of the Madras Railway from Podanur to Mettupalaiyam, whence a metre-gauge line on the rack principle has been constructed to Coonoor (17 miles), which it is proposed to extend to Ootacamund. Unfortunately, this Nilgiri railway, when ready for traffic in October 1898, was damaged by a storm which caused serious landslips, and the opening has been indefinitely postponed. There are three printing-presses in the district, one of which issues an English newspaper, and a library and reading-room, with an income of Rs.7660. The chief educational institution is the Lawrence Asylum at Ootacamund, with 304 boys and 71 girls, maintained by Government at a cost of Rs.45,685. There are three breweries, with a total out-turn of 341,000 gallons. The military quarters are at Wellington.

Nilsson, Christine [Countess de Miranda] (1843——), Swedish singer, was born at Wederslöff, near Wexiö, Sweden, on 3rd August 1843. Her father was a poor working man, and she used as a girl to sing and perform on the violin at popular gatherings. In 1857 a wealthy man, M. Tornérhjelm, perceiving the unusual beauty of her voice, provided the means for giving her a proper musical education, and in 1860 she made her first appearance in opera at Paris with great success. Between that date and 1872, when she married M. Auguste Rouzaud, she was the leading prima donna. Her first appearance in London was at Her Majesty's in 1867, and she visited the United States in 1870. After her marriage she only appeared in public at rare intervals. M. Rouzaud died in 1882, and five years afterwards Madame Nilsson married Count A. de Miranda.

Nimar, a district of British India, in the Nerbudda division of the Central Provinces. The administrative headquarters are at Khandwa; but the capital in Mahommedan times was Burhanpur, and, yet earlier, the hill fort of Asirgarh.

Area, 3357 square miles. Population (1881), 231,341; (1891), 285,944; (1901), 327,042, showing an increase of 24 per cent. between 1881 and 1891, and of 14·4 per cent. between 1891 and 1901; average density, 97 persons per square mile, being little more than half of that for the province generally. The land revenue and rates are Rs.3,13,478, the incidence of assessment being R.0 : 3 : 10 per acre. The cultivated area in 1897–98 was 562,069 acres, of which 13,752 were irrigated from wells. The number of police is 437. Boys at school (1896–97), 5726, being 30 per cent. of the male population of school-going age, the highest proportion for any rural district in the province. Registered death-rate (1897), 66 per thousand. The Great Indian Peninsula Railway runs through the district for 112 miles, with six stations, and a branch of the Rajputana line from Indore joins it at Khandwa. There are seven factories for ginning and pressing cotton at Khandwa, and manufacture of gold-embroidered cloth at Burhanpur. There is one printing-press, issuing a weekly newspaper in Marathi.

Nimburg, an old town on the right bank of the Elbe, in the government district of Podiebrad, in Bohemia, Austria. It has an interesting Gothic church (1282–1305), and portions of its old wall and gates. It has a sugar-refining factory, the works of the North-Western Railway, cattle and horse fairs, and a considerable trade in corn, timber, and live stock. Population (1890), 6659; (1900), 7843.

Nimeguen, or Nijmegen, a town of the Netherlands, province Gelderland, on the south bank of the Waal, 11 miles by rail south of Arnhem. Like this town and Cleves (17 miles by rail to the south-east), it is very pleasantly situated amongst wooded hills. The former town walls were taken down and the site converted into a boulevard in 1877–84, and since then a new quarter has grown up on the south. In addition to the Valkhof, there are now three other parks—the Huner Park on the east, near the Valkhof; the Emperor Charles's Plain, in the new quarter; and Kronenburg Park on the west. The town-hall has been restored, also the town weigh-house and meat market. An iron bridge has been thrown across from the Valkhof Park to the Belvedere, at the eastern extremity of the old town. Berg en Dal, about 3 miles to the south-east, is a favourite summer resort. Pale ale, Prussian blue, leather, tin, pottery, and cigars are the principal industrial products. About 75 per cent. of the inhabitants are Roman Catholics. Population (1900), 42,756.

Nîmes, or Nismes, chief town of department of Gard, France, 450 miles south-south-east of Paris by rail. It is the seat of a Calvinist consistory, and has a Protestant normal school for females, schools of design, music, manufactures, chemistry and physics as applied to the arts, and a school of artillery. Since 1894 the museums and the public library (80,000 volumes) have been installed in the old Jesuit College, formerly occupied by the lycée, to which an elegant façade adorned with statues of Painting and Music by Max Raphael was added in 1894. The collection of paintings occupies a separate building. Population (1881), 55,828; (1891), 63,625; (1901), 72,479.

Ningpo, a treaty port in the province of Chekiang, China. It is simply a local distributing centre subordinate to Shanghai, from which it is 100 miles distant, and the volume of trade shows little tendency to grow. The population is estimated at 255,000. The foreign residents are very few. There are, however, a great number of missionaries engaged in various parts in the interior of the province (Chekiang). The Church Missionary Society, the China Inland Mission, and the American Baptist and Presbyterian Societies are most strongly represented. The value of the trade passing through the custom house in 1900 was H. taels 15,414,191 (£2,312,000), as compared with H. taels 12,384,000 (£3,405,000) in 1880. Cotton and tea are the principal exports, and opium, shirtings, and sugar the chief imports.

Niort, chief town of the department of Deux-Sèvres, France, 258 miles south-west of Paris, and an important railway junction. The prefecture was rebuilt in 1893; the school of design is installed in a handsome new structure, and behind it is the library, containing 45,000 volumes, while the museum of antiquities is now lodged in the Elénore Palace. Population (1891), 20,082; (1901), 20,738.

Nipigon, Neepigon, or Nepigon, a lake of Thunder Bay district, Ontario, Canada, situated 30 miles north of the bay of the same name on Lake Superior, at an altitude of 850 feet above the sea. It is 70 miles long and 50 miles wide; contains over 1000 islands, is very deep, and has a much-indented shore-line measuring upwards of 580 miles. The Nipigon river, which discharges its waters, is the largest stream flowing into Lake Superior. It affords the finest trout-fishing in North America.

Nipissing, a lake of the district of the same name in Ontario, Canada, situated nearly midway between Lake Huron and the Ottawa river, at an altitude of 642 feet above the sea. It is 50 miles long; greatest breadth, 35 miles; discharges its waters by French river into Lake Huron, and is separated from the waters of Mattawa river by a low watershed. It has been proposed as the summit level of the projected Ottawa and Georgian Bay canal. With the Ottawa, Mattawa, and French, it formed the old *voyageur* route from Montreal to the Great Lakes.

Nish (written generally *Nisch*), after Belgrade the most important town of the kingdom of Servia, situated in a plain on the left shore of the Nishava, a tributary of the Morava. It is of great strategical and commercial importance, lying at the junction of several of the most important roads of the Balkan Peninsula. The great international railway lines, Vienna–Belgrade–Constantinople and Vienna–Belgrade–Salonica, bifurcate at Nish. There is a project to connect the Rumanian railways with the Servian through the Timok valley to Nish, and it is also intended to carry the line which is to connect the Adriatic with the centre of the peninsula to Nish, through the Toplitza valley. The town has a small obsolete fortress on the right bank of the Nishava, believed to have been erected on the site of the ancient Roman castle Naissus. The surrounding hills (Vinik, Goritza, Kamenitza) have, since 1886, been fortified by modern earthworks. Since it has ceased to be Turkish, Nish has made much progress, and is becoming a modern European town. The king and the Government reside for at least three months in the year in Nish, where also the National Assembly, before the new constitution of 1901, was regularly held. It is the see of a bishop, the seat of the district prefecture and a tribunal, and the headquarters of the territorial militia corps, having besides a large number of regular troops in garrison. The administration of the Servian railways has its principal store of material there, and also a factory for repairing engines. On the whole, Nish, with its population of 21,600 (1895), is one of the most prosperous towns in Servia. It is known also for the many picturesque and interesting places in its immediate neighbourhood (Yelashnitza, Sityevo, Mramor).

The ancient Roman city Naissus was mentioned as an already important place by Ptolemy of Alexandria. Under its walls was fought in A.D. 269 the great battle in which Emperor Claudius destroyed the army of the Goths. It was at Naissus that Constantine the Great was born. Though the Emperor Julian improved its defences, the town was destroyed by the Huns under Attila, but the Emperor Justinian did his best to restore it. In the 9th century the Bulgarians became masters of Naissus, but had to cede it to the Hungarians in the 11th century, from whom the Byzantine Emperor Emmanuel reconquered it in 1173. Towards the end of the 12th century the town was in the hands of the Servian Prince Stephen Nemanya, who there received hospitably the German Emperor Frederic Barbarossa and his Crusaders. In 1375 the Turks captured Naissus for the first time from the Servians. In 1443 the allied armies of the Hungarians under Hunyadi, and the Servians under George Brankovich, retook it from the Turks, but in 1456 it again came under Turkish dominion, and remained for more than 300 years the most important Turkish military station on the road between Hungary and Constantinople. In the frequent wars between Austria and Turkey during the 17th and 18th centuries the Austrians captured Naissus twice (in 1689 and 1737), but were not able to retain it long. The Servians having, in the beginning of the 19th century, successfully cleared Servia of Turks, were emboldened to attack Nish in 1809, but were repulsed with great loss. One of the Servian commanders, Singyelich, died a heroic death on that occasion by blowing up the gunpowder stores of the redoubt of which he found himself the only defender. The Turks raised a gruesome monument of their victory—a high tower composed entirely of the heads of the Servians slain in the battle of Nish. The remnants of this monument are still kept up. It stands half a mile to the east from Nish, and is called to this day by the Turkish name "Tyele-Koula," "the Tower of Skulls." In the Russo-Turkish war the Servian army, under the personal command of King Milan, besieged Nish, and forced it to capitulate on the 10th January 1878. The Berlin Congress decided that it should remain with Servia. (C. MI.)

Nishápúr, a province of Persia, situated between Mashad and Sabzvár, in northern Khorassan. It has a population of from 130,000 to 140,000, is divided into twelve districts, and pays a yearly revenue of about £12,000. It produces much grain and cotton, and is considered one of the most fertile districts of Persia. One of its subdivisions is that of Bár-i-Mâdan, with chief town Mâdan (situated 32 miles north-west of the city of Nishápúr, at an elevation of 5100 feet, in 36° 28′ N., 58° 20′ E.), where the famous mines are which have supplied the world with turquoises for at least 2000 years. (For description of mines, *vide* A. Houtum-Schindler, *Turquoise Mines of Nishápúr*, Diplomatic and Consular Reports, part ii., 1884.) The province used to be one of the administrative divisions of Khorassan, but is now a separate province, with a governor appointed by the Shah.

Nishápúr, the capital of the above province, situated at an elevation of 3920 feet, in 36° 12′ N. and 58° 40′ E., about 49 miles west of Mashad. It was once one of the four great cities of Khorassan, rivalling Rai (Rhages), "the mother of cities," in importance and population, but is now a small and comparatively unimportant place, with a population of barely 15,000. It has post and telegraph offices, and does a lively trade in wool, cotton, and dry fruits (almonds, pistachios). Eastwards of the present city, amongst the mounds and remains of the old town, in a ruined mosque, is the tomb of Omar Khayyám, who was also born here—an unsightly mass of plaster, without inscription.

Niué (Savage Island), or NIUÉ-FEKAI, as the natives prefer to call it, an island 14 miles long by 10 miles wide, situated in 19° 10′ S. and 169° 47′ W., in the South Pacific. The entire island is an old coral reef upheaved 200 feet, honeycombed with caves and seamed with fissures. The soil, though thin, is, as in other limestone islands, very rich, and cocoanuts, tara, yams, and bananas thrive. There is an abundant rainfall, but owing to the porous nature of the soil the water percolates into deep caves which have communication with the sea, and becomes brackish. The natives, a branch of the Malayo-Polynesians, with what seems to be an admixture of Micronesian blood, are the most industrious in the Pacific, and about 500 of the young men are generally absent as labourers in other islands. The consequent minority of men has been very destructive to the sexual morality of the women, which formerly stood high. The natives are keen traders, and though uncouth in manners when compared with their nearest neighbours, the Tongans and Samoans, are very friendly to Europeans. Their hostility to Captain Cook, which earned for them the name of "Savage Islanders," was due to their fear of foreign disease, a fear that has since been justified. The population, about 4400, is slightly decreasing. The natives are all Christians, and the majority have learned to read and write, and to speak a little English, under the tuition of the London Missionary Society. They wear European clothes. The island became a British protectorate on 20th April 1900, and was made a dependency of New Zealand in October 1900, the native government, of an elected "king" and a council of headmen, being maintained for the present. In 1900 there were thirteen Europeans on the island. The exports are copra (£6000), fungus (8 tons), and straw hats, which the women plait very cleverly.

HOOD. *Notes of a Cruise in H.M.S. "Fawn."* Edinburgh, 1863.—THOMSON. *Savage Island.* London, 1902. (B. H. T.)

Nivelles, a town of Belgium, in the province of Brabant, 19 miles south of Brussels. Vegetable parchment is one of the numerous manufactures of the arrondissement, and the railway workshops employ large numbers of men. Population (1890), 10,642; (1900), 11,645.

Nizhneudinsk, a growing district town of East Siberia, government of, and 351 miles by rail west-north-west of Irkutsk, on the Siberian Railway, and on the Uda river. It is a centre for the Biryusa gold mines, and in winter the head of a line of communication with the Lena and Bratskiy Ostrog. Population (1896), 6016.

Noakhali, a town and district of British India, in the Chittagong division of Bengal. The town, also known as Sudharam, is on a small river channel 10 miles from the sea. Population (1881), 5124; (1891), 5479. The high school had 269 pupils in 1897–98.

The district of NOAKHALI has an area of 1645 square miles. Population (1881), 820,772; (1891), 1,009,693; (1901), 1,141,817, showing an increase of 23 per cent. after the storm-wave, and of 13 per cent. between 1891 and 1901. Average density, 695 persons per square mile. Classified according to religion, Mahommedans in 1891 numbered 760,929; Hindus, 248,123; Christians, 641, of whom 10 were Europeans. The land revenue and rates in 1897–98 were Rs.7,27,354; number of police, 281; boys at school (1896–97), 39,764, being 51 per cent. of the male population of school-going age, compared with 28 per cent. for the province generally. Registered death-rate (1897), 37 per thousand. Besides rice, an important crop is areca-nut. A portion of the district is traversed by the railway from Chittagong towards Assam.

Nobel, Alfred (1833–1896), Swedish chemist and engineer, was born in 1833 at Stockholm. After studying at St Petersburg, he began to assist in the conduct of his father's engineering works, but it was not long before he took up the study of explosives. Previously to 1864 many attempts had been made to utilize nitro-glycerine as an explosive for practical purposes, but little success was attained until that year, when Nobel took out his patent for dynamite. He found that by incorporating nitro-glycerine with some porous substance, such as powdered charcoal or silica (usually kieselguhr), he obtained it in an altered condition, such that it ceased to be sensitive to shocks and could even be burned in a fire without explosion. He next combined nitro-glycerine with another high explosive, nitro-cotton, into a form that could be safely employed for blasting. Taking about 8 parts of the latter, he dissolved them by the aid of moderate heat in 92 of nitro-glycerine, and thus obtained a transparent, jelly-like substance that was a still more powerful explosive than dynamite. Blasting gelatin, as it was called, was patented in 1875, and was followed by a host of similar combinations, prepared in much the same way, but modified by the addition of nitrate of potash, wood-pulp, and various other substances. Some thirteen years later Nobel produced ballistite, one of the earliest of the nitro-glycerine smokeless powders, which contained in its latest forms about equal parts of gun-cotton and nitro-glycerine. This powder was a precursor of cordite, and Nobel's claim that his patent covered the latter was the occasion of vigorously-contested law-suits between him and the British Government in 1894 and 1895. Cordite also consists of nitro-glycerine and gun-cotton, but the form of the latter which its inventors wished to use was the most highly nitrated variety, which is not soluble in mixtures of ether and alcohol, whereas Nobel contemplated using a less nitrated form, which is soluble in such mixtures. The question was complicated by the fact that it is in practice impossible to prepare either of these two forms without admixture of the other, but eventually the courts decided against him, having come to the conclusion that he meant to employ the soluble variety, not the insoluble one, the method of using the latter being indeed not known at the date of his patent. From the manufacture of dynamite and other explosives, which were produced on a very large scale at the Nobel works at Ardeer, Ayrshire, and from the exploitation of the Baku oil-fields, in the development of which he and his brothers took a leading part, he amassed an immense fortune; and at his death, which occurred on 10th December 1896, at San Remo, he left the bulk of it in trust for the establishment of five prizes, to be awarded annually without distinction of nationality. The first three of these prizes are for the most important discovery or invention in physical science, in chemistry, and in medical science or physiology; the fourth is for the most remarkable literary work *dans le sens d'idéalisme*; and the fifth is to be given to the person who renders the greatest service to the cause of international brotherhood, in the suppression or reduction of standing armies, or in the establishment or furtherance of peace congresses.

Noble, Sir Andrew (1832–——), British physicist and artillerist, was born at Greenock on 15th September 1832, and was educated at Edinburgh Academy and at the Royal Military Academy, Woolwich. In 1849 he entered the Royal Artillery, attaining the rank of captain in 1855, and in 1857 he became secretary to the Royal Artillery Institution. About this time the question of the supersession of the old smooth-bores by rifled guns was coming to the fore, and on the appointment of the Select Committee on Rifled Cannon in 1858 to report on the matter, he was chosen its secretary, a capacity in which he devised an ingenious method for comparing the probable accuracy of the shooting attainable with each type of gun. In 1859 he was appointed Assistant-Inspector of Artillery, and in the following year he became a member of the Ordnance Select Committee and of the Committee on Explosives, serving on the latter for twenty years, until its dissolution. About the same time he was prevailed upon by Sir William, afterwards Lord, Armstrong, to leave the public service and take up a post at Elswick, where beyond doubt the facilities offered for experimental research enabled him to do more for his country in the way of improving guns and munitions of war than would have been possible under the cramping regulations of an official department. At Elswick, in the first instance, he was put in charge of the ordnance department, but it was not long before his organizing and administrative ability and scientific attainments enlarged the sphere of his influence, and he has probably done more than any other single man to develop Elswick to the commanding position it now enjoys among the arsenals of the world. Immediately on his appointment he began a systematic investigation of the phenomena which occur when a gun is fired, some of his first experiments being designed to discover with accuracy the pressures attained in the largest guns of that time. About 1862 he invented his chronoscope for the measurement of exceedingly small intervals of time, and began to apply it in ballistic experiments for ascertaining the velocity with which the shot moves along the barrel of a gun with different powders and different charges. Then he joined Sir Frederick Abel in a classical research on "Fired Gunpowder," the experimental work being largely carried on at Elswick, and the conclusions they arrived at had a great effect on the progress of gunnery, for they showed how increased muzzle velocities were to be attained without increased pressures in the gun. These inquiries, in fact, enabled Elswick in 1877 to turn out the

6-inch and 8-inch guns, with velocities of over 2000 feet per second, that obliged the British Government finally to give up the antiquated muzzle-loaders to which it had so obstinately adhered. Later, when the era of nitro or "smokeless" powders had begun, Captain Noble was an early advocate of their advantages, and when at length the British Government awoke to the necessity of selecting a powder of that character for the naval and military services of Great Britain, Elswick extended its hospitality to the committee that invented cordite, and gave the members facilities, which were not offered by the Government, for the necessary experimental work. Even after the powder was invented and the committee dissolved, inquiries—which it was nobody's official business to make, and which therefore were not made—were continued at Elswick to ascertain how by suitable modifications in form, composition, &c., cordite might the better perform the varied duties required of it. Noble became a member of the committee appointed in 1900 by Lord Lansdowne to consider, among other things, the excessive erosion alleged by some of the powder's critics to be produced by it in the barrels of the guns in which it is used. He was made C.B. in 1881, promoted to be K.C.B. in 1893, and was created a baronet among the Coronation honours in 1902; he was also the recipient of many foreign decorations and scientific honours, including a Royal medal from the Royal Society in 1880.

Noblesville, a city of Indiana, U.S.A., capital of Hamilton county, on the White river and the Chicago and South-Eastern and the Lake Erie and Western railways, in the central part of the state, at an altitude of 772 feet. It is in a rich agricultural region, and has natural gas. Population (1890), 3054; (1900), 4792.

Nocera Umbria, a town and bishop's see of the province of Perugia, Umbria, Italy, 12 miles by rail north by east of Foligno. It has mineral springs (known since 1510), with a hydropathic, situated 1969 feet above sea-level, on the west slope of Mount Pennino. There are a cathedral and other churches, in one of which good frescoes, dated 1434, were discovered in 1877. Cement is quarried. The town is the ancient Umbrian *Nuceria*. Population, about 5000.

Nogent-le-Rotrou, chief town of arrondissement, department of Eure-et-Loir, 38 miles west-south-west of Chartres by rail. It is of great antiquarian interest, and in the early part of the 17th century the overlordship was acquired by Sully, Henri Quatre's great minister of finance. There are statues of him and his wife, of General St Pol, killed at Sebastopol, and of the poet Remy-Belleau, a native of the town (1897); also, a departmental school for deaf mutes. An important industry is the manufacture of hats, employing about 700 persons. Population (1891), 6934; (1901), 7620.

Nogent-sur-Marne, a town in the arrondissement of Sceaux, department of Seine, France, 5 miles east of Paris on the railway to Belfort, which here crosses the Marne valley by a magnificent viaduct of 34 arches, at a height of 100 feet, and with a total length of 870 yards. A belfry dates from the 11th century, with 12th-century spire. A monument was erected in 1865 to Watteau, who died here in 1721. A large town hall was completed in 1884. The principal manufactures are chemicals and toys. The commune of Perreux was detached from Nogent in 1887. Total port traffic on the Marne, 1900, 24,123 tons. Population (1881), 7596; (1891), 8047; (1901), 10,391.

Nöldeke, Theodor (1836-——), German Orientalist, was born at Harburg on 2nd March 1836, and studied at Göttingen, Vienna, Leyden, and Berlin. In 1859 his history of the Koran won for him the prize of the French Académie des Inscriptions, and in the following year he rewrote it in German and published it with additions at Göttingen. In 1861 he began to lecture at this university, and three years later was appointed assistant professor there. In 1868 he became regular professor at Kiel, and in 1872 was appointed to the chair of Oriental languages at Strasburg. His range of studies is wide and varied, but in the main his work has followed the two lines already indicated by his prize essay, *i.e.*, Semitic languages, and the history and civilization of Islam. The Semitic religion he regards as simple, not favourable to a complicated mythology, and at the same time violent, exclusive, and fanatical. Professor Nöldeke is a prolific writer, and while a great deal of his work (*e.g.*, his *Neusyrische Grammatik*, his *Mandäische Grammatik*, and his translations from Tabarî) is meant for specialists, many of his books are of interest to the general reader as well. Several of his essays first appeared in the *Encyclopædia Britannica*, and the article on the Koran (MOHAMMEDANISM, *Ency. Brit.* vol. xvi.), with some others, was republished in a volume called *Oriental Sketches*. The articles dealing with Persia were republished in a German volume, *Aufsätze zur persischen Geschichte*. Among his best-known works are: *Das Leben Mohammeds*, *Beiträge zur Kenntnis der Poesie der alten Araber*, *Die alttestamentliche Litteratur*, *Untersuchungen zur Kritik des alten Testaments*. He has been a frequent contributor to the *Zeitschrift der deutsch-morgenländischen Gesellschaft*, the *Göttinger Gelehrtenanzeiger*, and the *Expositor*.

Norcia, a town and bishop's see of the province of Perugia, Umbria, Italy, 29 miles north-east of Terni, on the south-west foot-slopes of the Sibylline Mountains, still surrounded by old walls. There are a cathedral; the church of St Benedict, with a Romanesque façade; the town hall; and the prefecture, with Romanesque arcades. Norcia (the ancient *Nursia*) was the birthplace of Sertorius (slain 72 B.C.), of Vespasia, mother of the Emperor Vespasian, of Plotina, the wife of the Emperor Trajan, and of St Benedict, founder of the Benedictine order, and of his sister Scholastica. The town is famous for its pork and its cloth, and makes bricks and terra-cotta. Population (1899), about 5000.

Nord, a department of the farthest north-east of France, washed by the North Sea and bordering on Belgium.

Area, 2229 square miles. The population, 1,603,259 in 1881, had increased to 1,877,647 in 1901. In respect of population, therefore, Nord stands second among the departments of France. Births in 1899, 51,466, of which 6128 were illegitimate; deaths, 37,158; marriages, 15,858. In 1896 there were 2001 schools, with 292,000 pupils, more than 6 per cent. of the population being illiterate. The area under cultivation in 1896 measured 1,296,750 acres; 839,800 acres arable, 24,700 acres in gardens, 419,900 acres in woods and grass. One of the greatest wheat-growing departments, Nord produced in 1899 wheat valued at £2,122,000; rye, £100,000; barley, £118,000; oats, £948,000; potatoes, £544,000; mangold-wurzel, £244,000; flax, in harl and in seed, £45,000; tobacco, £44,000; hops, £72,000. In the production of beetroot Nord holds the first rank among the departments, producing in 1899 £1,420,000 worth. Its live stock in 1899 included 81,800 horses, 286,540 cattle, 84,200 sheep, 82,920 pigs, and 15,910 goats. The milk produced in 1899 was valued at £3,000,200. The industries dependent on agriculture have made enormous strides. The manufacture of sugar amounted in 1898 to 3,110,000 cwts., and the alcohol produced in 1898 was 18,100,000 gallons. Mining in 1898 produced 5,500,000 metric tons of fuel, valued at £2,120,000 sterling, while the industry in metals yielded 294,000 metric tons of cast-iron, 295,000 tons of iron, and 204,000 tons of steel, which, with the industries in other metals added, represented a value of £4,080,000. The textile industry is particularly active around Lille, Roubaix, and Tourcoing, which spin and weave cotton and wool, as also around Fourmies, which is specially a weaving town.

The cotton industry is carried on by 3000 looms and 1,300,000 spindles, distributed among 170 establishments. The woollen industry disposes of 20,000 looms and 1,760,000 spindles among 300 factories. Nord possesses one-seventh of the total steam-power of France. The chief towns of this department are Lille, with 215,431 inhabitants in 1901; Roubaix, 124,660; Tourcoing, 79,468; Cambrai, 26,586; Douai, 33,918; and Dunkerque, 40,329.

Norden, a town of Prussia, province of Hanover, 4 miles from the North Sea, and 20 by rail north of Emden. It has a 16th-century town hall, and its parish church was built in 1445. There are various industries—gin, sugar, chocolate, yeast, tobacco, and machinery; also a school of agriculture. Norddeich, a small port 4 miles to the north-west, is the shipping place for passengers bound for Norderney. Population (1900), 7048.

Nordenskiöld, Nils Adolf Erik, Baron (1832–1901), geographer and Arctic explorer, was the son of Nils Gustav Nordenskiöld, and was born at Helsingfors, 18th November 1832. His ancestors came originally from Sweden, but for several generations had been settled in Finland, where several members of the family were distinguished by their enthusiasm for scientific research. His father was both an able mineralogist and a considerable traveller, and to his influence may be ascribed that early devotion to geological investigation which laid the basis of Baron Nordenskiöld's career. After a few years at the gymnasium of Borgo, young Nordenskiöld entered the University of Helsingfors in 1849, where he applied himself specially to chemistry and mineralogy by spending his holidays in personal investigations of the chief mineral deposits in Finland. In 1853 he accompanied his father to the Ural Mountains, and studied with particular interest the iron and copper mines at Tagilsk. On his return to Helsingfors he received minor appointments both at the university and the mining office, but an unguarded speech at a convivial entertainment in November 1855 drew attention to his political views, and led to dismissal from his posts. He then visited Berlin, continuing his mineralogical studies, and returned to Helsingfors in 1856, where he obtained the Alexander travelling stipend at the university, and proposed to expend it in studying the geology of Siberia and Kamchatka. But before starting he took his master's and doctor's degrees at the promotion festival in 1857, and again, as in 1855, aroused the suspicion of the authorities during the entertainments to the deputation from Upsala and Lund. Russian officials, always jealous in all that regarded Swedish influence in Finland, again took the matter seriously, and this time Nordenskiöld's departure for Sweden was accompanied by deprivation of the right of ever holding office in the University of Helsingfors. Settling at Stockholm in 1857, he thenceforward became practically a Swedish citizen, for until 1862 he was refused permission even to visit Finland, and his friends had much difficulty in preventing a decree of permanent exile. The far north always had a great fascination for Nordenskiöld, and he had been only a few months in Stockholm when he met Otto Torell the geologist, who was making preparations for his first expedition to Spitsbergen, and offered to take Nordenskiöld with him. The result was most satisfactory, for to the remarkable observations of Torell on glacial phenomena Nordenskiöld added the valuable discovery at Bell Sound of remains of Tertiary plants, which has led to such important conclusions respecting the climates of those regions in former epochs. In 1861 Nordenskiöld took part in Torell's second Spitsbergen expedition, which yielded even more important results as regards the geological history of the islands. Its main object, however, was to take steps for the measurement of an arc of the meridian, and when a further expedition to the same quarter was promoted by the Swedish Academy in 1864, Nordenskiöld accepted the post of leader in the place of Dr Chydenius. But on this occasion the attempt to reach a high northern latitude was frustrated by the necessity of rescuing a party of shipwrecked walrus-hunters. Three years later, however, chiefly through the support of the Swedish Government and Mr Oscar Dickson, who contributed so largely towards the later expeditions of 1872 and 1875, Nordenskiöld headed a well-organized expedition in the *Sofia*, and reached the highest northern latitude attained up to that date in the eastern hemisphere. Arctic exploration had now become his all-absorbing object, and in 1870, with three young naturalists, he visited the vast inland ice-sheet of Greenland. His next expedition in 1872 did not answer expectation, for the tenders were caught in the ice, and the crews of the three vessels were forced to winter in Spitsbergen. In 1875–76, however, a successful voyage eastwards, including the ascent of the Yenisei, led Nordenskiöld to attempt the exploration of the "North-East passage." This led to the celebrated voyage of the *Vega*, in which Nordenskiöld navigated for the first time the northern coasts of Europe and Asia. Starting from Karlskrona on 22nd June 1878, the *Vega* doubled Cape Cheluiskin in the following August, and, after being frozen in at the end of September near Bering Strait, completed the voyage successfully in the following summer. This brought him conspicuously before the world, and, even if the discovery of the long-sought North-East passage has but little direct value, the indirect and scientific results are very far-reaching. The monumental record edited by Nordenskiöld, in five closely printed octavos, throws a flood of light on the past and present conditions of life on the north coast of Siberia, while the more popular account in two volumes, written by Nordenskiöld himself, is a model of lucid description and a perfect summary of the history of the subject. On his return to Sweden Nordenskiöld received a most enthusiastic welcome, and in April 1880 was made a baron and a commander of the Nordstjerne Order. In 1883 he again visited the east coast of Greenland, and succeeded in taking his ship through the great ice barrier, a feat that had been attempted in vain during upwards of three centuries. In addition to his heroic work as an explorer, Baron Nordenskiöld made a notable reputation in the field of historical geography by his monumental publications, the *Facsimile Atlas*, 1889, and the *Periplus*, 1897. The former contains reproductions of the most important geographical documents printed during the 15th and 16th centuries, and the latter, a work of far greater research, deals with the history of early cartography and the sailing charts in use among mariners during the Middle Ages. Baron Nordenskiöld died at Stockholm on the 12th of August 1901. (G. F. B.)

Norderney, an island of Prussia, province of Hanover, off the north coast of East Friesland. It is one of the most popular seaside resorts in all Germany, the summer visitors reaching the total of 24,000 annually. The village is situated at the western extremity of the island, and near it are a military convalescent home and the Empress Frederick's Children's Home. In 1898 the island was cleared by 2806 vessels of 213,340 tons. Norderney is immortalized by its association with Heine's *Nordseebilder*. Population (1900), 4018.

Nordhausen, a town of Prussia, province of Saxony, 60 miles by rail west of Halle. It possesses a museum of antiquities. In the corn market is a fountain by Rietschel (1825), and in the market-place another to Luther (1888). Population (1885), 27,083; (1900), 28,500.

Norfolk, an eastern county of England, bounded on the N. and E. by the North Sea, on the S. by Suffolk, and on the W. by Lincolnshire and Cambridgeshire.

Area and Population.—In 1901 the area of the ancient (geographical) county was 1,308,440 acres, and the population numbered 454,516 in 1891 and 460,040 in 1901, showing an increase of 9767 between 1881 and 1891, or at the rate of 2·2 per cent. during the ten years, and of 5524, or at the rate of 1·2, between 1891 and 1901, as compared with an increase at the rate of 1·4 per cent. during the ten years 1871–81. The 1901 returns give 0·35 persons to an acre, and 2·84 acres to a person. In 1891 the area of the registration county was 1,291,170 acres, and the population 460,362, of whom 221,688 were males and 238,674 females, and in 1901, 467,614. Particulars of birth-rate, death-rate, and the number of persons married per thousand inhabitants, as well as the illegitimacy-rate per thousand births, are given in the following table:—

	1871–80.	1881–90.	1889–98.	1899.
Birth-rate . .	30·8	30·7	28·1	26·9
Death-rate . .	19·8	18·3	17·4	16·6
Marriage-rate .	14·5	13·7	13·6	14·6
Illegitimacy-rate .	84	63	66	61

In 1891 the county contained 952 persons born in Scotland, 1152 born in Ireland, and 619 foreigners. At the same time there were 448 blind persons, 226 deaf and dumb, and 1856 insane.

Government, &c.—For parliamentary purposes the ancient county is divided into six divisions (North-Western, South-Western, Northern, Eastern, Mid, and Southern), and also includes the parliamentary boroughs of King's Lynn and Norwich, and part of the parliamentary borough of Great Yarmouth; each returning one member, except the city of Norwich, which returns two members. The administrative county includes the municipal boroughs of King's Lynn and Thetford. Norwich and Great Yarmouth form county and municipal boroughs. There are two courts of quarter sessions, and 25 petty sessional divisions. Each of the four municipal boroughs has a separate commission of the peace and a separate court of quarter sessions. The administrative county contains 692, the county borough of Norwich 1, and the county borough of Great Yarmouth 2, entire civil parishes; there are also 3 civil parishes which are partly in other administrative counties, and one which is partly in the administrative county of Norfolk and partly in the county borough of Great Yarmouth. The ancient county contains 595 entire ecclesiastical parishes and districts, and parts of 13 others. It is situated partly in the dioceses of Ely, Lincoln, and Norwich.

Education.—At Norwich there are the Norwich and Ely Diocesan Training College for Schoolmistresses (founded in 1853, the building dating from 1892) and an institution for the blind, and there are a deaf school and a blind school at Great Yarmouth. On 31st August 1900 there were in the county 501 elementary schools, of which 156 were board schools and 345 voluntary schools, the latter including 331 National Church of England schools, 4 Roman Catholic, and 10 British and other. The average attendance during the year was 47,686, out of a total of 57,682 on the register. The total receipts of the board schools during the year were £127,259, of which £4763 were earnings under the Agricultural Rates Act, and £385 earnings under the Technical Instruction Act.

Agriculture.—For the ten years following 1885 there was a general tendency towards an increase in the areas of pasture land and of meadows, but the latter decreased again after 1895. In 1889 a total of 882,432 acres were farmed by tenants and 212,698 acres by the owners, the corresponding figures in 1895 being 890,773 and 186,840 acres, and in 1900, 896,933 and 170,424 acres.

The following table shows the areas under the different kinds of crops at the periods named:—

Year.	Area in Cultivation.	Area under Corn Crops.	Area under Green Crops.	Area of Bare Fallow.	Area under Permanent Grass.
1880	1,083,737	444,476	202,992	11,002	...
1885	1,090,967	438,252	207,295	10,977	271,717
1890	1,093,395	427,039	195,951	13,392	286,651
1895	1,077,613	404,289	191,378	11,480	296,959
1900	1,067,357	409,632	195,950	6,177	289,189

The next table shows the numbers of the live stock at the periods named:—

Year.	Cows and Heifers.	Other Cattle.	Total Cattle.	Horses.	Sheep.	Pigs.
1880	27,937	80,341	108,278	63,840	638,791	85,483
1890	32,457	104,558	137,015	64,481	595,014	105,007
1900	35,635	98,892	134,527	66,602	547,245	100,712

Industries.—The total number of persons employed in factories and workshops in the county during the year 1897 was 29,997, of whom 9111 were employed in the clothing industries, 3593 in the making of machinery, implements, tools, &c., 3286 in the preparation of food, 2221 in the paper and printing trades, 1801 in the manufacture of silk, 1732 in brewing, &c., and 1655 in the wood industries.

The *Norfolk Broads*, which have attracted the attention of tourists, lie within a triangle which has for its angular points Happisburgh (on the coast), Norwich, and Lowestoft. They consist of shallow lakes or marshes, mostly fringed with reeds, and frequently of a picturesque appearance, and abound in fish and waterfowl. For the most part they belong to the lower basins of the rivers Bure, Yare, and Wavency, which converge upon Yarmouth. In the Bure basin are Wroxham, Hoveton, Hickling, Horsey, Martham, Heigham, Ormesby, Filby, Barton, Somerton, and Whitelsea; in the Yare basin, Rockland and Surlingham; and in the Waveney basin, Oulton.

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(J. T. BE.)

Norfolk, a city of Madison county, Nebraska, U.S.A., on the Elkhorn river and the Fremont, Elkhorn, and Missouri Valley, the Union Pacific, and the Chicago, St Paul, Minneapolis and Omaha railways, in the north-eastern part of the state, at an altitude of 1523 feet. It is a railway centre of some importance, and a distributing point for a large region of fertile farming country. Population (1880), 547; (1890), 3038; (1900), 3883, of whom 622 were foreign-born.

Norfolk, a city and seaport of Norfolk county, Virginia, U.S.A., on Norfolk Harbour, at the mouth of the Elizabeth river, in the south-eastern part of the state. Its site is level, it is divided into six wards, and its plan is irregular. It has an excellent water-supply and thorough sewerage, but its streets are ill-paved. It has a good harbour, accessible to vessels of great draught, and it has considerable export trade, consisting mainly of bread-stuffs, cotton, and lard. For the year ending 30th June 1901 the exports (including those of the smaller adjacent city of Portsmouth) amounted to $10,308,489. Regular steamship lines connect the city with New York, Boston, and southern ports. In 1900 it had 445 manufacturing establishments, with a total capital of $6,425,099, an average number of 4334 hands, and products valued at $9,397,355. The industries were varied, consisting of the roasting and grinding of coffee and the grinding of spice, and the production of clothing, fertilizers, flour, foundry and machine-shop products, and hosiery and knitted goods, the coffee and spice industry being of the most importance. The assessed valuation of real and personal property in 1900, on a basis of about three-fourths of the full value, was $26,175,980, the net debt $4,177,305, and the rate of taxation $22 per $1000. Population (1890), 34,871; (1900), 46,624—1705 foreign-born and 20,230 negroes.

Norfolk Island, in the Pacific Ocean, about 800 miles east of New South Wales, containing 8528 acres, of which about one-fourth remains unalienated. The fertility of the island is very great. Oranges, grapes, passion fruit, figs, pine-apples, and other fruits grow abundantly; while potatoes, onions, maize, and arrowroot can be largely produced. The inhabitants, however, have by no means made use of their opportunities. Since its constitution as a separate settlement in 1856 its condition has gone from bad to worse. The administration of justice in the hands of an elected magistrate was unsatisfactory. Crime was rarely punished, and debts were not recoverable. A lack of energy was everywhere apparent. Owing to intermarrying there has been steady deterioration of the race. The population was, in 1895, 882. The total trade barely exceeds £5500 annually. An attempt has been made to remedy matters by an improvement in the government. Although not actually annexed to New South Wales, the island is now more directly under the jurisdiction of the Governor of New South Wales, who has the power of legislation until the New South Wales legislature provides otherwise. A chief magistrate, appointed by the Governor, has taken the place of the elected magistrate, and an elected council of elders, consisting of twelve members, has superseded the general gathering of the adult population.

Parliamentary Paper C. 8358, *Correspondence relating to the Transfer of Norfolk Island to the Government of New South Wales*, 1897. (H. E. Eg.)

Norman, Sir Henry Wylie (1826——), English field-marshal and colonial governor, was born 2nd December 1826, and entered the army at the age of seventeen, his first appointment being to the 31st Native Infantry. Until 1840 the Norman family was entirely unconnected with India. In that year Sir Henry's father, who had been for many years a merchant in Cuba, became a partner in a mercantile house in Calcutta, where he was joined by his son in 1842. In 1844 the latter obtained a cadetship, and so began his career without social or professional influence to help him. Young Norman went through the second Sikh campaign with the 31st Native Infantry, and having attracted the favourable notice of Sir Colin Campbell, was selected by him to accompany an expedition against the Kohat Pass Afridis in 1850 as officiating brigade-major. The subaltern of twenty-four was given a substantive appointment in this capacity for a splendid deed of gallantry, which is recorded by Sir Charles Napier in the following terms: "In the pass of Kohat a sepoy picket, descending a precipitous mountain under fire and the rolling of large stones, had some men killed and wounded. Four of the latter, dreadfully hurt, crept under some rocks for shelter. They were not missed until the picket reached the bottom, but were then discovered by our glasses, high up and helpless. Fortunately the enemy did not see them, and some sepoys volunteered a rescue, headed by Norman of the 31st Native Infantry and Ensign Murray of the 70th Native Infantry. These brave men—would that the names of all were known to me for record!—ascended the rocks in defiance of the enemy, and brought the wounded men down." Norman served in numerous frontier expeditions between 1850 and 1854, and in the suppression of the Sonthal rebellion of 1855–56. In the Mutiny campaign he was constantly engaged, being present at the siege of Delhi, the relief of Lucknow, and a number of other affairs. Altogether he was mentioned twenty-five times in despatches. He afterwards became assistant military secretary for Indian affairs at the Horse Guards, military secretary to the Government of India, military member of the Viceroy's Council, and member of the Secretary of State for India's Council. It is generally understood that the Indian Staff Corps owed its origin to Sir Henry Norman, several members of whose family have won distinction in it. In 1883 Sir Henry began his colonial career as Governor of Jamaica, an appointment from which he was transferred in 1888 to the governorship of Queensland. Here he remained until 1895, when he came home to act as Agent-General for the colony in London. In 1893 he was offered the Viceroyalty of India, but, after first accepting, declined it. In 1897 he was chairman of the Royal Commission of Inquiry into the condition of the West Indies, a position for which his experience in Jamaica eminently fitted him. In April 1901 he was appointed Governor of the Royal Hospital, Chelsea, in succession to Field-marshal Sir Donald Stewart. In 1902 he was made a field-marshal.

Norristown, a borough of Pennsylvania, U.S.A., capital of Montgomery county, on the Schuylkill river, 16 miles from Philadelphia, in the south-eastern part of the state. It has a fairly regular plan, with ten wards, and a good water-supply from Schuylkill river. It has three railways, the Pennsylvania, the Philadelphia and Reading, and the Stony Creek. Though a residential suburb of Philadelphia, it has considerable manufactures, the products of which in 1900 were valued at $4,821,745, and consisted of cotton and woollen goods, carpets, hosiery and knitted goods, flour, iron and steel goods, &c. Population (1890), 19,791; (1900), 22,265, of whom 3048 were foreign-born and 728 negroes.

Norrköping, a town and port in the province of Östergötland, Sweden, on the river Motala, just before it enters Bråvik, an inlet of the Baltic, 113 miles south-west of Stockholm by the main line to Malmö. The falls in the river afford motive power to the cloth and cotton mills (spinning and weaving)—the staple industries—and to factories for sugar, paper, lithography, tobacco, and carpets, joinery works, and breweries. There are also shipbuilding yards and docks. Fine granite is quarried at Grafversfors, 7½ miles to the north. The inlet of Bråvik affords excellent harbour accommodation, there being from 33 feet to 17½ feet of water below the bridges in the town. In 1896 the port was entered and cleared by 4972 vessels of 605,137 tons. The chief new building is St Matthew's church (1892). Population (1880), 26,735; (1890), 32,826; (1900), 41,008.

Norrland, the most northerly of the three territorial divisions of Sweden, embraces the counties of Norrbotten, Vesterbotten, Vesternorrland, Jämtland, and Gefleborg, that is to say, the river basins of the Torneå, Kalix, Luleå, Piteå, Skellefteå, Umeå, Ångerman, and Indal, corresponding to the old districts of Gestrikland, Helsingland, Medelpad, Ångermanland, Herjeådal, Jämtland, Vesterbotten, and Lappmark. Its area is 98,771 square miles, or 57·8 per cent. of the whole area of Sweden. In 1900, however, notwithstanding the very rapid increase of the population, Norrland had only 16·6 per cent. of the total population of the kingdom. Population (1880), 628,742; (1890), 743,704; (1900), 860,254.

North Adams, a city of Berkshire county, Massachusetts, U.S.A., at the junction of the north and south branches of the Hoosac river, and the Fitchburg (at the western terminus of the Hoosac Tunnel) and the Boston and Albany railways, in the north-western part of the state, at an altitude of 704 feet. The village of North Adams, the principal population centre of the town, is a thriving manufacturing place. In 1900 there were in the town 231 manufacturing establishments, with a total capital of $14,563,492. They employed an average number of 6796 hands, and turned out products valued at $11,682,663. The most important industries were the manufacture of cotton and woollen goods, and of boots and shoes. Population (1890), 16,074; (1900), 24,200, of whom 6821 were foreign-born and 90 negroes.

Northampton.—One of the south midland counties of England, bounded on the N. by Lincoln, Rutland, and Leicester, on the W. by Warwick and Oxford, on the S. by Oxford and Buckingham, and on the E. by Bedford, Huntingdon, and Cambridge.

Area and Population.—In 1901 the area of the ancient (geographical) county was 641,992 acres, and the population 302,183, of whom 149,759 were males and 152,424 were females, showing an increase of 29,628 since 1881, or at the rate of 10·8 per cent.

during the ten years, as compared with an increase at the rate of 11·7 per cent. for the ten years 1871–81. In 1901 the population was 338,064, an increase of 35,881, or at the rate of 11·8 per cent. between 1891 and 1901. These last returns give 0·53 persons to an acre, and 1·89 acres to a person. In the year 1891 the area of the registration county was 641,925 acres, and the population 308,072, of whom 152,918 were males and 155,154 females, and in 1901, 348,924. Particulars of birth-rate, death-rate, and the number of persons married per thousand inhabitants, as well as the number of illegitimate births per thousand births, are given in the annexed table :—

	1871–80.	1881–90.	1889–98.	1899.
Birth-rate . .	34·8	31·8	29·8	29·3
Death-rate . .	19·6	17·1	16·2	15·5
Marriage-rate .	15·0	14·1	15·1	16·3
Illegitimacy-rate .	47	45	40	41

In 1891 the county contained 869 natives of Scotland, 1095 natives of Ireland, and 378 foreigners. At the same date there were 228 blind persons, 115 deaf and dumb, and 1452 insane.

Government, &c.—For parliamentary purposes the ancient county is divided into four divisions (Northern, Eastern, Mid, and Southern), the parliamentary borough of Northampton, and part of the parliamentary borough of Peterborough, each returning one member, except the borough of Northampton, which returns two members. The administrative counties of Northampton and the soke of Peterborough include four municipal boroughs, namely, Brackley, Daventry, Higham Ferrers, and Peterborough, together with the municipal and county borough of Northampton. There are one court of quarter sessions and nine petty sessional divisions. The county borough of Northampton and the liberty of the soke of Peterborough have each a separate court of quarter sessions and a separate commission of the peace. The administrative county contains 301 entire civil parishes and parts of seven others ; the soke of Peterborough contains twenty-nine entire civil parishes and parts of three others ; and the county borough of Northampton contains five entire civil parishes. The ancient county contains 288 entire ecclesiastical parishes or districts, with parts of ten others, most of them being in the diocese of Peterborough.

Education.—There is a diocesan training college for schoolmasters at Peterborough. On 31st August 1900 the county, inclusive of the soke of Peterborough, possessed 306 elementary schools, namely, 51 board schools and 255 voluntary schools, the latter including 238 National Church of England schools, three Wesleyan, three Roman Catholic, and 11 British and other. The average attendance during the year was 43,139, out of a total of 51,841 on the register. The school board receipts amounted during the year to £76,769, inclusive of £40 earned under the Technical Instruction Act and £1812 earned under the Agricultural Rates Act.

Agriculture.—Since 1880 there has been a very considerable decrease in the area devoted to corn crops and in the fallow land, and a slight decrease in the area planted with green crops. On the other hand, there has been an increase in the permanent grass and meadow-land since 1885. In 1889, 455,039 acres were farmed by tenants, 463,082 acres in 1895, and 478,343 acres in 1900 ; whilst in the same three years 104,602, 95,512, and 82,441 acres respectively were farmed by their owners.

The following table shows the areas under the different kinds of crops at the periods named :—

Year.	Area in Cultivation.	Area under Corn Crops.	Area under Green Crops.	Area of Bare Fallow.	Area under Permanent Grass.
1880	559,117	169,759	38,090	25,393	...
1885	559,325	153,365	40,419	15,775	309,730
1890	560,305	140,615	37,080	13,928	333,800
1895	558,594	127,985	36,703	13,513	343,787
1900	560,784	128,281	35,153	8,462	354,912

The next table shows the numbers of the live stock for the periods named :—

Year.	Cows and Heifers.	Other Cattle.	Total Cattle.	Horses.	Sheep.	Pigs.
1880	24,997	88,038	113,035	21,998	457,412	29,595
1885	29,457	100,452	129,909	21,953	452,638	32,713
1890	30,797	99,265	130,062	21,701	429,050	37,502
1895	27,352	92,350	119,702	22,357	409,043	39,576
1900	32,404	93,937	126,341	22,880	403,434	28,340

Industries.—The total number of hands employed in the factories and workshops of the county during 1897 was 42,795 ; and of these by far the greater portion, namely, 31,922, or 75 per cent. of the whole, was employed in the clothing (boots and shoes) industries. Next in importance came the making of machinery, implements, and tools, giving employment to 3008 persons ; the paper and printing trades, with 1185 hands ; the metal industries, with 1183 ; leather, with 1128 ; and wood, with 1073. Iron ore is extracted at various places in the middle of the county, *e.g.*, Kettering near Northampton, Wellingborough, Thrapston, and near Stamford ; and there are thirteen blast furnaces at the four places named. In 1900, 1,622,539 tons of ironstone were extracted and 247,908 tons of pig-iron were made. Further, in the same year 168,628 tons of limestone, 303,520 tons of clay, and 53,231 tons of gravel were produced. Altogether 1769 persons were employed in the mines and quarries, the total value of the products of which amounted to £191,941.

See C. A. MARKHAM. *The Church Plate of the County of Northampton.* London, 1894.—T. L. POWYS. *Notes on the Birds of Northamptonshire,* 2 vols. London, 1895. (J. T. BE.)

Northampton, a parliamentary, county, and municipal borough of England, capital of Northamptonshire, on the river Nene, 70 miles north-north-west of London by rail. The churches of St Peter and the Holy Sepulchre have been restored since 1883. St Crispin's chapel-of-ease was built in 1884. There are nine other ecclesiastical parishes, some with new churches since 1882, *e.g.*, St Mary's at Far Cotton, in the Early English Gothic ; St Paul's, Decorated ; St Matthew's, Gothic ; and St Michael's and All Angels'. Besides the cathedral, the Roman Catholics have the church of St John. The town hall was enlarged in 1892. The public buildings erected since 1883 embrace the county council room, the Masonic Hall, the museum and free library (1884), the Friendly Societies' Medical Institute, and the opera-house. The town also possesses a Roman Catholic convent, with schools, the Northampton and county modern and technical schools (opened in 1894), and half a dozen clubs. The water-supply of the town was increased by the construction of a new reservoir of 100 acres at Teeton in 1888. The parliamentary borough (area, 1972 acres ; population, 23,671 in 1891) returns two members to the House of Commons. The population of the municipal and county borough in 1891, on the then area (1311 acres), was 61,012. In 1898 the area was 1342 acres, and the population on this in 1891 was 75,075 ; in 1901, 87,021.

See *Records of the Borough of Northampton,* edited by C. A. MARKHAM and Rev. J. C. COX, 2 vols. Norwich, 1898.

Northampton, a city of Massachusetts, U.S.A., capital of Hampshire county, on the west bank of the Connecticut river, towards the western part of the state. It comprises an area of 37 square miles, mainly in the level Connecticut valley, is divided into seven wards, and includes, besides Northampton proper, the villages of Leeds and Florence. Northampton is irregularly planned, is on branches of the New York, New Haven and Hartford, and the Boston and Maine railways, and has extensive and varied manufactures. Northampton is the site of Smith College, one of the foremost of the colleges for women in the country. It is non-sectarian, was opened in 1875, and in 1899 had 68 instructors and was attended by 1074 students. Its library contained 7500 volumes, its property was valued at $1,566,252, and its income was $182,128. Besides the college library, there is in Northampton the public library with over 30,000, and the Forbes library with over 75,000 volumes. Population (1890), 14,990 ; (1900), 18,643, of whom 4498 were foreign-born and 108 negroes.

North Attleboro, a town of Bristol county, Massachusetts, U.S.A., in the south-eastern part of the state, and on a line of the New York, New Haven, and Hartford Railroad. It has an area of 20 square miles of rolling surface. The principal village, of the same name as the town, is regularly laid out. It is well known for its manufacture of jewellery. Population (1890), 6727; (1900), 7253, of whom 1786 were foreign-born and 59 negroes.

North Berwick, a royal burgh and watering-place of Haddingtonshire, Scotland, at the south corner of the mouth of the Firth of Forth. It has fine sands and famous golf-links. There is a town house, a library and reading-room, a hospital for infectious diseases, and a fishermen's hall. Little trade is done at the harbour, which is not easy of access. There is steamer communication in summer with Leith and Fife. The High School is one of the leading secondary schools in the county. Population (1891), 2376; (1901), 2784.

North Bierley, an extensive township in the Shipley parliamentary division of Yorkshire, England, 2 miles south-south-east of Bradford, on the Lancashire and Yorkshire Railway. Ironworks at Low Moor (in the township), established in 1790, provide employment for 3000 to 4000 people. In 1899 it was incorporated with Bradford. Population of sub-district, including townships of North Bierley and Wyke (1901), 22,151 (North Bierley, 16,266; Wyke, 5885).

Northbrook, Thomas George Baring, 1st Earl of (1826——), the eldest son of the first baron (long known as Sir Francis Baring), was born on 22nd January 1826, and educated at Christ Church, Oxford, where he graduated with honours in 1846. He entered upon a political career, and was successively private secretary to Mr Labouchere (Lord Taunton), Sir George Grey, and Sir Charles Wood. In 1857 he was returned to the House of Commons in the Liberal interest for Penryn and Falmouth, which constituency he continued to represent until he became a peer on the death of his father in 1866. Mr Baring was a Lord of the Admiralty in 1857–58; Under-Secretary for War, 1861; for India, 1861–64; for the Home Department, 1864–66; and Secretary to the Admiralty, 1866. When Mr Gladstone acceded to power in 1868, Lord Northbrook was again appointed Under-Secretary for War, and this office he held until February 1872, when, upon the assassination of the earl of Mayo, he was appointed Governor-General of India. The terrible famine in Bengal, which began in January 1874, taxed the administrative powers of the Indian authorities to the uttermost, but it was successfully grappled with. Another important event was the visit of the Prince of Wales to India. In February 1876 Lord Northbrook resigned. It is now admitted that his Government recommended the conclusion of arrangements with Shere Ali which would have prevented the second Afghan war; but the Viceroy's policy was overruled by the duke of Argyll, then Secretary of State. During a debate on Indian affairs in the House of Lords in February 1880, Lord Northbrook delivered a remarkable speech, which attracted a great deal of attention at home and abroad. Having traced the developments of Russian and British policy in northern India, he asked whether no stop could be put to a rivalry which was detrimental to the interests of both countries; and he affirmed that, to any one who looked beyond the events of the moment, there was something almost appalling in the position of the British and Russian empires in Asia. In recognition of his distinguished public services, he was created in 1876 Viscount Baring of Lee in the county of Kent, and earl of Northbrook in the county of Southampton. From 1880 to 1885 the earl held the post of First Lord of the Admiralty in Mr Gladstone's second Government. In 1884 Lord Northbrook was sent to Egypt as Lord High Commissioner to inquire into its finances and condition, and the result was a loan of nine millions sterling. When Mr Gladstone formed his third ministry in 1886 Lord Northbrook held aloof, being opposed to the Home Rule policy of the Premier; and he then ceased to take a prominent part in political life. In 1890 he was appointed lord-lieutenant of Hampshire.

North Carolina, one of the southern states of the American Union, with Virginia on the N., Tennessee on the W., South Carolina on the S., and the Atlantic on the E. The harbour facilities are poor, and for a long time the people were a body of small farmers without towns, manufactures, or easy access to the world beyond. At the middle of the 19th century came an impetus to railway building, and in 1865 the abolition of slave labour. One of these forces put the state into quick communication with the outside world, and the other made agriculture so much less profitable that a considerable number of small farmers became factory hands. Thus, though agriculture is still the chief industry, a movement towards urban manufacturing communities developed in the closing years of the 19th century. Of this the most striking form has been the manufacture of cotton products, as the following figures show:—

Year.	Number of Mills.	Looms.	Spindles.
1880	49	1,790	92,385
1894	167	15,058	703,997
1900	224	29,689	1,297,771

In 1890 North Carolina was tenth in the list of cotton manufacturing states of America; in 1900 it was third, while of the Southern states it was first in the number of mills, but second in output. In 1899 its mills consumed as much cotton as was produced in the state. In 1900 the total capital invested in the manufacture of cotton goods amounted to $33,011,516. The industry employed 30,273 hands, and the value of the products was $28,372,789. The greater part of this development has been due to home capital. Next to cotton manufacturing is the lumber industry. The diminution of the forests of the North and West has brought Southern lumber into demand, especially pine lumber. In 1880 the whole lumber product of the state was worth $2,672,796. In 1893, in forty-two pine-producing counties of the east it was worth $4,558,280. In 1898 and 1899 there was a still greater development in the same line, and more capital was embarked. In the western part there are vast forests of hard wood still untouched. In 1900 the total lumber and timber products of the state were worth $14,862,593. Tobacco manufacturing is largely followed in some towns, notably in Durham and Winston-Salem. Here are some of the largest smoking and plug tobacco and cigarette factories in the world. In 1900 the state contained 80 tobacco factories, which had an output valued at $13,620,816. In manufactures of all kinds North Carolina ranks twenty-eighth among the states of the Union.

The general development of manufacturing during the decade 1890–1900 is set forth in the following table:—

	1890.	1900.	Per cent. of Increase.
Number of establishments .	3,667	7,226	97·1
Capital	$32,745,995	$76,503,894	133·6
Salaried officials, clerks, &c.	2,589[1]	3,001	15·9
Salaries	$1,278,415[1]	$2,434,621	90·4
Wage-earners, average number	33,625	70,570	109·9
Total wages . . .	$6,552,121	$13,868,430	111·7
Miscellaneous expenses .	$3,329,101	$9,118,637	173·9
Cost of materials used .	$22,789,187	$53,072,388	132·9
Value of products . .	$40,375,450	$94,919,663	135·1

[1] Includes proprietors and firm members, with their salaries.

Agriculture.—Agriculture, which continues to absorb most of the industrial energy, has been devoted to the one-crop form. For this reason it has not been very profitable. Cotton and tobacco have been the chief products, but in recent years these have brought unexpectedly low prices, and real distress has followed. Efforts have been made to secure the adoption of more diversified farming, and with some success, so that the outlook for agriculture is somewhat better. In those counties of the east which have adequate railway facilities, truck farming has assumed large proportions. In the west considerable progress has been made in raising apples for winter markets. The building of towns has tended to produce diversified farming. In 1900 the number of farms was 224,637, comprising 22,749,356 acres, of which 36·6 per cent. was improved land. The total value of farm property was $233,834,693, in which was included: land, improvements, and buildings, $194,655,920; implements and machinery, $9,072,600; live stock, $30,106,173. The total value of farm products in the preceding year was $89,309,638. In 1900 the statistics of the chief crops were: Indian corn, 29,790,180 bushels, valued at $16,980,403; wheat, 5,960,803 bushels, valued at $4,887,858; cotton, 503,825 bales, valued at $18,145,257. As to tobacco, statistics are wanting since 1889, in which year the product amounted to 36,375,258 lb.

Mining.—Mining, which was once thought to have large industrial probabilities, has made no considerable advance. A Geological Survey was established in 1899, and has done good in surveying the mineral resources. Gold continues to be mined in paying quantities in a number of small mines; in 1899 the total reported product was $43,000. An attempt to smelt iron in well-equipped modern furnaces has proved a financial failure. The increased prices for copper have resulted in a revival of copper mining. Certain deposits of mica, corundum, talc, graphite, monazite, and some precious gems have been mined with profit. Yet none of these results are sufficient to make the state a considerable mining state. Building-stone has also been worked in several places, and some of the granite deposits have established a reputation.

Fisheries.—Fisheries have long been largely worked in the extensive sounds on the coast, and the increase in transportation facilities has given them an added impetus. In 1899 the capital employed was $1,218,459, and the total catch was worth $1,316,017.

Population.—Social conditions have followed the development of industry. In 1880 the population was 1,399,750, of whom 867,242 were whites and 531,277 were coloured. In 1890 it was 1,617,947, of whom 1,055,382 were white and 561,018 were coloured. In 1900 it was 1,893,810, of whom 1,263,603 were white, 624,469 negro, 5687 Indians, and 51 Chinese. The males numbered 938,677 and the females 955,133; the native-born 1,889,318 and the foreign-born 4492. The total number of square miles of land surface in the state is 48,580, and the average number of persons to the square mile was 39 in 1900, as compared with 33·3 in 1890. In 1880 there were 50,778 persons in the state living in towns having a population of 2000 and over; in 1890, 102,053, and in 1900, 202,274. The growth of manufacturing explains in large part this increase. The most important towns and their populations are as follows:—

Town.	1880.	1890.	1900.
Wilmington	17,350	20,056	20,976
Raleigh	9,265	12,678	13,643
Charlotte	7,094	11,557	18,091
Winston-Salem	4,194	10,729	13,650
Ashville	2,616	10,235	14,694
Durham	2,041	5,485	6,679
Greensboro	2,105	3,317	10,035

The migration into the state is slight but appreciable. Some come for health to the mountains of the west and to the pine-covered plains in the middle part, and others come as skilled labourers in the factories. In 1880 the male population over ten years of age was 465,268, and of these 393,211, or 84·51 per cent., were engaged in gainful occupations. In 1890 this population was 559,764, of whom 422,171, or 75·42 per cent., were likewise engaged. Of females over ten years of age in 1880 there were 494,683, of whom 86,976, or 17·58 per cent., were engaged in gainful occupations; and in 1890 there were 586,682 females of such an age, of whom 115,192, or 19·6 per cent., were likewise engaged.

Education.—The development of public schools has been a matter of severe difficulty. The state is not wealthy, and there are a vast number of negroes who pay small taxes, or none at all, and who are yet as much in need of education as any class in the community. It is to the credit of the state that the blacks are allowed an equal share of the school fund. This fund is realized chiefly from taxation. In 1898 it amounted to $986,514; the average length of the term was 14·06 weeks for the whites and 11·75 for the blacks. In 1898 there were 415,262 white children of school age, of whom 144,357 attended school. In the same year the coloured children of school age were 213,218, of whom 68,894 attended school. In 1890 there were 4701 teachers in the state, of whom 1817 were males and 2884 were females. The native white population above ten years of age in 1880 was 605,244, of whom 191,913, or 31·71 per cent., were illiterate. The same population in 1890 was 751,302, of whom 173,545, or 23·10 per cent., were illiterate. The coloured population of the same age in 1880 was 351,145, of whom 271,943, or 77·44 per cent., were illiterate. The same population in 1890 was 392,589, of whom 235,981, or 60·11 per cent., were illiterate. In 1900 the total white male population over twenty-one years of age numbered 289,263, of whom 54,474, or 18·83 per cent., were illiterate; at the same time the coloured male population over twenty-one years numbered 128,315, of whom 68,184, or 53·13 per cent., were illiterate. The general opinion of competent observers is that the illiteracy of the negroes is steadily decreasing. A hopeful feature is the fact that most of the towns have levied special taxes to establish modern graded schools. These are usually open during nine months in the year, and may be considered a permanent feature of the new urban life. In higher education the progress has been good. A number of the smaller colleges, so-called, have been relegated to the position of high schools or closed altogether, whereas new institutions of a higher grade have been established and old ones strengthened. The state has established an agricultural and mechanical college for each race, and a normal and industrial college for white women. The Baptists, the Lutherans, the Quakers, the Christians, and the Roman Catholics have founded institutions of higher learning, and the Methodists have so increased the equipment of their college of Trinity as to make it practically a new institution. The state university has more than doubled its attendance. The higher education of the coloured people is cared for by six institutions, established chiefly through the aid of philanthropic Northern persons or organizations. In 1897 there were 2868 students, male and female, attending institutions of higher learning in the state, with 253 instructors.

Religion.—North Carolina is a decidedly Protestant state, having in 1890 only 2640 Roman Catholics. The most important churches are the Baptists, with 3124 organizations and 310,920 communicants; the Methodists, with 2413 organizations and 276,336 communicants; the Presbyterians, with 411 organizations and 36,102 communicants; the Christians, with 158 organizations and 12,437 communicants; the Lutherans, with 131 organizations and 12,326 communicants; and the Episcopalians, with 178 organizations and 8186 communicants.

Charitable and Penal Institutions.—There are for the whites two asylums for the insane, at Raleigh and at Morganton, and one for the blacks at Goldsboro. In 1896 these had respectively 420, 654, and 425 inmates. There is also an institution for the deaf, dumb, and blind in Raleigh, with 275 inmates, and another for the deaf and dumb in Morganton, with 175 inmates. There is a soldiers' home at Raleigh, with 105 inmates. All these are supported by the state. The state has a penitentiary in Raleigh, in which in 1896 there were 1127 inmates. This institution has connected with it certain farms and other works at which a part of the convicts are kept.

Transportation.—The chief railway systems are: the Southern, which has in the state 1226 miles of track, valued at $15,479,002; the Atlantic Coast Line, with a mileage of 949 and a valuation of $13,932,026; and the Seaboard Air Line, with a mileage of 614 and a valuation of $8,683,861; and other lines with a total mileage of 861 and a valuation of $4,298,837. Thus the railways of the state have a total mileage of 3650 and a total valuation of $42,393,726. The steamboat lines are mainly on the sounds and rivers of the east. In 1900 there were 45 steamboats, valued at $145,214. The foreign commerce of the state is not great. The ports are Wilmington, New Berne, Beaufort, and Edenton; but only the first two reported imports and exports in 1899, the total of imports being worth $145,260, and of exports, $7,590,381.

Finance.—The total assessed valuation of real and personal property, including transportation and telegraph lines, in 1900 was $287,339,288. The state tax rate was for the same year 25 cents on the $100 valuation for ordinary purposes, and 18 cents on the $100 for public schools. A poll-tax is collected which by the constitution is equal to the property-tax on $300 in cash. This poll-tax for state and county must not exceed $2, so that it is impossible for the state and county property-tax combined to be more than 66⅔ cents on each $100 valuation. The state debt in 1900 was $6,527,770.

Banks.—The statistics of banking in 1901 (except for national banks, for which the figures are for 1897), are as follows:—

Kind of Bank.	Capital.	Deposits.
National	$2,701,000	$5,462,497
State	2,578,643	7,083,784
Private	165,500	630,220
Savings banks	238,384	2,159,419

In 1900 there were 29 building and loan associations, of which 28 had their home office in the state, and 1 had it out of it.

Political Development.—From 1880 till 1894 the political control of the state was in the hands of the Democratic party. In 1892 the People's party was organized in the state. It was greatly helped by the feeling on the part of many of the farmers that the control of the old parties was manipulated against their interests. This party was defeated in 1892, but in 1894 it made a combination with the Republicans which carried the state. Two United States senators were to be elected, and by previous agreement each of the victors elected one. In 1898 the Democrats made the election issue the opposition to negro office-holders. They were able to do this because their opponents had not been able to withstand the pressure from within their own ranks, and in some cases had appointed negroes to minor political offices. After a bitter campaign, in which a great deal of race feeling was aroused, the Democrats regained control of the legislature. So great was the feeling on the race question that the party was impelled to propose an amendment to the state constitution, the purport of which was to disfranchize the negro voters. This amendment provided (1) that every voter shall be able to read and write a section of the constitution and shall have paid his poll-tax, and (2) that no male person who was a qualified voter in 1867, and no lineal descendant of the same, shall be denied the franchise because of inability to read and write, provided he shall be duly registered by 1st November 1908. The latter clause was inserted confessedly because it was believed that without some such guarantee it would be impossible to carry the illiterate white voters for the measure. The amendment, which eliminated about half of the negro vote, was submitted to the people 2nd August 1900, and carried by a majority of 60,000, after a hotly conducted campaign in which there was not wanting a certain amount of force to terrorize the negro voters.

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North Dakota, one of the north-western group of states of the American Union, lies between 96° 25′ and 104° W. and 45° 55′ and 49° N. It has an extreme length east and west of 360 miles, an extreme width north and south of 210 miles, and an area of 70,795 square miles. Its vast expanse of level or rolling prairies is well supplied with surface water by several river systems and numerous small lakes. The most important rivers are the Red River of the North along the eastern border of the state, the Missouri in the western portion, and the Sheyenne and James in the central portion. The surface features of the state may in a general way be classified as follows: plains of the Red river valley, highlands of the Pembina and Turtle mountains, the rolling prairies of the central region, and the western Coteau of the Missouri. The uniformly level character of its surface, the absence of uplifts, and the lack of deep erosion over the greater part of the state have given it no very marked geological features. The formations occurring include rocks of the Archæan, Cambrian, Silurian, Cretaceous, and Tertiary ages, as well as Glacial drift and alluvial deposits. The Dakota sandstone of the Cretaceous group is especially important as being the water-bearing stratum of the Great Artesian belt, occupying a large part of the state. Many of the clay deposits of the Cretaceous and Tertiary formations, particularly those near Dickinson, Stark county, are remarkably pure, and are utilized in the manufacture of excellent fire and pressed brick. To the same formations belong the immense beds of lignite coal extending west of the Missouri river, from north of the Great Northern Railway into South Dakota. In portions of the Red river valley the drift and alluvial deposits attain a depth of 300 feet, giving a remarkably strong subsoil and a deep and rich upper soil of black vegetable mould. These deposits thin out westwards, with the gradually increasing altitude, till the high rolling prairies of the central portion of the state are reached.

Flora and Fauna.—Except along river banks, a few isolated lakes, and over a small area in the Pembina and Turtle mountain regions, the moisture has been insufficient for the growth of forest trees. There are nine or ten principal varieties of trees and about twenty different varieties of shrubs in the state, and over one hundred varieties of prairie grasses and forage plants. With the advent of the herdsman and farmer, the bison, which formerly roamed these prairies in vast numbers, have vanished, and the scattered elk, antelope, mountain sheep, and deer are rapidly disappearing. The brown and, very rarely, the grizzly bears, the prairie and timber wolves, the mountain lion, lynx, prairie dog, and rattlesnake are still found in the "bad lands" in the south-western part. Among the few remaining fur-bearing animals are the otter, mink, beaver, badger, and raccoon. The gopher or spermophile, by its ubiquity, has given to the state the sobriquet "Flickertail." Grouse, prairie chicken, geese, ducks, and swans furnish excellent hunting in their season.

Climate.—The climate is remarkably dry, cool, and invigorating. The temperature occasionally rises to 95° F. in summer, and occasionally falls to −40° in winter, but neither the exceptional heat of summer nor the exceptional cold of winter entails the discomfort attending a similar range of temperature in more humid climates. The summer nights are always cool. The mean temperature at many signal stations in the state for July and January, the hottest and coldest months, during the years 1892–98 inclusive, was 68·9° and 3·7° F. respectively. The mean temperature for the year was 39°. The average precipitation is 17·23 inches a year, ranging from more than 20 inches in the extreme eastern part to less than 10 inches in the extreme western. Fully three-fourths of the precipitation occurs during the growing season (April to August inclusive), and is sufficient for successful dry farming as far west as the 100th meridian. Beyond that meridian, save in localities of exceptional rainfall, the country is better adapted to stock-raising than to agriculture.

Agriculture.—Agriculture is the leading industry in the eastern half of the state, as stock-raising is in the western half. In 1900 there were in the state 45,332 farms, containing altogether 15,542,640 acres, of which about 62 per cent. was improved land. The total value of farm property was $255,266,751, comprising land, improvements, and buildings, $198,780,700; implements and machinery, $14,055,560; and live stock, $42,430,491. The total value of farm products in the preceding year was $64,252,494. The

	Quantity or Number.	Value.
Indian corn	1,284,870 bushels	$397,278
Wheat	59,888,817 ,,	31,733,763
Oats	22,125,331 ,,	5,852,615
Barley	6,752,060 ,,	1,996,082
Rye	368,240 ,,	138,771
Flax-seed	7,766,610 ,,	7,735,640
Hay and forage	1,748,213 tons	5,182,917
Potatoes	2,257,350 bushels	587,498
Dairy cows	125,503	4,078,546
Other neat cattle	531,931	11,732,091
Horses	359,948	22,728,511
Mules and asses	6,976	489,597
Sheep (not including lambs)	451,437	1,605,730
Swine	191,798	930,470
Wool	3,030,478 lb	503,744
Milk, butter, and cheese	...	2,853,133
Animals sold	...	3,902,074
Animals slaughtered on farms	...	1,573,588

leading crops are wheat, oats, barley, flax, rye, corn, and potatoes. The most important crop is wheat. Spring wheat is grown exclusively, mostly of the Scottish Fife variety, and ranking as No. 1 Hard, the best grade known to the market. Apples, pears, and peaches are not grown to any extent, but all the small fruits, wild and domestic grasses, and all root crops are grown in great profusion and of excellent quality. The foregoing table shows the yield and estimated value of the leading crops for the year 1899, together with the number and estimated value of live stock and dairy products.

Manufactures and Mines.—The following table is a comparative summary of the manufacturing and mechanical industries as returned at the censuses of 1890 and 1900, with the percentage of increase :—

	1890.	1900.	Percentage of Increase.
Number of establishments	382	1,130	195·8
Capital	$2,894,553	$5,396,490	86·4
Wage - earners, average number . . .	1,499	2,398	60·0
Wages	$759,132	$1,222,472	61·0
Cost of material used .	$3,087,161	$5,615,793	81·9
Value of products . .	$5,028,107	$9,183,114	82·6

The principal products are those of flour and grist mills. While manufacturing is increasing, agriculture and stock-raising are still the principal industries. The western half of North Dakota is largely underlaid with lignite coal of a superior quality. The mining of this coal, from comparatively recent beginnings, is rapidly becoming an important industry. It is expected that it will soon become the chief source of fuel supply.

Charitable and Penal Institutions.—The state maintains the following charitable and penal institutions :—The state asylum for the insane, and school for the feeble-minded at Jamestown (inmates, 24th April 1902, 413 ; 231 males, 182 females) ; the school for the deaf at Devils Lake (attendance, 1st January 1902, 57—males 31, females 26 pupils) ; soldiers' home at Lisbon (number of inmates, 1902, 36) ; the state penitentiary at Bismarck (inmates, 1st January 1902, 122 males, 1 female).

Religion.—The chief religious denominations are the Baptists, Roman Catholics, Congregationalists, Lutherans, Methodists, Presbyterians, and Episcopalians. These denominations all have substantial church homes and a large membership in all the important towns. The following statistics are for the year 1901 :—

Denomination.	Organizations.	Edifices.	Value of Church Property.	Membership.
Baptists . . .	67	48	$122,800	3,493
Roman Catholics . .	121	121	171,550[1]	26,427[1]
Congregationalists .	104	62	150,000	3,450
Episcopalians . .	35	41	101,647	1,932
Lutherans[2] . . .	237	244	136,275[1]	43,603
Methodists . . .	215	180	335,000	5,655
Presbyterians . .	115	100	175,000	4,179

In the Roman Catholic and Lutheran churches all persons who have been baptized are counted as members.

Education.—There were, on 30th June 1900, 77,680 pupils enrolled in the public schools of the state, with 4083 teachers, and school property, not including lands, valued at $2,587,865. The census of 1890 showed the percentage of illiteracy to be 4·9 for males ten years of age and over, and 7·4 for females. The census of 1900 showed the percentage of illiteracy of males over twenty-one years of age to be 3·8 for the native-born and 6·6 for the foreign-born. The state maintains a state university and school of mines at Grand Forks ; an agricultural college and school of mechanic arts at Fargo ; three normal schools, at Mayville, University, and Valley City respectively ; an industrial school at Ellendale ; and a school for the deaf at Devils Lake. There are about 110 teachers employed in these schools, with more than 2000 pupils in attendance. All grades of public instruction are closely articulated under the supervision of a Board of Commissioners, consisting of the governor, superintendent of public instruction, and the president of the state university. One-eighteenth of all lands (aggregating 2,531,200 acres) was early set aside for the use of the common schools, while grants ranging from 20,000 to 130,000 acres each were made to the state educational institutions. None of these lands may be sold for less than $10 an acre, the proceeds to constitute a perpetual fund, whose integrity is guaranteed by the state for the use of these schools.

[1] Census of 1890.

[2] Norwegian and Swedish Lutherans. In addition to these there are about 13,000 Danish, English, German, and Icelandic Lutherans.

Transportation.—There were, in 1899, 2866 miles of railway in the state, including sidings. The Great Northern, Northern Pacific and St Paul, Minneapolis, and Sault Ste Marie are the leading railways, the two former crossing the state from east to west near the lines of the 47th and 48th parallels respectively on their way to the Pacific coast, and the latter crossing the state diagonally from the south-east to north-west and connecting with a branch of the Canadian Pacific at the international boundary line. The Chicago, Milwaukee, and St Paul and the Chicago and North-Western railways both have short branch lines in the southern part of the state. The Bismarck, Washburn, and Great Falls Railway has been constructed for a distance of about 40 miles north from Bismarck.

The Red River of the North is navigable as far south as Fargo, although boats do not ordinarily go south of Grand Forks. The Missouri river is navigable throughout its entire course in the state.

Finances.—The assessed valuation in 1901 was $124,115,341 (real estate, $77,858,024 ; personal property, $27,739,423 ; railways, $17,983,367 ; express companies, $139,220 ; telephone companies, $108,017 ; telegraph companies, $287,290), representing an actual value of approximately $400,000,000. The bonded indebtedness, 1st January 1900, was $845,300. The constitution limits the bonded indebtedness of the state to $200,000 additional to North Dakota's share of the bonded indebtedness of Dakota territory. The tax rate for state purposes is limited by the constitution to four mills on the dollar of the assessed valuation of the state. This rate, on the basis of the assessment of March 1902, yields an income of about half a million dollars a year.

Banks.—There were, 1st January 1900, 23 national banks, with a paid-up capital of $1,450,000 and a surplus of $194,900, and deposits (7th September 1899) of $5,000,186 ; 169 state banks (1902) with a paid-up capital of $1,641,000 and deposits of $9,391,594. Recent legislation has forced all private banks to take out charters as state banks.

Population.—The population in 1880 of that part of Dakota territory embraced in the present state of North Dakota was 36,909 ($\frac{5}{10}$ to the square mile) ; the population in 1890 was 182,719 ($2\frac{5}{10}$ to the square mile) ; and in 1900 it was 319,146 ($4\frac{5}{10}$ to the square mile), showing an increase for the decade of 74·7 per cent. Of the population in 1890, 101,590 were males, 81,129 females ; 101,258 native-born, 81,461 foreign-born ; 7980 Indians, 373 negroes. Of the population in 1900, 177,493 were males, 141,653 females ; 206,055 were native-born, 113,091 foreign-born ; 311,712 were white, 286 negroes, 180 Chinese and Japanese, 6968 Indians. Fargo (population in 1900, 9589) and Grand Forks (population in 1900, 7652), the leading towns, are the centres of a large wholesale and retail trade. Bismarck, the capital (population in 1900, 3319), is situated near the centre of the state, at the junction of the Northern Pacific Railway with the Missouri river.

History.—Dakota was a part of the Louisiana purchase of 1803. It was organized as an independent territory in 1861. The territory was divided by Act of Congress, 22nd February 1889, and North Dakota admitted as a state 2nd November of the same year. In politics the state has been uniformly Republican, except in 1892, when it was carried by the combined Democrats and Populists by a plurality on the Presidential ticket of 181. (W. Me.)

North-Eastern Rhodesia. See Central Africa, British.

Northeim, a town of Prussia, province of Hanover, 12 miles by rail north of Göttingen. It has an interesting church (1519), containing old wood-carving and stained glass. The place is said to date from the 9th century, was a member of the Hanseatic League, and was stormed by the Imperialists in 1627. There are tobacco, sugar, and boot manufactures, besides flour-milling, tanning, and brewing. Population (1900), 7833.

North Plainfield, a borough of Somerset county, New Jersey, U.S.A., in the northern part of the state. It was organized from a part of North Plainfield township. Population (1900), 5009, of whom 749 were foreign-born and 182 negroes.

North Sea.—The North Sea is bounded on the E. by the continent of Europe and on the W. by Great Britain. At its southern end it communicates by the narrow Strait of Dover with the English Channel, and so with the Atlantic, and towards the north it widens out gradually to 345 miles between St Abb's Head and the coast of Denmark, and narrows

Position and boundaries.

again to 270 miles between Duncansby Head and the coast of Norway. To the north of Scotland it communicates with the Atlantic westwards by the Pentland Firth and the channel between the Orkney and Shetland Islands, and northwards with the Norwegian Sea.

Area and relief.

Its total area is given by Murray as 162,600 square miles, and by Krümmel as 547,623 square kilometres, or 159,131 square miles. Murray estimates the volume of the North Sea at 11,200 cubic miles, and Krümmel at 48,718 cubic kilometres or 7634 cubic miles, giving mean depths of 61 and 48 fathoms respectively. The North Sea is thus on the whole shallow; its bed is part of the continental shelf on which the British Isles stand, and it slopes upwards with fair regularity from north to south. In the south and east there is a broad coastal strip over which the depth nowhere exceeds 20 fathoms, and the whole south-eastern part of the area is less than 30 fathoms deep. In about its middle latitude the Dogger Bank crosses the North Sea from east to west, extending for about one-third of the whole distance; near the English coast the depth here is under 10 fathoms, and it increases eastwards to about 20 fathoms. South of the Dogger there are local depressions, mostly of small area, in which the depth is as much as 45 fathoms, as in the "Silver Pit." Krümmel points out that a line drawn from the northern edge of the Dogger to the middle of the Skagerrack constitutes a rough boundary of the shallow southern basin, the depth increasing very slowly beyond this line to the "Norwegian Channel"—a deep gully closely following the Scandinavian coast, and extending into the Skagerrack, in which the depth increases to as much as 400 fathoms.

History.

According to Jukes-Browne, the North Sea, in its present form, first took shape as a result of the tectonic movements indicated by the break between the older and newer Pliocene deposits. The southern end of the North Sea was probably little affected by the general subsidence which occurred during the Glacial period; its boundary in this direction was apparently within the present land area of France and Belgium, while a narrow inlet may have run westwards between France and England in the present position of the Strait of Dover. Meanwhile immense quantities of ice detritus from Scotland and Scandinavia were deposited in the North Sea, to a thickness of perhaps 600 feet, and the whole region was subsequently raised above sea-level, constituting the "structural surface" upon which the present river system was developed as a series of tributaries to a great river which formed a continuation of the Rhine. Finally, the land subsided again, the plain of the North Sea was again submerged, and the western inlet of Pleistocene times became the Strait of Dover.

Coasts.

For reasons which will be sufficiently obvious from the historical sketch just given, the coasts of the southern part of the North Sea are of no great height. In England they consist of low cliffs with sandy beaches, while on the Continental side are immense flats and marshes, with parts below sea-level protected by sand-dunes and artificial dykes. Suess has shown that no evidence is forthcoming of tectonic movement since the Bronze Age, and the rapid changes of coast-line now taking place in many parts are therefore wholly due to the action of the sea, which is probably specially effective on account of the relatively recent opening of the Strait of Dover. The erosion of the North Sea coasts has been made a subject of minute study (in England especially by the British Association), and recently Harmer has obtained interesting results by comparing the British and Continental coasts as characteristic "weather" and "lee" shores.

Circulation.

The physical conditions of the waters of the North Sea have been extensively studied by expeditions sent out by the Swedish, Norwegian, Danish, German, and British Governments. Professor Pettersson of Stockholm, to whose initiative much of this work is due, classifies the waters found in the North Sea as follows:—(1) oceanic water of 35 *pro mille* salinity or more; (2) water of salinity 34 to 35 *pro mille*, called "North Sea" water; (3) water of salinity 32 to 34 *pro mille*, found along the coasts of Holland, Germany, Denmark, and Norway, and called "bank-water"; (4) water of 32 *pro mille* salinity or less, belonging to the stream flowing out from the Baltic. Of these (1) and (4) are to be regarded as "in-flowing" waters, while the others are due to mixture, which may or may not take place in the North Sea itself. The oceanic water consists of a mixture of waters of Atlantic and Polar origin; it enters the North Sea from the north-west, and makes its way southwards along the coast of Scotland, especially during the summer months. Dr Fulton, scientific adviser of the Scottish Fishery Board, has, by using floats or "drifters," traced a movement of water southwards along the English coast as far as the Wash, and thence in an east-north-east direction towards the coast of Denmark. The supply of water from the Baltic varies with the seasons (see BALTIC SEA).

Apart from its effect on the quantity and composition of the inflowing waters, the mixing and circulation in the North Sea are almost wholly under the control of the winds. Dickson has shown that (*a*) calm weather favours the spreading of a thin layer of "North Sea" water over a great part of the surface; (*b*) strong northerly winds tend to broaden the area covered by oceanic water, and to drive back the fresher out-flowing waters—an important effect of this is to send "bank-water" southwards along the west coast of Norway; (*c*) westerly and south-westerly winds tend to form a continuous band of oceanic water along the central axis of the North Sea, and there is strong upwelling of water along the British coasts; and (*d*) easterly winds reduce the salinity as a whole by spreading the fresher waters over the surface. The distribution and circulation are therefore liable to great variations at different seasons and in different years.

Tides.

The tides of the North Sea are of great complexity, and have not as yet been fully investigated. The tidal wave of the Atlantic enters by the Strait of Dover and by the channels in the north. In the latter place a division into two parts takes place, one wave travelling southwards along the coast of Scotland in comparatively shallow water, while another moves with greater speed across the deeper water to the Norwegian Channel, and thence southwards to the Skagerrack and the Danish coast. The southwards-moving waves are greatly retarded in the shallow water over the Dogger Bank; the trough of the "Silver Pit," accordingly, gives the Scottish wave a strong easterly component, and the three systems—the Scottish, Norwegian, and Channel waves—meet to the east of the Dogger, producing complicated interference phenomena. Along the English coasts the tidal streams are for the most part normal, the flood stream running south to south-east and the ebb north to north-west, but on the Continental coast the movements become very complex, on account of the varying influence of the waves from different sources.

Fauna.

The North Sea is particularly rich in organisms of all kinds, and the abundance of food attracts fish in such quantities that the North Sea fisheries are the most productive in the world. Flat fishes, and those feeding at the bottom on smooth ground, are chiefly caught by means of the trawl. The favourite trawling-grounds are the Dogger Bank in winter, and the shallow waters off the Continental coasts in summer; these yield halibut, soles, turbot, brill, plaice, cod, haddock, whiting, &c. In rough ground where the trawl cannot be used, hook- and line-fishing are carried on most successfully, and "mid-water" fish are also taken in this way, although the trawl and line-fishing overlap considerably. Herring and mackerel are caught by means of drift-nets. The herring fishing off the British coasts exhibits a remarkable variation during summer and autumn, beginning in Shetland in June, and becoming progressively later southwards, until it ends off the Norfolk coast in November. Various attempts have been made to connect this succession with the physical changes already described, especially with the periodic influx of Atlantic water, but no very definite relation has as yet been established.

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North Sea and Baltic Canal. See CANALS.

North Tonawanda, a city of Niagara county, New York, U.S.A., on the Niagara river, at the mouth of Tonawanda creek, in the western part of the state. It is entered by three railways, and has had a rapid growth, aided by the development of power at Niagara Falls. Population (1890), 4793; (1900), 9069, of whom 2402 were foreign-born.

Northumberland, a northern maritime county of England, on the Scottish border, bounded on the E.

by the North Sea, on the S. by Durham, on the W. by Cumberland, and on the N.W. by Roxburgh and Berwick.

Area and Population.—The area of the ancient county is 1,289,756 acres, or 2015 square miles, with a population in 1881 of 433,711, in 1891 of 506,030, of whom 252,283 were males and 253,747 females, and in 1901 of 602,859, the number of persons per square mile being 299, and of acres to a person 2·14. The area of the administrative county (including the county borough of Newcastle-on-Tyne) and the area of the registration county are identical with that of the ancient county. Of the population in 1891, 360,000 were urban and 145,230 rural. The increase of population between 1881 and 1891 was 17·01 per cent., and between 1891 and 1901, 19·1 per cent. Between 1881 and 1891 the excess of births over deaths was 66,340, but this was exceeded by the increase of the population, which was 72,319. The following table gives the numbers of marriages, births, and deaths, with the number of illegitimate births, for 1880, 1890, and 1898 :—

Year.	Marriages.	Births.	Deaths.	Illegitimate Births.	
				Males.	Females.
1880	3428	15,204	9,032	469	447
1890	4314	16,553	10,239	379	384
1898	5028	18,326	11,169	358	358

The number of marriages in 1899 was 5112, of births 19,123, and of deaths 11,474.

The following table gives the marriage-, birth-, and death-rates, with the percentage of illegitimate births, for a series of years :—

	1870–79.	1880.	1880–89.	1890.	1888–97.	1898.
Marriage-rate .	18·7	15·9	15·9	17·2	16·1	17·8
Birth-rate . .	38·3	35·2	34·3	33·0	32·7	32·5
Death-rate . .	22·9	20·9	19·9	20·5	19·1	19·8
Percentage of illegitimacy . .	5·9	6·0	5·3	4·6	4·5	3·9

Both the birth-rate and the death-rate are above the average. In 1891 there were in the county 26,155 natives of Scotland, 10,414 natives of Ireland, and 3686 foreigners.

Constitution and Government.—The county is divided into four parliamentary divisions, and it also includes the parliamentary boroughs of Newcastle-on-Tyne, returning two members, and of Morpeth and Tynemouth, returning one member each. It contains four municipal boroughs: Berwick-on-Tweed (13,437), Morpeth (6158), Newcastle-on-Tyne (214,803), and Tynemouth (51,514). Newcastle-on-Tyne is a county borough. The following are urban districts: Alnwick (6716), Amble (4426), Ashington (13,956), Bedlingtonshire (18,768), Benwell and Fenham (18,347), Brackley (2467), Cowpen (17,803), Cramlington (6437), Earsdon (9190), Gosforth (10,605), Hexham (7071), Newbiggin-by-the-Sea (2022), Newburn (12,503), Rothbury (1303), Seghill (2213), South Blyth (5472), Walker (13,335), Wallsend (20,932), Weetslade (5453), Whitley and Monkseaton (7705), and Wellington Quay (8046). The county is in the north-eastern circuit, and assizes are held at Newcastle-on-Tyne. The boroughs of Berwick-on-Tweed and Newcastle-on-Tyne have separate courts of quarter sessions and separate commissions of the peace, and the borough of Tynemouth has only a separate commission of the peace. The ancient county—which is in the diocese of Newcastle-on-Tyne—contains 159 entire ecclesiastical parishes or districts.

Education.—In Newcastle-on-Tyne are the Durham College of Medicine and the Durham College of Science. In connexion with the College of Science there is a day training college for schoolmasters and schoolmistresses. In Newcastle-on-Tyne is also the Northern Counties Institution for the Deaf, and at Benwell the Royal Victorial School for the Blind. The total number of elementary schools on 31st August 1899 was 349, of which 79 were board and 270 voluntary schools, the latter including 179 National Church of England schools, 1 Wesleyan, 28 Roman Catholic, and 62 "British and other." The average attendance at board schools was 37,117, and at voluntary schools 45,468. The total school board receipts for the year ended 29th September 1899 were £152,399. The income under the Technical Instruction Act was £616, and that under the Agricultural Rates Act was over £1214.

Agriculture.—Only about five-ninths of the total area is under cultivation, and of this nearly five-sevenths is in permanent pasture. There are also about 470,000 acres under hill pasture, and about 50,000 acres under woods. Northumberland is one of the largest sheep-rearing counties in Great Britain, being much on a par with Argyll, and exceeded only by Lincoln and Yorkshire. Cattle are also very largely raised, chiefly for fattening purposes. The bulk of the acreage under corn crops, which has greatly diminished, is under oats and barley, and turnips occupy as much as five-sixths of the area under green crops, potatoes occupying only about a tenth. The following table gives the principal divisions of the cultivated area at intervals from 1880 :—

Year.	Total Area under Cultivation.	Corn Crops.	Green Crops.	Clover.	Permanent Pasture.	Fallow.
1880	704,778	130,743	56,096	85,662	417,184	15,080
1885	714,432	118,565	53,383	90,731	440,269	11,476
1890	717,698	106,610	50,916	92,743	458,803	8,221
1895	707,407	92,860	47,617	84,792	476,182	5,436
1900	707,486	88,527	45,889	76,657	492,160	3,681

The following table gives the numbers of the principal live stock for the same years :—

Year.	Total Horses.	Total Cattle.	Cows or Heifers in Milk or in Calf.	Sheep.	Pigs.
1880	18,052	92,927	19,964	930,393	10,428
1885	17,889	107,300	25,197	935,874	13,244
1890	17,505	104,953	25,067	1,002,928	14,277
1895	18,723	108,022	25,010	1,000,038	13,377
1900	17,449	113,724	26,518	1,065,206	10,250

Industries and Trade.—According to the report for 1898 of the chief inspector of factories (1900), the total number of persons employed in 1897 in factories and workshops was 56,394, as compared with 56,208 in 1896. The number employed in non-textile factories was 48,753, there being an increase between 1895 and 1896 of 17·3 per cent., and between 1896 and 1897 of 0·6 per cent. As many as 30,467 were employed in the manufacture of machines, appliances, conveyances, and tools, chiefly in the shipbuilding yards and ironworks on the north bank of the Tyne, from Newcastle to the sea, 4742 in the founding and conversion of metal, 1744 in clay and stone industries, 2115 in the manufacture of paper, &c., and 1634 in the manufacture of chemicals, most of the other classified industries being also represented. Of the 7334 persons employed in workshops 3809 were employed in clothing industries. The total number of persons employed in connexion with mines and quarries in 1899 was 39,388. In the same year 302,546 tons of clay were raised, 108,682 tons of igneous rocks, 132,462 tons of sandstone, and 103,528 tons of limestone. No iron ore is dug, but some pig-iron is made at Elswick. Lead has almost ceased to be raised. The following table gives particulars regarding the more valuable minerals in 1890 and 1899 :—

Year.	Barytes.		Fireclay.		Coal.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1890	6486	£12,972	183,759	£25,267	6,751,308	£2,503,610
1899	7309	£14,618	185,266	£27,790	11,184,072	£3,946,579

In 1899 there was landed 343,136 cwt. of fish (more than two-thirds at North Shields), valued at £253,800.

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Northumberland Strait, the strait separating Prince Edward Island from Nova Scotia and New Brunswick.

North-Western Rhodesia.—See Central Africa, British.

North-West Frontier Province, The, a new province of British India, constituted on 9th November 1901, and placed under a Chief Commissioner and Agent to the Governor-General. It was formed by separating from the Punjab two entire districts (Peshawar and Kohat) and portions of three more (Bannu, Dera Ismail Khan, and Hazara) lying mainly beyond the Indus, together with the political charge of a large area occupied by frontier tribes extending from Baluchistan to Chitral.

The capital is at Peshawar. The total area of the districts under British administration is 13,197 square miles, with a population (1901) of 2,044,000. The cultivated area is 2,559,000 acres, of which 717,000 are irrigated from canals. The land revenue is Rs.21,56,000, and the total expenditure is estimated at Rs.67,83,824.

North-Western Provinces and Oudh, formerly the name of a province of British India, under the administration of a lieutenant-governor. It comprises two native states — Garhwal amid the Himalaya, and Rampur in the centre of Rohilkhand. Total area, 112,612 square miles; population (1891), 47,697,576; (1901), 48,545,999. The capital is Allahabad. The title of the province had long been a misnomer. After the creation of the North-West Frontier province in 1901, it was resolved to change the name to The United Provinces of Agra and Oudh.

The following table gives the area and population of the several divisions and districts of the North-Western Provinces and Oudh, together with the two native states, in 1891 and 1901 :—

Area and Population of the North-Western Provinces and Oudh (1891 and 1901).

Divisions.	Districts.	Area in Square Miles.	Number of Towns and Villages.	Population, 1891.	Population, 1901.			Density of Population to Square Mile.
					Males.	Females.	Total.	
BRITISH TERRITORY.								
N. W. Provinces.								
Meerut . . .	Dehra Dun . .	1,193	440	168,135	102,728	74,918	177,646	141
	Saharanpur . .	2,242	1,633	1,001,280	561,723	484,689	1,046,412	447
	Muzaffarnagar . .	1,658	900	772,874	469,828	408,156	877,984	466
	Meerut . . .	2,370	1,541	1,391,458	820,769	719,148	1,539,917	587
	Bulandshahr . .	1,911	1,510	949,914	599,174	539,122	1,138,296	497
	Aligarh . . .	1,952	1,731	1,043,172	640,858	562,189	1,203,047	534
		11,326	7,755	5,326,833	3,195,080	2,788,222	5,983,302	470
Agra . . .	Muttra . . .	1,441	850	713,421	408,846	354,375	763,221	494
	Agra	1,845	1,204	1,003,796	570,373	490,173	1,060,546	544
	Farukhabad . .	1,720	1,709	858,687	500,003	424,657	924,660	499
	Mainpuri . . .	1,701	1,417	762,163	451,263	378,087	829,350	448
	Etawah . . .	1,691	1,492	727,629	437,844	368,781	806,625	430
	Etah	1,741	1,482	702,063	466,310	397,409	863,719	403
		10,139	8,154	4,767,759	2,834,639	2,413,482	5,248,121	470
Gorakhpur . .	Azamgarh . . .	2,148	4,686	1,728,625	756,866	773,689	1,530,555	805
	Gorakhpur . .	4,576	7,574	2,994,057	1,466,580	1,488,963	2,955,543	654
	Basti	2,767	6,863	1,785,844	935,297	910,461	1,845,758	645
		9,491	19,123	6,508,526	3,158,743	3,173,113	6,331,856	685
Kumaun . .	Kumaun[1] (Naini Tal)	7,151	5,966	563,131	170,150	136,212	306,362	79
	Garhwal . . .	5,629	3,660	407,818	211,621	218,271	429,892	72
	Tarai[1] (Almora) .	963	583	210,568	236,823	229,053	465,876	219
		13,743	10,201	1,181,567	618,594	583,536	1,202,130	85
Rohilkhand . .	Bijnor . . .	1,898	2,139	794,070	406,277	373,084	779,361	417
	Moradabad . .	2,282	2,458	1,179,398	631,162	561,186	1,192,348	517
	Budaun . . .	2,017	1,856	925,598	552,487	472,401	1,024,888	418
	Bareilly . . .	1,595	1,934	1,040,691	584,959	504,591	1,089,550	652
	Shahjahanpur . .	1,744	2,037	918,551	494,896	426,728	921,624	526
	Pilibhit . . .	1,372	1,051	485,366	249,692	220,997	470,689	354
		10,908	11,475	5,343,674	2,919,473	2,558,987	5,478,460	489
Allahabad . .	Cawnpore . . .	2,363	1,976	1,209,695	674,348	584,895	1,259,243	512
	Fatehpur . . .	1,633	1,428	699,157	349,403	337,008	686,411	428
	Banda . . .	3,060	1,200	705,832	317,917	313,420	631,337	231
	Hamirpur . . .	2,289	764	513,720	230,319	228,326	458,645	224
	Allahabad . . .	2,852	3,516	1,548,737	744,393	743,511	1,487,904	543
	Jhansi . . .	1,640	667	409,419	313,586	298,058	611,644	249
	Jalaun . . .	1,480	861	396,361	206,701	193,918	400,619	268
	Lalitpur . . .	1,948	680	274,200	...[2]	...[2]	...[2]	141
		17,265	11,092	5,757,121	2,836,667	2,699,136	5,535,803	333
Benares . . .	Mirzapur . . .	5,223	4,307	1,161,508	529,870	552,836	1,082,706	222
	Benares . . .	1,099	1,992	921,943	444,784	438,188	882,972	912
	Ghazipur . . .	1,462	2,614	1,077,909	444,263	469,885	914,148	737
	Ballia . . .	1,170	1,719	942,465	455,817	494,149	949,966	805
	Jaunpur . . .	1,550	3,194	1,264,949	590,551	612,159	1,202,710	810
		10,504	13,826	5,368,774	2,465,285	2,567,217	5,032,502	515
Carried forward		83,376	81,626	34,254,254	18,028,481	16,783,693	34,812,174	417

[1] Between the census of 1891 and the census of 1901 the districts of Kumaun and Tarai were redistributed, two new districts, Almora and Naini Tal, being organized out of them.

[2] The population of the former district of Lalitpur is enumerated under Jhansi in the 1901 census.

Area and Population of the North-Western Provinces and Oudh (1891 and 1901)—continued.

Divisions.	Districts.	Area in Square Miles.	Number of Towns and Villages.	Population, 1891.	Population, 1901.			Density of Population to Square Mile.
					Males.	Females.	Total.	
	Brought forward	83,376	81,626	34,254,254	18,028,481	16,783,693	34,812,174	417
Oudh.								
Lucknow	Lucknow	967	914	774,163	414,852	378,482	793,334	800
	Unao	1,778	1,667	953,636	498,386	477,469	975,855	536
	Sitapur	2,255	2,328	1,075,413	619,975	555,604	1,175,579	477
	Rae Bareli	1,751	1,732	1,036,521	509,835	524,113	1,033,948	592
	Hardoi	2,324	1,885	1,113,211	582,684	510,517	1,093,201	479
	Kheri	2,965	1,711	903,615	478,411	426,788	905,199	305
		12,040	10,237	5,856,559	3,104,143	2,872,973	5,977,116	486
Fyzabad	Fyzabad	1,728	2,684	1,216,959	657,776	640,310	1,298,086	704
	Bahraich	2,680	1,886	1,000,432	544,502	507,354	1,051,856	373
	Gonda	2,880	2,831	1,459,229	713,699	688,651	1,402,350	507
	Sultanpur	1,710	2,471	1,075,851	534,449	549,666	1,084,115	629
	Partabgarh	1,439	2,188	910,895	484,462	456,633	941,095	633
	Bara Banki	1,740	2,067	1,130,906	603,449	576,083	1,179,532	649
		12,177	14,127	6,794,272	3,538,337	3,418,697	6,957,034	557
Total British Territory		107,593	105,990	46,905,085	24,670,961	23,075,363	47,746,324	436
NATIVE STATES.								
Rampur		945	1,516	551,249	279,729	252,338	532,067	583
Garhwal		4,164	802	241,242	132,168	135,440	267,608	58
Total Native States		5,109	2,318	792,491	411,897	387,778	799,675	155
Grand total		112,702	108,308	47,697,576	25,082,858	23,463,141	48,545,999	423

Since 1891 the population has increased by little more than 1·6 per cent., which is much below the rate of increase for India generally. In the central Doab there is an actual decrease, while the highest rates of increase are to be found in the Himalayan districts and in the submontane tracts, where waste land is still available for tillage. Elsewhere, it may almost be said that population has reached the stationary stage. It is noteworthy that the urban population, which forms 12 per cent. of the total, has increased at a slower rate than the population generally. The density of population is greatest in the east, where the conditions approximate to those of Behar. The purely agricultural districts of Azamgarh and Ballia each support more than 800 persons per square mile. For Oudh alone the average density is 557 persons per square mile. In Bundelkhand (Allahabad) it falls to less than half, and in the Himalayan districts to only 85 persons per square mile.

Classified according to religion, and excluding native states, Hindus in 1891 numbered 40,413,250, or 86 per cent. of the total population. They were slightly more numerous, in proportion to Mahommedans, in Oudh than in the North-West proper; and it is noteworthy that they have increased somewhat faster than the Mahommedans, which is contrary to the experience of India generally. Mahommedans numbered 6,346,710, or 13 per cent., being proportionately most numerous in Rohilkhand, where they formed 23 per cent. of the population. Christians numbered 58,441, or ·1 per cent., of whom 27,995 were Europeans and 7040 Eurasians, leaving 23,406 for native converts, who were proportionately most numerous in the Himalayan districts and in Rohilkhand. Jains (including Buddhists) numbered 85,988, or ·2 per cent, being most numerous in Meerut, Agra, and Jhansi. "Others," chiefly Sikhs, Parsis, and Jews, numbered 696. The census for the North-Western Provinces ignores aboriginal tribes.

In the North-West proper, out of a total area of 52,597,361 acres, 6,159,711 acres were included under the Bengal permanent settlement, the incidence of assessment being nearly 15 annas per acre. On the temporarily settled tract, where the assessment is liable to revision every thirty years, the incidence is R.1 : 2 : 6 per acre. Similarly, in Oudh, out of a total area of 15,537,846 acres, the amount in five districts that has been granted in permanent settlement is 1,112,921 acres, on an average assessment of nearly 15 annas per acre; while the incidence on the temporarily settled portion is R.1 : 1 : 9 per acre. In 1896–97, in the North-West proper, the total cultivated area was 22,742,416 acres, of which 4,272,569 were cropped more than once. The irrigated area was 7,432,218 acres, of which 2,083,118 acres were watered from Government canals, and the rest from wells, &c. The principal crops are rice, wheat, barley, millet, pulse, maize, cotton, and sugar-cane. Indigo was grown on 413,724 acres, chiefly in the Doab; opium on 199,163 acres, chiefly in the permanently settled tract; tea on 7919 acres, in Dehra Dun and Kumaun. The Government canals are classified under the headings of (1) protective, (2) major works, and (3) minor works. The following table gives the financial results of the first two of these classes for 1897–98 :—

	Capital Outlay.	Total Receipts.	Working Expenses.	Interest.	Net Result.	Profit per cent.
Protective—	Rs.	Rs.	Rs.	Rs.	Rs.	
Betwa Canal	43,02,017	1,37,700	1,14,824	1,62,954	*−1,40,078*	*−3·26*
Major Works—						
Ganges Canal	2,99,43,303	43,51,132	11,51,384	11,25,955	20,73,793	6·92
Lower Ganges Canal	3,49,19,049	31,18,612	9,35,709	12,98,424	8,84,479	2·53
Agra Canal	95,31,879	9,74,061	2,42,961	3,54,115	3,76,985	3·95
Eastern Jumna Canal	38,54,711	16,65,275	3,52,985	1,44,349	11,67,941	30·29
Fatehpur Ganges Canal	24,00,670	...	...	70,482	*−70,482*	*−2·93*
Total	8,06,49,612	1,01,09,080	26,83,039	29,93,325	44,32,716	5·50

In the case of the minor works, on which interest is not charged, the net receipts amounted to Rs.1,66,990, being 5·58 per cent. on a capital outlay of Rs.29,90,331.

There are no great industries in the North-Western Provinces corresponding to the cotton of Bombay or the jute of Bengal. The chief manufacturing centre is Cawnpore, with 4 cotton mills, 1 woollen mill, 1 jute mill, and several large tanneries and leather factories. There are in all 6 cotton mills, with 1638 looms and 257,622 spindles, employing 7496 hands, of whom nearly all are male adults. The out-turn in 1897–98 was 26,746,853 ℔ of yarn, mostly between counts Nos. 10 and 20; and 3,042,991 ℔ of cloth, mostly grey goods. There are breweries at the hill stations, and also at Lucknow; and a large factory for refining sugar and distilling rum near Shahjahanpur. No coal-mines exist, nor any important iron-works. The province is well supplied with railways. The main line of the East Indian runs throughout south of the Ganges, which is bridged at Benares and Cawnpore. North of the river, the Oudh and Rohilkhand system connects with Bengal on the one hand and with the Punjab on the other. From Allahabad, Cawnpore, and Agra trade finds an outlet to the sea at Bombay as well as at Calcutta. In 1897–98 the total rail-borne traffic with other provinces amounted to 57,557,329 maunds (say, two million tons), valued at Rs.37,12,12,027. The principal imports are cotton goods, grain, salt, coal, metals, and railway materials. The principal exports are wheat, oil-seeds, hides, sugar, raw cotton, indigo, opium, and lac. In 1900–01 the total trade with other provinces by rail amounted to 75,765,863 maunds (2,783,000 tons) valued at Rs.43,73,99,947, and by river to 24,665,124 maunds (906,000 tons), valued at Rs.2,35,38,535. The frontier trade is registered with Nepal and with Tibet. In 1897–1898 the imports from Nepal were valued at Rs.59,54,383, of which nearly half was rice, other important articles being oil-seeds, *ghi*, timber, and drugs. The exports to Nepal were valued at Rs.33,32,331, of which more than two-thirds were cotton goods, other important articles being salt, sugar, and spices. The imports from Tibet were valued at Rs.6,34,949, chiefly wool, borax, and salt. The exports into Tibet were valued at Rs.7,84,830, mostly food-grains, with some sugar and cotton goods.

The administration of the North-Western Provinces is conducted by a lieutenant-governor, who is also chief commissioner of Oudh, with a chief secretary, 2 secretaries, and 3 under-secretaries. As in Bengal, there is no executive council; but there is a board of revenue, consisting of 2 members. For legislative purposes the lieutenant-governor has a council, first constituted in 1886 and augmented in 1893. It consists of 15 members, of whom not more than 7 may be officials. Of the remaining members, 6 are nominated on the recommendation of groups of municipalities and district boards, selected public associations, and the senate of Allahabad University. The whole of Oudh, and also the Kumaun division, rank as "non-regulation." Including Oudh, the number of divisions or commissionerships is 9, with 48 districts or independent charges under a collector or deputy commissioner. The total number of civil and revenue judges is 727, and of magistrates of all kinds 992. In 1898 the total strength of the police force was 24,888 officers and men, being 1 policeman to every 3673 of the population. In addition, the railway police numbered 783.

Since the reorganization of the Indian army in 1895, the North-Western Provinces and Oudh form part of the Bengal command, containing two first-class and the larger part of three second-class districts. The chief military stations are Meerut, Lucknow, Allahabad, and Bareilly. The volunteer force consists of 5 administrative battalions, with an enrolled strength in 1898 of 4301 men, of whom 372 were mounted.

The number of municipalities is 104, with an aggregate population of 3,267,308; of these, 7 have more than 100,000 inhabitants, and 10 between 50,000 and 100,000. In all but 6 of them the majority of the boards are elected by the ratepayers, who form about 2 per cent. of the municipal population. In the six largest towns the district magistrate is *ex-officio* chairman of the board, and elsewhere he is almost always elected to that office. Out of a total of 1608 municipal commissioners, 1229 are elected and 338 nominated; 315 are officials and 1293 non-officials; 1403 are Indians and 205 Europeans. In 1897–98 the aggregate municipal income was Rs.44,83,166, of which Rs.32,25,223 was derived from taxation, mainly from octroi. The average incidence of taxation was just under R.1 per head, but at both Naini Tal and Mussoorie it was more than Rs.5. The aggregate expenditure was Rs.44,86,884, of which Rs.9,90,127 was devoted to conservancy, Rs.6,43,578 to public safety, Rs.5,28,226 to water supply, Rs.3,92,785 to public works, Rs.1,81,087 to drainage, Rs.1,74,890 to hospitals, and Rs.1,45,436 to education. The aggregate debt outstanding was Rs.85,43,343. The average death-rate was 45·55 per thousand, compared with 37·69 in the preceding year.

The number of district boards is 44, composed of 1245 elected, 193 nominated, and 100 *ex-officio* members, of whom 63 are Europeans. In every case the magistrate of the district is chairman. In addition, there are 4 district committees, composed entirely of *ex-officio* and nominated members. These bodies, which were first constituted in 1883, possess no power of taxation, but administer certain funds made over to them by the Government. In 1897–98 their aggregate income was Rs.39,51,080, of which Rs.28,03,415 was derived from rates. Their aggregate expenditure was Rs.39,67,371, of which Rs.20,16,123 was devoted to public works, Rs.13,16,951 to education, and Rs.5,53,119 to dispensaries, vaccination, &c.

The following was the net revenue and expenditure of the North-Western Provinces and Oudh for 1897–98 (in tens of rupees), distributed under the three heads of imperial, provincial, and local:—Net revenue—Imperial, 5,068,159; provincial, 2,291,411; local, 824,411; total, 8,183,981. Net expenditure—Imperial, 586,682; provincial, 2,078,539; local, 1,037,283; total, 3,702,504.

The following table gives the gross revenue under five principal heads (in tens of rupees) for the two years 1887–88 and 1897–98:—

	1887–88. Rx.	1897–98. Rx.
Land	5,699,841	5,602,180
Stamps . . .	658,887	732,196
Excise . . .	557,241	451,496
Forests . . .	124,745	138,667
Assessed taxes . .	218,828	250,129

The following table gives the chief statistics of education in the North-Western Provinces and Oudh for the years 1886–87 and 1896–97:—

	1886–87.		1896–97.	
	Schools.	Pupils.	Schools.	Pupils.
Colleges . . .	18	1,311	29	2,435
Secondary schools .	620	66,579	500	59,172
Primary schools . .	5,322	181,473	6,292	216,273
Special schools . .	61	3,163	55	3,581
Private institutions .	6,866	77,055	5,630	71,511
Total . .	12,887	329,581	12,506	352,972

However these figures be looked at, they show little progress. If we compare the number of pupils with the estimated population of school-going age (15 per cent. of the total population), the proportion has remained stationary at 5 per cent. Taking girls alone, the number at school has risen in ten years from 13,242 to 15,461, and the proportion to the female population of school-going age from ·4 to ·5 per cent. In every respect the standard of education in the North-West falls far below that of India generally. But it should be said that a considerable improvement has recently been effected. The following table gives the expenditure on education for the same years, according to sources:—

	1886–87. Rs.	1896–97. Rs.
Provincial revenues .	5,36,902	6,20,410
Local funds . .	13,57,832	13,83,614
Municipal funds . .	75,567	1,06,091
Fees	3,30,010	7,66,235
Other sources . .	5,67,994	7,63,556
Total .	28,68,305	36,39,906

The total expenditure on education steadily increased. But the most notable feature was the large increase under fees, which more than doubled during the period. Altogether, the proportion of the total borne by public funds fell in ten years from 69 to 58 per cent., though it was still higher than for India generally. In secondary schools alone public funds contributed only 43 per cent. Collegiate education was stimulated by the foundation in 1887 of an independent university at Allahabad, whose examinations give a larger place to science than in the Calcutta university. During the five years ending 1896–97 the total number of students who matriculated was 3621, while 740 graduated B.A. and 108 M.A., and 183 passed examinations in law. At present there is no faculty of medicine.

The North-Western Provinces suffered severely from the famine of 1896–97. Distress first made itself felt in Bundelkhand in March 1896, and relief operations had to be continued until October 1897. Altogether 19 districts were officially recognized as famine-stricken, while in 18 more districts the distress was held to reach the point of scarcity. For several months more than one million persons were in receipt of relief, the maximum being 1,696,722 at the end of February 1897. The total expenditure incurred by Government was Rs.2,17,00,000, the daily cost of each person relieved being just over one anna (= one penny). The Famine Commission reported that the result was a "conspicuous success and a great administrative feat." During the twelve months ending September 1897 the mortality in the famine-stricken districts rose only to 39 per thousand, compared with a normal death-rate of 33 per thousand. The North-West was fortunate in almost entirely escaping the subsequent famine of 1899–1900; nor has it suffered from the plague in an epidemic form. Down to April 1899 the total number of deaths recorded from plague was only 117, but the disease has since taken a firmer hold of the eastern districts. (J. S. Co.)

North-West Territories.—Under this name are comprised the portion of the Labrador peninsula not included in Quebec or the Labrador coast strip, the Arctic islands between 62° W. and 141° W., and all that part of British North America which lies between Manitoba and Keewatin on the east, and British Columbia and Yukon on the west. It includes the districts of Ungava (see LABRADOR), Assiniboia, Alberta, Saskatchewan, Athabasca, Mackenzie, and Franklin. It formerly included Yukon also, but the latter was erected into a separate territory in 1898.

Physical features.

The Laurentian "plateau" occupies the greater portion of Ungava and Mackenzie and the eastern half of Athabasca. The most striking features are the innumerable lakes, with intervening rocky elevations, forest-clad if in the south, but usually bare or covered with moss and lichens in the north, forming the so-called "barren lands." In this area there are, in addition to the Laurentian rocks, outliers referred to the Cambrian as well as bands of Huronian rocks. Minerals of economic value are almost entirely confined to the latter, and, though undeveloped, include gold, iron, mica, phosphate, graphite, marble, and copper. The continental plain is bounded on the E. by the Laurentian plateau, and on the W. by the Rocky Mountains. It extends from the 49th parallel, where it has a width of about 800 miles, north-westward to the Arctic Ocean, where its width has diminished to about 300 miles. South of the North Saskatchewan it includes the prairie country of western Canada, an area of nearly 200,000 square miles; beyond it becomes a forest region with occasional tracts of prairie. East of the Missouri Coteau—a line of escarpment that crosses the 49th parallel in 103° 30′ W. long., and extends in a north-westerly direction to the North Saskatchewan—the general elevation is about 1600 feet; to the west it is about 3000 feet, and rises gradually to the foothills of the Rocky Mountains. With the exception of a belt of Cambro-Silurian, Silurian, and Devonian along the eastern and north-eastern border of the plain, it is underlain by Cretaceous and Tertiary rocks to the Peace river; beyond the latter the Devonian rocks occupy the greater portion of the area and continue to the Arctic, there forming a great part of the northern archipelago. There are immense beds of bituminous and lignite coals in the Cretaceous; natural gas has been found in large quantities in the Devonian, and extensive outcrops of sandstone saturated with tar evidence the existence of very large deposits of petroleum. The Rocky Mountains extend, with a width seldom exceeding 60 miles, in a north-westerly direction from the international boundary to the Arctic. They are composed of a series of roughly parallel mountain ridges of Cambrian quartzites and slates, and Carboniferous and Devonian limestones. They are, as a rule, forest-clad, the growth being more luxuriant on the western slopes, and have, in the southern portion, several summits exceeding 11,000 feet, notably Robson peak, 13,700; Athabasca, 13,500; Assiniboine, 11,830; Freshfield, 12,000; Victoria, 11,250; Lefroy, 11,080; Alberta, 13,000; Lyell, 12,000; Mummery, 12,000; Temple, 11,658; and Geikie, 11,000; also Brown, 9050.

Rivers.

The principal river is the Mackenzie, 2350 miles long, including its great tributary the Peace; the Athabasca, 740 miles long; the Liard, 650 miles long. Other important tributaries of the Mackenzie are the Hay, Nahanni, Dahadinni, Arctic Red, Peel, and Great Bear rivers. The Anderson, Coppermine (475 miles long), and Backs river (560 miles) also discharge into the Arctic; the Dubawnt (660 miles) into Chesterfield inlet; the Churchill (925 miles) and the Nelson (1450 miles long), including its great tributary the Saskatchewan, into Hudson Bay.

Lakes.

The principal lakes in Saskatchewan are Cedar, Moose, Playgreen, an expansion of the Nelson, La Plonge, and the northern portion of Winnipegosis; in Athabasca, Reindeer, with an area of 2490 square miles, and 1150 feet above the sea; Wollaston, area 900 square miles, and altitude, 1300 feet; Athabasca, 3085 square miles, and 690 feet above the sea; Clair, La Ronge, Lesser Slave, and Ile a la Crosse, altitude, 1330 feet: in Mackenzie, Kasba, 1270 feet; Dubawnt, 500 feet, and an area of 1700 square miles; Pelly, Aylmer, Clinton-Colden, Great Slave, 9770 square miles, and altitude 520 feet, and Great Bear, 11,200 square miles, and 340 feet above the sea.

Climate.

The salient features of the climate of the southern Territories are a bright, dry, and bracing atmosphere, cold winters and warm summers, with a small rainfall and snowfall. In the northern Territories a short, hot summer is followed by a long cold winter with extremely low temperatures. The percentage of bright sunshine at Battleford is 42 per cent., and at Winnipeg 46 per cent. The table below gives the average temperature and precipitation at a number of stations in the Territories:—

	Elevation.	Mean Temperature.		Average Precipitation.
		Summer.	Winter.	
	Feet.	Degrees.	Degrees.	Inches.
Regina, Assiniboia	1885	50·0	0·0	9·03
Swift Current ,,	2423	60·0	9·4	17·04
Maple Creek ,,	2495	62·9	15·3	10·18
Medicine Hat ,,	2171	62·9	14·3	12·69
Norway House, Keewatin . .	710	...	...	19·26
York Factory, Keewatin . .	sea level	48·7	12·6	28·73
Prince Albert, Sask.	1402	54·6	0·9	14·45
Battleford ,,	1615	61·4	7·1	13·62
Calgary, Alberta .	3421	55·8	15·4	12·98
Banff ,, .	4515	52·0	15·9	19·44
Edmonton ,, .	2158	56·0	10·3	15·15
Chipewyan, Atha.	700	54·2	−7·3	11·05
Dunvegan ,, .	1300	...	...	23·23

Flora.

The broad and level or rolling plains of Assiniboia and southern Alberta are, with the exception of the river valleys and more undulating lands, almost treeless. Saskatchewan, Athabasca, southern Mackenzie, and northern Alberta are traversed by a belt of forest varying from 550 to 800 miles wide, and including an area of about 1,500,000 square miles. The principal trees are Banksian pine (*Pinus banksiana*), white spruce (*Picea alba*), black spruce (*Picea nigra*), tamarack (*Larix americana*), aspen poplar (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and paper birch (*Betula papyrifera*). The principal trees of the Rocky Mountains are aspen and balsam poplars, white spruce, Engelmann's spruce (*Picea engelm.*), mountain balsam (*Abies subalpina*), Douglas fir (*Pseudotsuga douglasii*), Rocky Mountain pine (*Pinus flexilis*), black pine (*Pinus murrayana*), and mountain larch (*Larix lyallii*).

Area and population.

In 1895 the unorganized portion of the North-West Territories was divided into the districts of Ungava, Mackenzie, and Franklin, and the eastern boundary of Athabasca was shifted eastwards from approximate 111° 38′ W. to 100° W. In 1898 the district of Yukon was constituted a separate territory.

Ungava comprises the whole of the Labrador peninsula north of Quebec, and west of the Labrador coast strip, and has an area of 347,000 square miles.

Assiniboia (89,535 square miles) is bounded on the E. by Manitoba, on the S. by the states of North Dakota and Montana, on the W. by Alberta, and on the N. by Saskatchewan. The principal towns are:—Regina (population, 2645), the capital of the Territories; Broadview, Moosejaw, Swift Current, Medicine Hat, Moosomin, Yorkton, Estevan, and Qu'Appelle.

Alberta (106,100 square miles) is bounded on the E. by Assiniboia and Saskatchewan, on the S. by the state of Montana, on the W. by the summit of the Rocky Mountains, and on the N. by Athabasca. The principal towns are Calgary (population, 4152); Edmonton (2626), the distributing point for the country drained by the Athabasca, Peace, and Mackenzie rivers, and, till the construction of the White Pass and Yukon Railway, the most northerly railway station in America; Lethbridge (2279), with its coal mines and at the junction of a railway from Great Falls, Mon., with the Crow Nest Pass line of the Canadian Pacific; Macleod, at the junction of the last-named line with a branch from Calgary and in a fine ranching district; Red Deer, in the midst of an excellent farming district, and Banff, in the Rocky Mountains, with its national park and famous hot springs.

Saskatchewan (107,090 square miles) is bounded on the E. and S.E. by the Nelson river, Lake Winnipeg, and Manitoba, on the S. by Assiniboia, on the W. by Alberta, and on the N. by Athabasca and Keewatin. The principal towns are Prince Albert (population, 2193), on the right bank of the North Saskatchewan, and the terminus of a branch of the Canadian Pacific, Battleford, Carlton, and Saskatoon.

Athabasca (245,740 square miles) is bounded on the E. by Keewatin, on the S. by Saskatchewan and Alberta, on the W. by British Columbia, and on the N. by Mackenzie. There are small settlements at Dunvegan, in the valley of the Peace; Chipewyan, on Lake Athabasca, and the see of a Roman Catholic bishop; Peace River Landing and Lesser Slave. There are also several Hudson Bay Company's posts; Lesser Slave, at the head of Lesser Slave Lake, Stanley, Vermilion, McKay, Ile a la Crosse, and Brochet.

Mackenzie (530,000 square miles) is bounded on the N. by the Arctic Ocean, on the E. by Keewatin, on the S. by Athabasca and British Columbia, and on the W. and S.W. by Yukon territory.

Fort Smith is on the Slave river at the first interruption to navigation from the Arctic Ocean, Resolution and Rae on Great Slave Lake, Providence, Simpson, Norman, Wrigley, and Good Hope on the Mackenzie, and M'Pherson on Peel river, the most northerly civilized community in British North America.

Franklin (approximately 590,000 square miles) includes all the Arctic islands of British North America and Boothia and Melville (26,000 square miles) peninsulas. The larger islands and "lands," with their approximate areas, are Baffin Land, 230,000 square miles (including Cockburn Land); North Devon, 22,000; Ellesmere Land, 18,000; Grinnell Land, 86,000; North Somerset, 10,000; Prince of Wales Land, 15,800; King William Land, 6000; Prince Albert Land, Victoria Land, and Wollaston Land, 80,000; Banks Land and Baring Land, 80,000; Prince Patrick and the Parry Island group, including Melville, 17,000; and Bathurst Islands.

The following table shows the population in the census years 1881 and 1891 and in 1901, including the district of Keewatin:—

	1881.	1891.	1901.
Alberta	25,515	25,277	145,000
Assiniboia		30,372	
Saskatchewan		11,150	
Other Territories	30,931[1,2]	32,168[1,2]	75,000
	56,446	98,967	220,000[1]

In 1901 there were 27,057 Indians in the North-West Territories and Keewatin, made up as follows:—Assiniboia, 3214; Alberta, 5697; Saskatchewan, 5993; Athabasca, 3716; Mackenzie, 2041; Keewatin and Franklin, 5834; and Ungava, 562. In the same year there were 14,266 half-breeds in Manitoba and the Territories, as follows: Assiniboia, 2155; Alberta, 3686; Saskatchewan, 5677; Athabasca, 2395; and other territories, 373. The Indian population of Manitoba and the treaty limits of the North-West Territories numbered, in 1893, 23,608, and in 1898, 21,316, a decrease of 2292.

In 1901 there was in Alberta 1 person to 1·6 square miles; in Assiniboia, 1 to 1·3 miles; in Saskatchewan, 1 to 4·2 miles. In the same year there were in the Territories 100,641 males and 83,789 females; the urban population, 20·7 per cent., and rural, 79·3 per cent. In 1891 there were 13,804 persons engaged in agriculture and mining; 2291 in domestic and personal service; 1669 in manufactures and mechanical industries; 2299 in trade and transportation; 1690 in professional avocations, and non-productive, 178. Principal nationalities (by birth) in 1901: Canada, 116,846; England, 10,989; Scotland, 4259; Ireland, 2500. There were 2691 births, 937 deaths, and 827 marriages in 1901.

Immigration. The total number of declared settlers that arrived in Canada in the year 1901–02 was 63,700, most of whom settled in Manitoba and the Territories. There were 41,000 from Great Britain and other European countries, and 22,700 from the United States. In 1899 about 8000 Russian Doukhobors settled in the Swan river district in Manitoba.

Government. The North-West Territories were at first under the lieutenant-governor of Manitoba, then under a lieutenant-governor and council nominated by the Dominion Government; by degrees further powers were conferred, and their affairs are now administered by a lieutenant-governor appointed by the Governor in Council, and an executive council consisting of three members, responsible to the legislative assembly, which consists of thirty-one members. The powers conferred on the legislature are the same as in other provinces of Canada, except that they cannot borrow money on the credit of the Territories. While Ungava, Mackenzie, and Franklin are under the control of the government of the North-West Territories, and while the latter has power to pass laws dealing with internal matters, the Dominion Government assumes the right of legislating with regard to these districts, and did so in 1898 when creating the territory of Yukon.

Religion. Classified according to religion, the principal denominations were in 1901 as follows:—

Roman Catholics	35,200	Baptists	5,416
Presbyterians	27,857	Doukhobors	8,700
Church of England	29,027	Other denominations	25,459
Methodists	24,772	Not specified	15,901
Lutherans	12,098		

In 1901 it was estimated that there were, in the Territories and Keewatin, 18,627 Indians professing the Roman Catholic faith, 4160 Anglicans, 1477 Methodists, 795 Presbyterians, 5606 pagans, and 6392 unknown, but probably pagans.

Education. The educational system is under the control of a council of public instruction, consisting of the executive committee of three, and of three appointed members without votes. A school district may comprise an area of not more than 25 square miles, and must contain four resident heads of families and a school population—children between the ages of five and twenty—of not less than ten. In 1901 there were 564 schools, with a total of 23,837 pupils and 682 teachers. The total expenditure for school purposes amounted to $548,809.

Finance. The principal sources of revenue are the subsidy from the Dominion Government, $425,359 in 1902, and fees received from the sale of liquor licences, &c.

Minerals and Mining. There are immense beds of coal in the Territories, and it has been estimated that, to the south of the 56th parallel, an area of 60,000 square miles is underlain by beds of bituminous and lignite coals. The lignites are found in the undisturbed prairie region, bituminous in the foothills, and bituminous and anthracite in the Rocky Mountains. The principal mines in operation are at Lethbridge, Banff, and Canmore, Alberta; they produced in 1901, 351,950 tons, valued at $839,375. Great outcrops of Cretaceous sandstone, saturated with inspissated petroleum, are found along the Athabasca river, evidencing the existence of extensive deposits of petroleum in the underlying Devonian rocks. Natural gas has been found in considerable quantities in borings, notably in a bore-hole sunk near the confluence of the Pelican and Athabasca rivers, to test the presence of petroleum, which eventually caused the suspension of the boring operations. Gold, supposed to have been concentrated from drift deposits, has been washed from the sands of the Saskatchewan for years; yield in 1901, $15,000.

Agriculture. The soil in southern Assiniboia and Alberta is of a very fertile character, and produces good crops, though in some sections irrigation is required. In 1901 there were 169 irrigation ditches, with a total of 469 miles, constructed at a cost of $500,000; increased value of the land estimated at $1,229,368, and land susceptible of irrigation from constructed ditches, 614,684 acres. To the north of this more or less arid belt are immense partly-wooded districts, with a rich and fertile soil favourable for mixed farming. Up to 1901, 6,500,000 acres had been brought to the uses of the farmer, and 605,795 acres were covered by grazing leases. The following are crop statistics for 1901:—

	Acres.	Bushels.	Yield per acre.
Wheat	508,564	12,923,343	25·40
Barley	20,044	736,749	36·75
Oats	229,439	11,113,066	48·43

Total acreage, wheat, barley, and oats, 1891, 183,915 acres, and 1901, 758,047 acres. In 1900 the Indians in the southern Territories raised the following crops: wheat, 31,930 bushels; oats, 36,333; barley, 4359; potatoes, 31,286; other roots, 10,693; hay and other fodder, 38,442 tons.

Manufactures. The population of the Territories being essentially an agricultural one, the manufactures are as yet insignificant. In the census year 1891 the industrial establishments numbered 375; fixed capital, $670,502; working capital, $1,042,677; persons employed, 1081; wages per annum, $425,153; raw material, $846,017; and value of finished product, $1,827,310.

Commerce. The following table gives statistics of exports, &c., at five-year intervals, for the period 1879–1901:—

	1879.	1884.	1889.	1894.	1901.
	$	$	$	$	$
Imports	60,139	...	...	79,494	1,520,936
Exports	157,462	486,739	128,755	117,398	1,436,249
Duty	21,970	70,148	24,549	11,012	140,952

Railways. In 1901 the railway lines in Assiniboia, Saskatchewan, and Alberta aggregated 2056 miles, equal to 1 mile of track to 147 square miles of area. The systems operating in the Territories are—the Canadian Pacific, Canadian Northern, and Alberta Railway and Coal Company. (J. WH*.)

Northwich, a market town in the Northwich parliamentary division of Cheshire, England, at the confluence of the rivers Weaver and Dane, 18 miles east-north-east of Chester by rail, connected with the Manchester Ship Canal. The amount of white and rock salt exported from this locality (including Winsford, 6 miles distant) is about 1,500,000 tons annually. The white salt is chiefly shipped to America, Belgium and Prussia importing rock salt. Population (1891), 14,914; (1901), 17,609.

Norton, Charles Eliot (1827–——), American scholar and author, was born in Cambridge, Massachusetts,

[1] Including Keewatin. [2] Estimated.

16th November 1827, being the son of Andrews Norton, a Unitarian theologian and doctrinal writer of prominence in his time. Having graduated at Harvard in 1846, Norton travelled in India and Europe, and on his return devoted himself to a life of letters and culture. From 1864 to 1868 he edited, with James Russell Lowell, the *North American Review*, and from 1875 to his resignation in 1898 he was professor of the history of art at Harvard. Beginning with *Notes of Travel and Study in Italy* (1859), his principal books have been *Historical Studies of Church-Building in the Middle Ages: Venice, Siena, Florence* (1880), annotations on Turner's *Liber Studiorum* and Blake's *Job*, a bibliography of Michael Angelo, and a translation of Dante's *New Life* and of the *Divine Comedy* in prose, the publication of the several parts of which extended from 1858 to 1892. His version of the *New Life*, in particular, is noteworthy for accuracy and felicity. He took a prominent part in the work of editing and publishing letters and other writings of Emerson and Carlyle, after their death, and was appointed his literary executor by John Ruskin.

Norton, Thomas (1532–1584), lawyer, politician, and writer of verse, was born in London in 1532. He was educated at Cambridge, and early became a secretary to the Protector Somerset. In 1555 he was admitted a student at the Inner Temple, and married Margaret Cranmer, the daughter of the archbishop. Several years before this, indeed from his eighteenth year, Norton had begun to compose in verse. We find him connected with Jasper Heywood; as a writer of "sonnets" he contributed to *Tottel's Miscellany*, and in 1560 he composed, in company with Sackville, the earliest English tragedy, *Gorboduc*, a remarkable work in blank verse, which was performed before Queen Elizabeth in the Inner Temple on the 18th of January 1561. In 1562 Norton, who had served in an earlier Parliament as the representative of Gatton, became M.P. for Berwick, and entered with great activity into politics; he was eminent in the House as a "wise, bold, and eloquent" orator. In his attitude to religion he was inspired by the sentiments of his great deceased father-in-law, and was in possession of Cranmer's MS. code of ecclesiastical law; this he permitted Foxe to publish in 1571. Norton, in fact, became one of the extremest Puritans of that pro-puritanic age. He went to Rome on legal business in 1579, and from 1580 to 1583 frequently visited the Channel Islands as a commissioner to inquire into the status of these possessions. Norton's Calvinism grew with years, and towards the end of his career he became a rabid fanatic. His punishment of the Catholics, as their official censor from 1581 onwards, led to his being nicknamed "Rackmaster-General." Among the more illustrious victims of his tortures were Edmund Campion and Francis Throgmorton. At last his turbulent puritanism made him an object of fear even to the English bishops; he was deprived of his office and thrown into the Tower. Walsingham presently released him, but Norton's health was undermined, and on the 10th of March 1584 he died in his house at Sharpenhoe, Bedfordshire. The famous tragedy of *Gorboduc* was first published, very corruptly, in 1565, and, in better form, as *The Tragedy of Ferrex and Porrex*, in 1570. Norton's early lyrics have in the main disappeared. The most interesting of his numerous anti-Catholic pamphlets are those on the rebellion of Northumberland and on the projected marriage of Mary Queen of Scots to the duke of Norfolk. Norton also translated Calvin's *Institutes* and Nowell's *Catechism.* By far the best account of Thomas Norton is that published in 1895 by Mr Sidney Lee, who destroys the notion, which had gradually grown up among the historians of English literature, that the credit of *Gorboduc* was entirely, or at all events mainly, due to Sackville. There is more evidence for an opposite thesis, namely, that the principal credit for starting English tragedy is due to Thomas Norton. (E. G.)

Norwalk, a town of Fairfield county, Connecticut, U.S.A., on Long Island Sound, in the south-western part of the state. The town has an area of 25 square miles of hilly country, within which are the cities of South Norwalk and Norwalk and the villages of East and West Norwalk, Winnipauk, Four Corners, and Five Corners. It is traversed by the New York, New Haven, and Hartford Railroad. South Norwalk has an excellent harbour, with regular steamboat communication with New York and Sound ports, giving it a large coasting trade. It has extensive and varied manufactures, the capital invested amounting, according to the census of 1900, to $4,129,841, and the value of the product to $5,097,720. Population of the town (1890), 17,747; (1900), 19,932; of the city (1900), 6125, of whom 1023 were foreign-born.

Norwalk, a city of Ohio, U.S.A., capital of Huron county, in the northern part of the state, on the Lake Shore and Michigan Southern and the Wheeling and Lake Erie railways, at an altitude of 718 feet. It is in a farming district, and has varied manufactures. Population (1890), 7195; (1900), 7074.

NORWAY.

I. Geography and Statistics.

NORWAY is the western section of the Scandinavian peninsula, lying between 57° 58′ and 71° 11′ N. and 4° 30′ and 31° 12′ E., bounded on the N. by the Arctic Ocean, on the E. by Lapland and Sweden, on the S. by the Skagerrack and the North Sea, and on the W. by the Atlantic. So far as physical features are concerned, the article in the earlier volumes of this Encyclopædia (xvii. 575) gives a full account, which it is unnecessary to supplement with further details here; and it only remains to give the statistics for more recent years.

Population and Area.—During the course of the 19th century the population of Norway increased 152·7 per cent., from 883,038 in 1801 to 2,231,395 in 1900. During the seven years 1892–98 inclusive the marriage-rate per thousand of the population averaged 6·58 annually, the birth-rate 31·6, and the death-rate 16·00. Of the births 7·67 per cent. were illegitimate. During the fourteen years 1880–93 inclusive an average of 18,290 persons emigrated every year; during 1894–99 inclusive, an average of 4852. Almost the whole of them went to the United States. In 1900 the rural population amounted to 1,606,864, or 72 per cent. of the whole, and the urban to 624,531, or 28 per cent. In 1891 there were 20,786 Lapps and 9378 Finns (Kvæns). The lunatics numbered 1659 in 1899, as compared with 1581 in 1895. Deaf mutes numbered 2139 in 1891, and blind persons 2565. In the twelve years 1887–98 the suicides averaged 128 annually.

The following table gives the population and density of the counties in 1891 and 1900, together with the areas:—

Counties.	Population as per Census, 1891.	Population as per Census, 1900.	Area in Sq. Miles.	Density per Sq. Mile in 1900.
Smaalenene	120,360	136,298	1,600	85·1
Akershus	99,111	115,113	2,054	56·0
Christiania	151,239	225,686[1]	6·5	34,720·9
Hedemarken	119,129	125,856	10,618	11·8
Christians	108,076	115,615	9,790	11·8
Buskerud	104,769	112,608	5,789	19·2
Jarlsberg and Laurvik	100,957	103,772	896	115·8
Bratsberg	92,034	98,788	5,863	16·8
Nedenes	81,043	79,605	3,608·5	22·0
Lister and Mandal	78,738	81,454	2,804	29·0
Stavanger	117,008	127,192	3,530·5	36·0
South Bergenhus	128,213	135,337	6,024·5	22·3
Bergen	53,684[2]	72,179	5·5	13,123·4
North Bergenhus	87,552	88,948	7,130	12·4
Romsdal	127,806	135,899	5,786	23·5
South Trondhjem	123,817	135,133	7,182	18·8
North Trondhjem	81,236	83,344	8,788·5	9·5
Nordland	131,850	151,537	14,513	10·4
Tromsö	65,125	74,296	10,131	7·3
Finmarken	29,170	32,735	18,291	1·8
Totals	2,000,917[3]	2,231,395	124,411	17·9

Classified according to occupations, the population (total number and percentage) was distributed as follows in the year 1891 :—

	Agriculture and Forestry.	Domestic Labour.	Industry.	Fishing.	Commerce and Trade.	Navigation.	Independent.	Children.
Total number	335,093	480,672	175,641	57,667	42,649	45,368	57,686	709,639
Per cent.	16·7	24·0	8·7	2·9	2·1	2·3	2·9	35·4

Religion and Education.—Except for 30,685 persons (in 1896), of whom 8200 were Free Lutherans, 8200 Methodists, and 4000 Baptists, the population are adherents of the Evangelical Lutheran Church. Notwithstanding the sparseness of the population and the great distances, education in Norway has reached a high standard, being free, and all children between seven and fourteen being obliged to attend school. In the rural districts there are about 6000 primary schools, at which 257,440 out of 272,562 children of school age were educated in 1897 at a cost of £232,274, an average of 18s. 0½d. per child, or an addition of over 50 per cent. of the cost in 1875. In the towns 69,475 children were educated out of 90,832 of school age in 1897, the total cost being £211,526, or at the rate of £3, 0s. 10½d. per child. Secondary education is in a transitional stage, the old classical standards having been discarded in 1896. In 1897 there were 154 communal burgher and communal middle schools and state lyceums, in which 19,207 children were taught, private secondary schools being also included. The special schools embrace an agricultural high school, 3 technical schools, 2 commercial schools, a military school, and a naval school. There is one university, state-aided, at Christiania.

Agriculture.—Although 75 per cent. of the total area is unproductive, and less than 1 per cent. is arable land, the number of people dependent upon agriculture exceeds any other group in the country. Including those who breed and tend live stock, and those employed in the forest industries, agriculture gave occupation to 335,093 persons in 1891, or 28 per cent. of the total working population. The Government help to maintain a flock of Cheviot sheep on the island of Rennes, near Stavanger. There is a higher school of agriculture at Aas (20 miles south of Christiania), and 18 agricultural schools in other parts of the country. Barley is almost the only cereal found north of 68° N.; hay and potatoes ripen as far north as Tromsö and Hammerfest (70° 39′ N.). The next table shows the number of acres under the principal crops in the years cited :—

Year.	Oats.	Barley.	Oats and Barley mixed.	Rye.	Total Cereals.	Potatoes.
1875	249,250	138,000	51,000	35,650	525,850	95,900
1890	241,650	127,900	36,650	34,000	459,450	96,650

In 1897 and 1898 there were some tentative attempts to grow tobacco. In 1890 the live stock numbered 150,900 horses, 1,006,500 cattle, 1,417,500 sheep, 272,500 goats, 121,100 swine, and 170,100 reindeer (domesticated).

Manufacturing Industry.—The next largest group of occupations embraces the manufacturing industries, namely, 175,641 persons, or 15 per cent. of the working population. During the last decade of the 19th century a great number of waterfalls were sold for industrial purposes to manufacturers or their agents, English and German capital being invested as well as Norwegian. A powerful impulse was given to the development of industrial enterprise in Norway by the expiration and non-renewal of the customs treaty with Sweden in 1897, the effect being virtually to establish in Norway a protective system against the sister kingdom. At the same time (between 1896 and the middle of 1899) there was an extraordinary increase in the number of new factories, whilst the importation into Norway of manufactured goods from Sweden very greatly decreased in 1898. In 1885 there were altogether 1925 factories, employing 45,313 workpeople; in 1895, 1910 factories employing 59,796 workpeople; and in 1899, no less than 3074 factories, employing 79,136 workpeople. The chief industrial centre is Christiania (with 402 factories and 17,294 workpeople in 1899); next come Fredrikstad and Sarpsborg, then Bergen, Drammen, Skien and Porsgrund, Fredrikshald, Trondhjem, and Stavanger. The most important branches of industry are saw-mills and planing-mills and wood-pulp factories (17,650 men in 1899); foundries and engineering shops (17,385 men); spinning and weaving mills (8943); brick and tile works, breweries, paper mills, tobacco factories, flour mills, glass works and potteries (6958 men); nail works, shipbuilding yards, match factories, margarine factories, rope walks, factories for preserved foods, fish guano, boots, hosiery; distilleries and tanneries. The building of small wooden vessels, formerly a very active industry, is rapidly decreasing. Including wood-pulp, but excluding the produce of the forests and fishing-grounds, the total export of the industrial products of Norway amounted to £1,303,000 in 1887, £3,080,700 in 1897, and about £2,469,200 in 1900.

Fisheries.—In respect of the value of the product, the fisheries of Norway rank next after her timber. The fish principally taken are cod and herrings, with ling and coal-fish (sayc), salmon and sea-trout, mackerel, lobsters, and oysters. The total annual value of the coast fisheries of Norway ranges generally from one million to one million and a half sterling. There are three principal fishing-grounds for cod: (i.) the Lofoten, from January to April, when the fishing is carried on by 25,000 to 32,500 men, using 6000 to 8000 boats; (ii.) the Finmark, carried on by a fluctuating number of men, 12,000 to 29,000, and of boats, 4000 to 7500; (iii.) the Romsdal, employing 12,250 to 17,000 men and 2000 to 3000 boats. During the whole of the year 1899 the cod fisheries of Norway gave employment to a total of 77,139 men; the number of boats employed was 17,892, and the aggregate number of fish caught was 37,584,000, a little more than half the annual average for the years 1888–97, their value being £617,900 (average for the years 1888–97, £781,600). Since 1898 there has been a sensible falling-off in these fisheries, so much so that in 1901 less than 20 million cod were taken in the Lofoten and Finmark catches, the lowest for many years. The principal fishing-grounds for herrings are off the coast of Nordland, the west coast between Trondhjem and Bergen, off Bukken Fjord and in Christiania Fjord, and along the south coast. In 1897 some 203,600 tons of herrings were caught, the largest quantity since 1874, their value being £441,888; in 1900 only 120,000 tons were taken, but they realized £489,000. As a rule the annual take of herrings ranges between £200,000 and £350,000. Of salmon and sea-trout 709 tons, valued at £52,590, were taken in 1899; average value, 1881 to 1897 inclusive, £35,000. To these must be added £17,000 to £18,000 for the salmon caught in the fresh-water rivers and lakes. Coal-fish and ling were caught along the coast of Finmark to the value of £259,100 in 1899; average for 1881 to 1897, £156,700. The value of the mackerel (south coast), lobsters, and oysters caught in 1899 was £51,300. Norwegian fishermen, especially from Tönsberg and the northern ports of Tromsö, Hammerfest, Vardö, and Vadsö, take part in the Arctic whale, seal, shark, and walrus hunting. In 1900 a fishery board for the administration of all the Norwegian fisheries was established at Bergen.

Mercantile Marine.—Next after the fisheries comes the merchant navy. It was in 1879 that Norway first took a relatively high

[1] The increase is partly due to the extension of the municipal boundaries.

[2] The municipal boundaries were extended between the census of 1875 and the census of 1891.

[3] Or, including Norwegian sailors serving abroad on Norwegian vessels, 2,004,102.

place. In that year 5 per cent. of the total measured tonnage of the world flew the Norwegian flag. It should, however, be mentioned that now there are a large number of British-owned vessels sailing under the Norwegian flag. The principal ship-owning ports in 1899 were, in the order of tonnage: Bergen (579,950 calculated[1]) tons, Christiania (393,600 tons), Tönsberg (261,800), Stavanger (162,400), Arendal (109,450), Haugesund (107,300), Drammen, Grimstad, Porsgrund, Fredrikstad, Kragerö, and Christiansand. The growth of the Norwegian mercantile marine will be apparent from the following table:—

Year.	Steam-ships.	Tonnage.	Sailing Ships.	Tonnage.	Total Vessels.	Total Calculated Tonnage.
1887	514	438,458	6755	1,381,778	7269	1,820,236
1897	1004	1,379,232	6143	1,169,079	7147	2,548,311
1900	1128	1,736,089	5698	1,052,687	6826	2,788,776

The rugged coast of Norway is well protected by lighthouses.

Commerce.—The subjoined table gives particulars of the total trade with all foreign countries:—

Year.	Imports.	Per Head of Population.	Exports.	Per Head of Population.	Total Imports and Exports.	Per Head of Population.
1887	£7,427,300	£$3\frac{3}{4}$	£5,923,800	£3	£13,351,100	£$6\frac{3}{4}$
1897	14,651,020	7	9,316,480	$4\frac{3}{8}$	23,967,500	$11\frac{3}{8}$
1900	17,951,350	8	9,834,400	$4\frac{3}{8}$	27,785,750	$12\frac{3}{8}$

In 1887 Great Britain supplied imports to the total value of £1,965,000 (26·5 per cent.), and received exports to £1,921,000 (32·4 per cent.); in 1897 she supplied £3,752,000 (25·6 per cent.) of the imports and received £3,632,600 of the exports (39 per cent.). In 1900 Great Britain sent 30 per cent. of the imports, and received 42·5 per cent. of the exports; and in the same year the United States contributed 5·5 per cent. of Norway's imports, and took 1·1 per cent. of her exports. The most important exports are fish and fish products (£3,295,000 in 1899), timber (£2,197,700), wood-pulp (£1,016,500), paper (£452,000), butter and condensed milk (£476,100). Next in order come textiles, hides and leather, mineral ores and metals, nails, hewn stone and bricks, ships, matches, and ice. The imports of greatest value are cereals and flour (£2,843,450), textiles (£1,393,600), groceries and preserved fruits (£1,342,800), ironmongery (£1,536,100), coal (£1,334,400), raw cotton, wool, &c., and yarn (£767,500), ships (£1,041,450), raw metals (£749,400), machinery, &c. (£595,400), with timber, skins, bacon and meat, wines and spirits, glass and pottery, books, paper, salt, &c. In 1897 Great Britain took 60 per cent. of the timber, Cape Colony 4·5 per cent., and Australia 2·8 per cent. of the total of 74 million cubic feet.

The subjoined table shows the number of vessels which entered at Norwegian ports in the years mentioned, together with their aggregate tonnage:—

Year.	Total.		British.		German.		United States.	
	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.
1886	11,209	2,316,278	3348	1,104,243	972	272,417	48	59,861
1896	13,201	2,908,946	3805	1,458,051	1061	340,159	57	98,143

In 1898 all the Norwegian ports together were entered and cleared by an aggregate of 6,297,400 tons, of which 4,197,250 tons were Norwegian, 737,000 British, 521,300 Danish, and 414,100 Swedish.

Forests.—In 1897 it was estimated that 33,582 square miles, or 26·9 per cent. of the entire area, was under forests. They occupy all the eastern and middle parts of the country from 58° up to 68° N. Of the timber standing in 1897 it was estimated that 73 per cent. was pine wood (red and white), and the rest umbrageous trees, amongst which the birch predominated.

Mining.—Norway has mines of copper pyrites, silver, nickel, zinc, cobalt, molybdenum, iron, and apatite, but none of these is worked on a very extensive scale. In the years 1888–98 inclusive from 1650 to 2500 men were employed annually in mining in Norway; and in 1900 the number was 2750. The total value dropped from £206,555 in 1889 to £147,777 in 1893, but in 1900 rose to £210,800. The average for the ten years 1887–96 was £165,746. In 1897 the yield was the largest ever known, and embraced 90,000 tons of copper pyrites and 1450 tons of pure copper, and the aggregate value of the ores delivered at Norwegian ports for export was £207,182. The pyrites and copper mines are at Röros (100 miles south-south-east of Trondhjem by rail), Sulitjelma (at the head of Salten Fjord, in 67° 20′), Ranen (on the west coast, in 66° 15′), Lyngen and Alten in the extreme north, at Killingdal, Drogset in Meldal, and on Ytterö. Silver is mined at Kongsberg; iron in Hardanger, at Ulefos, and near Arendal; cobalt at Modum; molybdenum at Knaben; nickel at Evje in Sætersdal, north from Christiansand; zinc at Sand, between Stavanger and Bergen; and apatite at Ödegaard, between Laurvik and Kragerö. Coal exists on Andenäs in the Lofotens. Granite is extensively quarried in the vicinity of Fredrikstad, Fredrikshald, and Sarpsborg, and exported as paving setts and kerbstones, mostly to Great Britain and Germany. Fine beds of marble, in some parts running 10 to 12 miles on end and several yards thick, are worked near Fredrikshald. Other beds occur in the Salten and Ranen districts.

Communications.—Norway possesses only one line of railway of any considerable length, namely, that which runs north from Christiania to Trondhjem; but there are several short lines, such as the connexions eastwards with the Swedish railway systems from Christiania and Trondhjem, the lines connecting the capital with Drammen and Skien, the Sætersdal railway, the Jæderen railway, and the line from Bergen to Vossevangen. This last is now being continued towards Christiania. Another important line, perhaps the most northerly in the world, is that intended to connect Narvik or Victoria Harbour (on the Ofoten Fjord, in 68° 30′ N.) with the iron mines of Gellivara in Sweden. Altogether there were 1230 miles of railways open in 1900, of which 1119 were State lines; the gross earnings for the year 1899 being £804,450, of which £259,450 was net profit. In 1895 there were 5991 miles of main roads and 10,776 of communal roads. Most of these have been reconstructed since 1850, and several of them exhibit evidence of considerable engineering skill. By the aid of Government subventions, regular steamboat communication is maintained all the year round on the fjords, coasts, and larger lakes. Even in winter steamboats run regularly to Hammerfest and Vadsö. Both telegraph and telephone systems are exceptionally extensive for such a country as Norway. The annexed table gives particulars of the telegraph system:—

Year.	Total Length.		Receipts.	Net Profits.	No. of Telegrams.	
	Of Lines.	Of Wires.			At Home.	Abroad.
1899	7164	20,650	£120,150	£15,950	1,340,708	818,062

In 1887 an aggregate total of 15,801,600 home letters and post-cards passed through the post office, and in 1899, 36,700,000; received from and despatched to foreign countries, 2,694,800 in 1887 and 11,797,800 in 1899. The book post and parcel post packets for home numbered 21,557,900 in 1887 and 54,877,400 in 1899; those from and for foreign countries numbered 809,300 in 1887 and 5,643,900 in 1899. The gross earnings of the post office in 1899 amounted to £267,870, and the net profits to £13,560.

Banks and Finances.—There are two State banks—the Bank of Norway and the Mortgage Bank of the Kingdom of Norway. The former is a joint-stock bank, owned in great part by the Government, its directors being elected by the Storthing or Parliament, except the president of the head office, who is nominated by the king. It is the only bank in Norway authorized to issue bank-notes. There were, further, 411 savings banks in 1900, having 671,241 depositors, with £16,829,400 (or an average of £25, 1s. 5d. per head, as compared with £23, 5s. 7d. in 1870) deposits to their credit. Budget particulars, and the amount of the national debt, are contained in the following table:—

Year.	Receipts.	Expenditure.	Receipts from Customs Dues.	Receipts from Indirect Taxes.[1]	National Debt.	National Debt per Inhabitant.
1887	£2,387,600	£2,449,200	£1,141,600	£1,419,500	£6,023,760	£3 1 1
1897	3,835,950	4,262,800	1,578,700	2,019,800	10,074,700	4 15 6
1899	5,315,850	4,959,100	2,079,000	2,731,350	11,030,500	4 18 0

The income-tax was first levied in 1892; in 1895 it was made "graduated," the lowest income to be taxed being 1000 kroner (=£55, 6s. 8d.). The produce of the tax increased from £158,900 in 1892 to £280,229 in 1899; and the total incomes upon which the tax was levied increased during the same period from £17,028,000 to £24,383,400.

Government.—In 1899, after long and heated parliamentary action, and after being twice vetoed by the king, Norway extorted the right to remove the sign of union with Sweden from the flag of her merchant marine. There was also a violent agitation for Norwegian consuls abroad distinct from Swedish consuls. In 1898 parliamentary franchise was made universal, the right to vote being given to every man of Norwegian nationality who is twenty-five years of age, who has dwelt five years in the country, and who possesses the necessary property and legal qualifications. In

[1] One steam ton is taken as equivalent to 3·6 sailing tons.

[1] This includes the figures given under the column headed "Receipts from Customs Dues."

each town and bailiwick there is a court of arbitration, over which two authorities preside who have been selected by the (elected) parliamentary voters. As a rule all civil disputes are, in the first instance, brought before these arbitrators. There are now only three courts of appeal, each with three justices, at Christiania, Bergen, and Trondhjem respectively.

Army and Navy.—The army embraces the line, the militia or reserve, and the second reserve. All men of twenty-two years of age and upwards are liable for conscription, and when called they serve five years in the line, four years with the reserve, and four years with the second reserve. The men of the line are the only troops who can be sent out of the country for purposes of war. But, though the nominal period of service is altogether thirteen years, the men only meet for annual military training for periods of eighteen to seventy days in each year. The peace establishment of the line amounts to 12,000 men, with 750 officers; its war footing to 18,000 men, or more. The navy consists of about 850 officers and men on permanent service; but all seafaring men between the ages of twenty-two and thirty-five are liable for maritime conscription, and are all put through some preliminary training. The war vessels embrace four turret-ships of 3500 tons each, and about a dozen other modern vessels, some small gunboats, and a torpedo flotilla—the whole being intended for coast defence only.

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(J. T. BE.)

II. HISTORY.

Events leading to the union with Sweden.

After a union of nearly 400 years between Norway and Denmark, the Danish king, Frederick VI., without consulting the Norwegians, ceded Norway to Sweden by the treaty of Kiel (14th January 1814). By this arbitrary act—one of the results of the great European upheaval in the early years of the 19th century—Norway, as events proved, benefited more than most European states. Some time previously Sweden had joined the Allied Powers in their struggle against Napoleon, while Denmark had, unwisely, sided with the French. In 1813 the Swedish crown prince, Carl Johan (formerly Bernadotte, one of Napoleon's marshals[1]), proceeded to Germany and took command of one of the armies of the Allied Powers. After the power of Napoleon had been broken at the battle of Leipzig, Carl Johan advanced against Denmark, and King Frederick soon saw himself compelled to accede to the Swedish demand—the cession of Norway, the possession of which had long been the aspiration of the Swedes, especially after the loss of Finland in 1809. In the treaty of Kiel Frederick VI. absolved the Norwegians from their oath of allegiance, and called upon them to become the loyal subjects of the Swedish king. But the Norwegians, who had not been consulted in the matter, refused to acknowledge the treaty, declaring that, while the Danish king might renounce his right to the Norwegian crown, it was contrary to international law to dispose of an entire kingdom without the consent of its people. They would not tamely submit to be handed over as mere chattels to Sweden; they asserted their independence and their right to decide their own fate. A meeting of delegates from all parts of the country was convened at Eidsvold, not far from the Norwegian capital, where, on the 17th of May 1814, a constitution, framed upon the constitutions of America, of France (1791), and of Spain (1812), was adopted. Among its most important features are that the Storthing or National Assembly is a single-chamber institution, and that the king is not given an absolute veto, or the right to dissolve the Storthing. The then Danish governor of Norway, Prince Christian Frederick, was unanimously elected king. Soon afterwards the Swedes, under Carl Johan, the Swedish crown prince, invaded Norway. They met with a gallant resistance, but Prince Christian soon saw the hopelessness of the struggle, and declared himself willing to abdicate. The hostilities lasted only a fortnight, when Carl Johan opened negotiations with the Norwegians. A convention was held at Moss, where it was proposed that the Norwegians should accept the Swedish king as their sovereign, on the condition that their constitution of the 17th of May should remain intact, except with such alterations as the union might render necessary. An extraordinary Storthing was then summoned at Christiania, and on the 4th of November 1814 Norway was declared to be "a free, independent, and indivisible kingdom, united with Sweden under one king." A month previously Prince Christian Frederick had laid down his crown and left the country.

The union was more fully defined by the "Act of Union," which was accepted by the National Assemblies of both countries in the following year. In the preamble to the Act it is clearly stated that the union between the two peoples was accomplished "not by force of arms, but by free conviction," and the Swedish foreign minister declared to the European Powers, on behalf of Sweden, that the treaty of Kiel had been abandoned, and that it was not to this treaty, but to the confidence of the Norwegian people in the Swedish, that the latter owed the union with Norway. The constitution framed at Eidsvold was retained and forms the *Grundlov*, or fundamental law of the kingdom. It is generally acknowledged to be the freest and most democratic constitution of all monarchical states. The union thus concluded between the two countries was really an offensive and defensive alliance under a common king, each country retaining its own government, parliament, army, navy, customs, &c. The relations between the two countries may be more clearly understood when it is realized that a Norwegian is a foreigner in Sweden, and a Swede in Norway, and that consequently a Norwegian can hold no official appointment in Sweden, and *vice versa*.

In Sweden the people received only an imperfect and erroneous insight into the nature of the union, and for a long time believed it to be an achievement of the Swedish arms, while to the leading men of the country, who knew the terms of the union better, it was a great disappointment. They had hoped to make Norway a province of Sweden, and now they had entered into a union in which both countries were equally independent. During the first fifteen years the king was represented in Norway by a Swedish viceroy, while the Government was, of course, composed only of Norwegians, selected from various parties in the country. Count Wedel Jarlsberg was the first to be entrusted with the important office of head of the Norwegian Government, while several of Prince Christian Frederick's councillors of state were retained, or replaced by others holding their political views. The Swedish Count v. Essen was appointed the first viceroy of Norway, and was succeeded two years afterwards by his countryman Count v. Mörner, over both of whom Count Wedel exercised considerable influence.

Strained relations between king and Storthing.

During the first years of the union the condition of Norway was in many respects most unprosperous. The country suffered from poverty and depression of trade, and the finances were in a deplorable condition. The first Storthing was chiefly occupied with financial and other practical measures. In order to improve the finances of the country a Bank of Norway was founded, and the army was reduced to one half, as the defence of the country was not considered to be of great importance now that the union

[1] In 1810 he was elected heir to the Swedish throne, in succession to the childless King Carl XIII., who died in 1818.

had been concluded. The paid-up capital of the bank was procured by the assessment of an extraordinary tax, and this, together with the growing discontent among the peasantry, brought about a rising in Hedemarken and the neighbouring districts, the object of which was to dissolve the Storthing and to obtain a reduction in the taxation. It was also rumoured that the organizers of this agitation intended establishing an absolute government, and many therefore imagined they saw the machinations of the royal power behind the rising; while, on the other hand, the king himself believed he had to deal with Danish intrigues. The rising, however, soon subsided, and the bountiful harvest of 1819 brought more prosperous times to the peasantry. Meanwhile, however, the financial position of the country had nearly endangered its independence. The settlement with Denmark with regard to Norway's share of the national debt common to both, which had so long been deferred, and could not be evaded, had assumed threatening proportions. In the interest of Denmark, the Allied Powers asked for a speedy settlement, and in order to escape their collective intervention, Carl Johan, who had now succeeded to the throne of Sweden and Norway, on the death (5th February 1818) of the old King Carl XIII., accepted England's mediation, and was enabled in September 1819 to conclude a convention with Denmark, according to which Norway was held liable for only 3,000,000 specie dollars (nearly £700,000). But the Norwegians considered that this was still too much, and the attitude of the Storthing in 1821 had nearly occasioned a fresh interference of the Powers. The Storthing, however, yielded at last, and agreed to raise a loan and pay the amount stipulated in the convention. Although this matter now seemed to be in a fair way of being settled, the king evidently had his doubts as to whether the Norwegians really intended to fulfil their obligations. As his relations with the Storthing had already become strained, and as he was occupied at that time with plans, which it is now known meant nothing less than a *coup d'état* in connexion with the revision of the Norwegian constitution, he decided to adopt military preparations, and in July 1821 he collected a force of 3000 Swedish and 3000 Norwegian troops in the neighbourhood of Christiania, ostensibly for the mere purpose of holding some manœuvres, but his object was undoubtedly to impress the Storthing with his authority and to frighten it into submission. In a circular note (1st June) to the European Powers, signed by the Swedish foreign minister, Engström—but it is not difficult to recognize the hand of the king as the real author—the minister complained bitterly of the treatment the king had met with at the hands of the Storthing, and represented the Norwegians in anything but a favourable light to the Powers, the intention being to obtain their sympathy for any attempt that might be made to revise the Norwegian constitution, as, for example, by the substitution of an absolute for a suspensive veto, by conferring upon the king the right to dissolve the Storthing and to elect its presidents—in short, to adapt the Norwegian constitution to the liking of his less democratic Swedish subjects.

About this time another important question had to be finally settled by the Storthing, which the king was anxious to oppose at all costs. The Storthings of 1815 and 1818 had already passed a bill for the abolition of nobility, but the king had on both occasions refused his sanction. The Norwegians maintained that the country was too poor consistently to keep up an aristocracy, and that the few counts and barons still to be found in Norway were all Danish and of very recent origin, while the really true and ancient nobility of the country were the Norwegian peasants, descendants of the old jarls and chieftains, who had no desire for titular distinction. According to the constitution, any bill which has been passed by three successively elected Storthings (elections are held every third year) becomes law without the king's sanction. When the third reading of the bill came on, the king did everything in his power to obstruct it, but in spite of his opposition the bill was eventually carried and became law. These conflicts with the king had increased the strained relations which for some time had existed between him and the Storthing; but after the question of the debt to Denmark had been settled, and the king had formally sanctioned the bill for the abolition of nobility, a more conciliatory feeling set in.

In 1822 Count Wedel Jarlsberg retired from the Government. He had become unpopular through his financial policy, and was also at issue with the king on vital matters. In 1821 he had been impeached before the Rigsret (the supreme court of the realm) for having caused the State considerable losses. J. Collett was appointed as his successor to the post of Minister of Finance.

Royal proposals for constitutional revision.

The king had by this time apparently abandoned his plan of a *coup d'état*, for in the following August he submitted to the Storthing several proposals for fundamental changes in the constitution, all of which aimed at removing all that was at variance with a monarchical form of government. The changes, in fact, were the same as he had suggested in his circular note to the Powers, and which he knew would be hailed with approval by his Swedish subjects. It may seem strange that the king, favoured as he was by circumstances, took the constitutional course, when he might easily have gained his end by a *coup d'état;* but although Carl Johan was a man of courage on the battlefield, he seems to have been wanting in *courage civil*, and he doubtless feared that a *coup d'état* might result in unpleasant and humiliating consequences for himself. At the same time he knew that the Great Powers looked upon him with distrustful eyes, and that even in Sweden there were powerful enemies working against him.

When the Storthing met again in 1824 the royal proposals for the constitutional changes came on for discussion. The Storthing adopted a friendly attitude towards the king personally, without, however, showing itself subservient; but the assembly unanimously rejected not only the king's proposals, but also several others by private members for changes in the constitution. The king submitted his proposals again in the following session of the Storthing, and again later on, but they were always unanimously rejected. In 1830 they were discussed for the last time, with the same result. The king's insistence was viewed by the people as a sign of absolutist tendencies, and naturally excited fresh alarm. They felt they would have to be on their guard against all attempts at encroachment and at amalgamation between Norway and Sweden. In the eyes of the people the members of the Opposition in the Storthing were the true champions of the rights and the independence which they had gained in 1814.

The king's absolutist tendencies.

For several years the Norwegians had been celebrating the 17th of May as their day of independence, it being the anniversary of the adoption of the constitution of 1814; but as the tension between the Norwegians and the king increased, the latter began to look upon the celebration in the light of a demonstration directed against himself, and when Collett, the Minister of Finance, was impeached before the supreme court of the realm for having made certain payments without the sanction of the Storthing, he also considered this as an attack upon himself and his royal prerogatives in general. His irritation knew no bounds, and although Collett was acquitted by the supreme court, the king, in order to express his irritation with the Storthing and the action they had taken against one of his ministers, dissolved the National Assembly with every sign of displeasure. The Swedish viceroy at the time, Count Sandels, had tried to convince him that his prejudice against the celebration of the 17th of May was groundless, and for some years the king had made no objection to the celebration. In 1827 it was, however, celebrated in a very marked manner, and later in the same year there was a demonstration against a company of Swedish actors who had been performing a foolish political piece called *The Union*, and this being privately reported to the king and represented to him in as bad a light as possible, he thought that Count Sandels, who had not considered it worth while to report the occurrence, was not fitted for his post, and had him replaced by Count Platen, an upright but narrow-minded statesman, who was looked upon as a mouthpiece of the prevailing opinion in Sweden, where the people considered themselves defrauded of the real union they had hoped for.

Count Platen's first act was to issue a proclamation warning the people against celebrating the day of independence; and in April 1828 the king, against the advice of his ministers, summoned an extraordinary Storthing, in consequence of the judgment of the supreme court and the uncertain basis upon which that judgment seemed to place his royal prerogatives, his intention being to wrest from the Storthing the supremacy it had gained in 1827. He also intended to take steps to prevent the celebration of the 17th of May, and in order to give due emphasis to his proposals he assembled a force of 2000 Norwegian soldiers in the neighbourhood of the capital. The king arrived in Christiania soon after the opening of the extraordinary Storthing. He did not succeed, however, in his attempt to make any constitutional changes, but the Storthing met the king's wishes with regard to the celebration of the 17th of May by deciding not to continue the celebration, and the people all over the country quietly acquiesced. This was all that resulted from the king's great efforts on this occasion; but even this little triumph did not last long. The following year trouble broke out again. The students had decided to celebrate the 17th of May with a festive gathering, which, however, passed off quietly. But it was known that the authorities had made extraordinary preparations, and large masses of the people paraded the streets, out of curiosity, singing and shouting, and gathered finally in the market-place. There was no rioting or disturbance, but the Riot Act was read, and the police and the military eventually dispersed the people and drove them to their homes with sword and musket. This episode has become known as the "Battle of the Market-place," and did much to increase the general ill-feeling against Count Platen, who, it has since been proved, was no friend of Norway, having actually

The "battle of the market-place."

advised the king to try a *coup d'état*. His health eventually broke down from disappointment and vexation at the indignities and abuse heaped upon him. He died in Christiania at the end of the year, and owing to the state of public feeling his post was not filled by a Swede, but remained vacant for several years, the presidency of the Norwegian Government in the meantime being taken by Collett, its oldest member. From this time the day of independence has been celebrated every year with increasing enthusiasm.

By the July Revolution the political situation in Europe became completely changed, and the lessons derived from that great movement reached also to Norway. A new generation had grown up, which was more familiar with the forms of political freedom, and also bolder in adopting them. The representatives of the peasantry, for whom the constitution had paved the way to become the ruling element in political life, were also beginning to distinguish themselves in the National Assembly, where they now had taken up an independent position against the representatives of the official classes, who in 1814 and afterwards had played the leading and most influential part in politics. This party was now under the leadership of the able and gifted Ole Ueland, who remained a member of every Storthing from 1833 to 1869. The Storthing of 1833 was the first of the so-called "peasant Storthings." Hitherto the peasantry had never been represented by more than twenty members, but the elections in 1833 brought their number up to forty-five, nearly half of the total representation. The attention of this new party was especially directed to the finances of the country, in the administration of which they demanded the strictest economy. They often went too far in their zeal, and thereby incurred considerable ridicule, and even the contempt of the official and well-to-do classes, who began to regard the new party with distrustful and hostile feelings.

Increased political power of the peasantry.

About this time the peasant party found a champion in the youthful poet Henrik Wergeland, who threw himself heart and soul into the political questions of the day, and soon became one of the leaders of the "Young Norway" party. He was a republican in politics, and the most zealous upholder of the national independence of Norway and of her full equality with Sweden in the union. He soon became as detested by the "party of intelligence," as the official and well-to-do classes were called, as the party he had joined. In addition to the political struggles of the day, a literary conflict now began, which lasted for many years, and which in violence and intensity has scarcely ever been equalled in the history of the country. A strong opposition to Wergeland and the peasant party was formed by the upper classes under the leadership of another rising poet and writer, Johan Sebastian Welhaven, and other talented men, who wished to retain the literary and linguistic relationship with Denmark, while Wergeland and his party wished to make the separation from Denmark as complete as possible, and in every way to encourage the growth of the national characteristics and feeling among the people. Wergeland had therefore welcomed with joy the increase of the peasant party: he considered the peasantry the real descendants of the old Norsemen, the kernel of the nation, in fact, and with the prophetic foresight of the poet saw the important part they would play in the future political and intellectual life of the country. He devoted much of his time, by writing and other means, to promote the education of the people; but although he was most popular with the working and poorer classes, he was not able to form any political party around him, and at the time of his death he stood almost isolated. He died in 1845, and his opponents became now the leaders in the field of literature, and carried on the work of national reconstruction in a more restrained and quiet manner. The peasant party still continued to exist, but restricted itself principally to the assertion of local interests and the maintenance of strict economy in the budget.

Wergeland; opposed by Welhaven.

The violent agitation that began in 1830 died away, and after Wergeland's death the political life of the country assumed a more quiet and harmonious aspect. The tension between the king and the legislature, however, still continued, and reached its height during the session of 1836, when all the royal proposals for changes in the constitution were laid aside, without even passing through committee, and when various other steps towards upholding the independence of the country were taken. The king, in his displeasure, decided to dissolve the Storthing; but before it dispersed it proceeded to impeach Lövenskiold, one of the ministers, before the supreme court of the realm, for having advised the king to dissolve the Storthing. He was eventually sentenced to pay a fine of 10,000 kroner (about £550), but he retained his post. Collett, another minister who had greatly displeased the king by his conduct, was dismissed; but unity in the Government was brought about by the appointment of Count Wedel Jarlsberg as viceroy of Norway. From this time the relations between the king and the Norwegian people began to improve, whereas in Sweden he was in his later years not a little disliked.

When the king's anger had subsided, he summoned the Storthing to an extraordinary session, when several important bills were passed. Towards the close of the session an address to the king was agreed to, in which the Storthing urged that steps should be taken to place Norway in political respects upon an equal footing with Sweden, especially in the conduct of diplomatic affairs with foreign countries. The same address contained a petition for the use of the national or merchant flag in all waters. According to the constitution, Norway was to have her own merchant flag, and in 1821 the Storthing had passed a resolution that the flag should be scarlet, divided into four by a blue cross with white borders. The king, however, refused his sanction to the resolution, but gave permission to use the flag in waters nearer home; but beyond Cape Finisterre the naval flag, which was really the Swedish flag, with a white cross on a red ground in the upper square, had to be carried. In reply to the Storthing's address the king in 1838 conceded the right to all merchant ships to carry the national flag in all waters. This was hailed with great rejoicings all over the country; but the question of the national flag for general use had yet to be settled, and later on gave rise to long and violent strifes before it was finally settled in accordance with the wishes of the people. With regard to the question raised in the address of the Storthing about the conduct of diplomatic affairs, and other matters concerning the equality of Norway in the union, the king in 1839 appointed a committee of four Norwegians and four Swedes, who were to consider and report upon the questions thus raised. In 1835 a royal decree had ordained that when the Swedish minister of foreign affairs transacted business which concerned the two countries, or Norway only, the Norwegian minister in attendance upon the king at Stockholm should be present; but the Storthing, in its address, declared that it only considered this resolution to be a preparatory step towards a more complete and satisfactory arrangement of this important matter.

The national flag question.

During the sitting of this first "Union Committee," as it was called, the question of a complete revision of the Act of Union was raised by the division of the Norwegian Government in attendance upon the king at Stockholm, but the proposal was not accepted by the Norwegian home Government. The powers of the committee were, however, extended to consider a comprehensive revision of the Act of Union, with the limitation that the fundamental conditions of the union must in no way be interfered with. But before the committee had finished their report the king died (8th March 1844), and was succeeded by his son Oscar I. According to the constitution the Norwegian kings must be crowned in Throndhjem cathedral, but the bishop of Throndhjem was in doubt whether the queen, who was a Catholic, could be crowned, and after the question had become the subject of public discussion, the king decided to forego the coronation both of himself and his queen. The new king soon showed his desire to meet the wishes of the Norwegian people. Thus he decided that in all documents concerning the internal government of the country Norway should stand first where reference was made to the king as sovereign of the two kingdoms. After having received the report of the committee concerning the flag question, he resolved (20th June 1844) that Norway and Sweden should each carry its own national flag as the naval flag, with the mark of union in the upper corner; and it was also decided that the merchant flag of the two kingdoms should bear the same mark of union, and that only ships sailing under these flags could claim the protection of the State. The Union Committee did eventually present a report, in which it was proposed that the two countries should have a foreign minister in common, which the Norwegian Government gave their opinion upon, but which the Swedish Government rejected.

Death of King Carl Johan; succeeded by Oscar I.

The financial and material conditions of the country had now considerably improved, and King Oscar's reign was marked by the carrying out of important legislative work and reforms, especially in local government, of which Norway now possesses one of the most perfect systems. New roads were planned and built all over the country, the first railway was built, steamship routes along the coast were established, lighthouses were erected, and trade and shipping made great progress. The king's reign was not disturbed by any serious conflicts between the two countries, and the relations between the Government and the Storthing were of a harmonious character, both working for the internal development of the country. No change took place in the ministry under the presidency of the Viceroy Lövenskiold upon King Oscar's accession to the throne, but on the death or retirement of some of its members the vacant places were filled by younger and talented men, among whom was Frederik Stang, who in 1845 took over the newly established Ministry of the Interior. During the Schleswig-Holstein rebellion (1848–50) and the Crimean war King Oscar succeeded in maintaining the neutrality of Norway and Sweden, by which Norwegian shipping especially benefited. The abolition of the English Navigation

Acts (1850) was of great importance to Norway, and opened up a great future for its merchant fleet.

In 1826 a treaty had been concluded with Russia, by which the frontier between that country and the adjoining strip of Norwegian territory in the Polar region was definitely delimited; but in spite of this treaty Russia in 1851 demanded that the Russian Lapps on the Norwegian frontier should have the right to fish on the Norwegian coast, and have a portion of the coast on the Varanger fjord allotted to them to settle upon. The Norwegian Government refused to accede to the Russian demands, and serious complications might have ensued if the attention of Russia had not been directed in another direction. While his father had looked to Russia for support, King Oscar was more inclined to secure the Western Powers as his allies, and during the Crimean war (1855) he concluded a treaty with England and France, according to which these countries promised their assistance in the event of any fresh attempts at encroachment on Norwegian or Swedish territory by Russia. In consequence of this treaty the relations between Norway and Sweden and Russia became somewhat strained; but after the peace of Paris (1856) and the accession of Alexander II., whose Government was in favour of a peaceful policy, the Russian ambassador at Stockholm succeeded in bringing about more friendly relations.

Relations with Russia.

In 1855 two commissions, consisting of an equal number of Norwegians and Swedes, were appointed. One of these was to consider a new bill for regulating the commercial relations between the two countries, which was to take the place of an older one of 1827; while the other commission was to prepare a bill for the execution in either country of judicial judgments delivered in the other. The reports of these commissions were laid before and passed by the Swedish Riksdag; but when they came before the Norwegian Storthing they were rejected as unsuitable for Norway, a decision which caused great irritation in Sweden.

Owing to the king's ill-health, his son, Crown Prince Carl, was appointed regent in 1857, and two years later, when King Oscar died, he succeeded to the thrones of the two countries as Carl XV. He was a gifted, genial, and noble personality, and won the hearts of all who came into contact with him. He was also of an artistic nature, and devoted himself to painting, poetry, and music. He had desired to inaugurate his reign by giving the Norwegians a proof of his willingness to acknowledge the claims of Norway, but he did not live to see his wishes in this respect carried out. According to the constitution, the king had the power to appoint a viceroy for Norway, who might be either a Norwegian or Swede. Since 1829 no Swede had held the post, and since 1859 no appointment of a viceroy had been made, the general hope being that the office would be abolished altogether. But the paragraph in the constitution still existed, and the Norwegians naturally wished to have this stamp of "provinciality" obliterated. A proposal for the abolishment of the office of viceroy was laid before the Storthing in 1859, and passed by it. The king, whose sympathies on this question were known, had been appealed to, and had privately promised that he would sanction the proposed change in the constitution; but as soon as the resolution of the Storthing became known in Sweden, a violent outcry arose both in the Swedish press and the Swedish Estates. The latter adopted a resolution declaring that the paragraph relating to the office of viceroy was a necessary condition of the union between the two countries, and could not be altered without the consent of the Swedish executive. Under the pressure that was brought to bear upon the king in Sweden, he eventually refused to sanction the resolution of the Storthing; but he added that he shared the views of his Norwegian counsellors, and would, when "the convenient moment" came, himself propose the abolition of the office of viceroy. This was but a poor consolation for the Norwegian people, who well knew that it was the dominant feeling in Sweden against the equality of Norway in the union which had come out triumphantly on this occasion. When the Storthing received the news of the refusal, it adopted an address to the king (April 1860) which stated that no Norwegian who had any regard for his country and his own honour would take any share in the revision of the Act of Union on any other basis than that of the complete equality of the two kingdoms in the union.

Death of Oscar I.; accession of Carl XV.

Question of Norwegian viceroy.

In the following year the Swedish Government again pressed the demands of the Swedish Estates for a revision of the Act of Union, which this time included the establishment of a union or common parliament for the two countries, on the basis that, according to the population, there should be two Swedish members to every Norwegian. The proposal was sent to the Norwegian Government, which did not seem at all disposed to entertain it; but some dissensions arose with regard to the form in which their reply was to be laid before the king. The more obstinate members of the ministry resigned, and others, of a more pliable nature, were appointed under the presidency of Fredrik Stang, who had already been minister of the interior from 1845 to 1856. The reconstructed Government was, however, in accord with the retiring one, that no proposal for the revision of the Act of Union could then be entertained, as the attitude of Sweden towards the claims of the Norwegians for equality in the union seemed to be the same as in 1859 and 1860, and the question was in consequence to be allowed to rest for the time being. The king, however, advocated the desirability of a revision, but insisted that this would have to be based upon the full equality of both countries.

Swedish proposals for revision of Act of Union.

In 1863 the Storthing assented to the appointment by the king of a Union Committee, the second time that such a committee had been called upon to consider this vexatious question. It was not until 1867 that the report of the committee was made public, but it could not come on for discussion in the Storthing till it met again in 1871. During this period the differences between the two countries were somewhat thrust into the background by the Danish complications in 1863–64, which threatened to draw the two kingdoms into war. King Carl was himself in favour of a defensive alliance with Denmark, but the Norwegian Storthing would only consent to this if an alliance could also be effected with two, or at least one, of the Western Powers. Under the circumstances the king felt himself obliged to withdraw from the proposed alliance with Denmark, as none of the Western Powers showed any sign of assisting the Danes, although they had guaranteed the indivisibility of Denmark.

In 1869 the Storthing passed a resolution by which its sessions from 1871 were made annual instead of triennial according to the constitution of 1814. The first important question which the first yearly Storthing in 1871 had to consider was once more the proposed revision of the Act of Union. The Norwegians had persistently maintained that in any discussion on this question the basis for the negotiations should be (1) the full equality of the two kingdoms, and (2) no extension of the bonds of the union beyond the line originally defined in the Act of 1815, but the draft of the new Act contained terms in which the supremacy of Sweden was presupposed, and which introduced important extensions of the bonds of the union; and, strangely enough, the report of the Union Committee was adopted by the new Stang ministry, and even supported by some of the most influential newspapers and in several of the leading circles of the Norwegian community. The reactionary tendencies, which were hidden under the plausible garb of "Scandinavianism," reasserted themselves, and the official classes saw in this new union a safeguard against the growing liberal and democratic movements in the country. Under these circumstances the "lawyers' party," under the leadership of Johan Sverdrup, who was to play such a prominent part in Norwegian politics, and the "peasant party," led by Sören Jaabæk, a gifted peasant proprietor, who was also destined to become a prominent figure in the political history of the country, formed an intimate alliance, with the object of guarding against any encroachment upon the liberty and independence which the country had secured by the constitution of 1814. This was the foundation of the great national party, which became known as the "Venstre" (the left), and which before long became powerful enough to exert the most decisive influence upon the political affairs of the country. When, therefore, the proposed revision of the Act of Union eventually came before the Storthing of 1871, it was rejected by an overwhelming majority, and this contentious question, which since 1859 from time to time had assumed a most threatening aspect, may now be said to have been finally shelved and disposed of. The position which the Government had taken up on this question helped to open the eyes of the Norwegians to some defects in the constitution, which had proved obstacles to the development and strengthening of the parliamentary system, of which the constitution had laid the foundation, and to the desirability of a harmonious co-operation between the executive and legislative powers of the country, in order that the smaller State might more effectively assert its rights and position in the union in opposition to the greater, which seemed ever intent upon assuming the rôle of the predominant partner in the union. And this gave rise to the great question of the admittance of the ministers to seats in the National Assembly, which came to a crisis in the 'eighties.

Foundation of the Norwegian national party.

In 1872 a private Bill came before the Storthing, proposing that the ministers should be admitted to the Storthing and take part in its proceedings. After a number of stormy debates, the Bill was successfully carried under the leadership of Johan Sverdrup, by a large majority (80 against 29); but the Government, evidently jealous of the growing powers and influence of the new Liberal party in the Storthing, advised the king to refuse his sanction to the Bill, although the Government party itself had several times in the preceding half-century introduced a similar Bill for admitting the ministers to the

Question of admittance of ministers to seats in the Storthing.

Storthing; but at that time the Opposition had looked with suspicion on the presence of the ministers in the National Assembly, lest their superior skill in debate and political experience should turn the scale too readily in favour of Government measures. Now, on the contrary, the Opposition had gained more experience and confidence in its own strength, and no doubt found that the legislative work could better be carried on if the ministers were present to explain and defend their views; but the Government saw in the proposed reform the threatened introduction of full parliamentary government, by which the ministry could not remain in office unless supported by a majority in the Storthing. The king's refusal created great dissatisfaction and irritation both in the Storthing and throughout the country. The relations between the Government and the majority in the Storthing were already considerably strained, and in the refusal the Storthing only saw another ill-timed assertion of governmental authority. Before the Storthing separated the Liberals carried a vote of censure against the Government; but the king declared that the ministers enjoyed his confidence, and that he would uphold his right to appoint and keep what ministers he pleased, and took no further notice of the vote. Two of the ministers, who had advised the ratification of the Bill, resigned, however; and a third minister, who had been in the Government since 1848, resigned also, and retired from public life, foreseeing the storm that was brewing on the political horizon. Numerous public meetings were held all over the country in support of the proposed reform, fully approving of the step the Storthing had taken by proposing the vote of want of confidence. Among the speakers was Johan Sverdrup, who had now become the acknowledged leader of the Liberal party, and who was hailed with great enthusiasm as the champion of the proposed reform.

Death of Carl XV.; accession of Oscar II.

This was the political situation when King Carl died (18th September 1872). He was succeeded by his brother, who ascended the throne as Oscar II. In the following year he gave his sanction to the Bill for the abolition of the office of viceroy, which the Storthing had again passed, and the president of the ministry was afterwards recognized as the prime minister and head of the Government in Christiania. Fredrik Stang, who was the president of the ministry at the time, was the first to fill this office. In the same year Norway celebrated its existence for a thousand years as a kingdom, with great festivities.

Proposals by the Storthing for full popular control.

In 1874 the Government, in order to show the people that they to some extent were willing to meet their wishes with regard to the great question before the country, laid before the Storthing a royal proposition for the admittance of the ministers to the National Assembly. But this was to be accompanied by certain other constitutional changes, such as giving the king the right of dissolving the Storthing at his pleasure and providing fixed pensions for ex-ministers, which they held up as a guarantee against the majority of the assembly misusing its new power. The Liberal party in the meantime received more and more support all over the country for their proposal and for full parliamentary government. Johan Sverdrup well summed up their policy in the following curt sentence: "All power must be gathered in this hall." The Bill which the Government brought in was unanimously rejected by the Storthing, the Conservatives also voting against it, as they considered the guarantees insufficient. The same year, and again in 1877, the Storthing passed the Bill for admitting the ministers to the National Assembly, but in a somewhat different form from that of 1872. On both occasions the king refused his sanction to the Bill.

The king's veto.

The Storthing then resorted to the procedure provided by the constitution to carry out the people's will. In 1880 the Bill was passed for the third time, and on this occasion by the overwhelming majority of 93 out of 113. Three Storthings after three successive elections had now carried the Bill, without any divergent resolution having been adopted in the period between the first and third reading, and according to the constitution the Bill would then become law with or without the king's sanction. It was, however, generally expected that the king and his Government would at length comply with the wishes of the people, but the king on this occasion also refused to sanction the Bill, declaring at the same time that his right to the absolute veto was "above all doubt." A feeling of disappointment and irritation pervaded the whole country, and many even of the Conservatives, both in and out of the Storthing, regretted the king's decision. Johan Sverdrup, the leader of the Liberal party and president of the Storthing, brought, however, the question to a prompt issue by proposing to the Storthing that the Bill, which had been passed three times, should be declared to be the law of the land without the king's sanction. This proposal was carried by a large majority on the 9th of June 1880, but the king and his ministers in reply declared that they would not recognize the validity of the resolution.

Struggle between the king and the Storthing.

From this moment the struggle may be said to have centred itself upon the existence or non-existence of an absolute veto on the part of the crown. The king requested the Faculty of Law at the Christiania University to give its opinion on the question at issue, and with one dissentient the learned doctors upheld the king's right to the absolute veto in questions concerning amendments of the constitution, although they could not find that it was expressly stated in the fundamental law of the country. The ministry also advised the king to claim a veto in questions of supply, which still further increased the ill-feeling in the country against the Government, and the conflict in consequence grew more and more violent.

Elections of 1882.

In the midst of the struggle between the king and the Storthing, the prime minister, Frederik Stang, resigned, and Christian August Selmer became his successor; and this, together with the appointment of another member to the ministry, K. H. Schweigaard, plainly indicated that the conflict with the Storthing was to be continued. In June 1882 the king arrived in Christiania to dissolve the Storthing, and on this occasion delivered a speech from the throne, in which he openly censured the representatives of the people for their attitude in legislative work and on the question of the absolute veto, the speech creating considerable surprise throughout the country. Great preparations were now made by both parties for the impending elections, and public meetings were held during the recess all over the country. Johan Sverdrup and Björnstjerne Björnson, the popular poet and dramatist, were the principal speakers, and called upon the people to support the Storthing in upholding the resolution of the 9th of June, and to rouse themselves to a sense of their political rights. The elections resulted in a great victory for the Liberal party, who returned stronger than ever to the Storthing, the Liberals now numbering 83 and the Conservatives only 31. The ministry, however, showed no sign of yielding or resigning their offices, and when the new Storthing met in February 1883, the Odelsthing (the lower division of the National Assembly) decided upon having the question finally settled by impeaching the whole of the ministry before the Rigsret, or the supreme court of the realm, the last constitutional means by which the Storthing could obtain the dismissal of the ministry, which for years had continued to govern without the confidence or support of the National Assembly. The jurisdiction of the Rigsret is limited to the trial of offences against the State, and there is no appeal against its decisions. The charges against the ministers were for having acted contrary to the interests of the country by advising the king to refuse his sanction—first, to the amendment of the law for admitting the ministers to the Storthing; secondly, to a bill involving a question of supply; and thirdly, to a bill by which the Storthing could appoint additional directors on the State railways.

Impeachment of ministers by the Storthing, 1883.

The ministry sentenced by the Rigsret.

The trial of the eleven ministers of the Selmer cabinet began in May 1883, and lasted over ten months. In the end the Rigsret sentenced the prime minister and seven of his ministers to be deprived of their offices, while three, who had either recommended the king to sanction the Bill for admitting the ministers to the Storthing, or had entered the cabinet at a later date, were heavily fined. The excitement in the country, already considerable before the verdict had been given, rose to feverish anxiety in expectation of what the king would do. The Conservative organs of the country openly advised the king to disregard the judgment of the supreme court, while party feeling everywhere ran high. Rumours of all kinds were afloat, and it was generally believed that the king would attempt a *coup d'état*. Many of the Conservative party in Sweden also encouraged the king to set the judgment aside, and it was even hinted that he might depend upon the Swedish army to assist him in carrying out his policy in Norway. Fortunately the king did not follow this advice, and after some hesitation he issued (11th March) an order in council announcing that the judgment of the supreme court would be carried into effect, and Selmer was then called upon to resign his position as prime minister. The king, however, in his declaration upheld the constitutional prerogative of the crown, which, he maintained, was not impaired by the judgment of the Rigsret. The Conservatives were much disappointed with the king's course of action, but consoled themselves by forcing upon the king the urgent necessity of appointing a new Conservative ministry, which would carry on the policy of the late cabinet. The following month the king, regardless of the large Liberal majority in the Storthing, asked Schweigaard, one of the late ministers, whose punishment consisted in a fine, to form a ministry, and the so-called "April ministry" was then appointed. It tried to adopt the policy of its predecessors in a moderate form, but it met with such opposition from the very first that it sent in its resignation in the following month. Professor Broch, a former minister, next attempted to form a ministry, but without success, and the king

Acquiescence by the king.

was at last compelled to appoint a ministry in accordance with the majority in the Storthing. In June 1883 Johan Sverdrup was asked to form a ministry. He selected for his ministers leading men on the Liberal side in the Storthing, and the first Liberal ministry that Norway had was at length appointed. The Storthing, in order to satisfy the king, passed a new resolution admitting the ministers to the National Assembly, which then received the formal sanction of the king.

First Liberal ministry, 1883.

During the following years a series of important reforms were carried through. Thus in 1887 the jury system in criminal matters was introduced into the country after violent opposition from the Conservatives. A Bill intended to give parishioners greater influence in Church matters, and introduced by Jakob Sverdrup, the minister of education, and a nephew of the prime minister, met, however, with strong opposition, and was eventually rejected by the Storthing, the result being a break-up of the ministry and a disorganization of the Liberal party. In June 1889 the Sverdrup ministry resigned, and a Conservative one was formed by Emil Stang, the leader of the Conservatives in the Storthing, and during the next two years the Storthing passed various useful measures; but the ministry was eventually wrecked on the rock of the great national question which about this time came to the front —that of Norway's share in the transaction of diplomatic affairs. At the time of the union in 1814 nothing had been settled as to how these were to be conducted, but in 1835 a resolution was issued, that when the Swedish foreign minister was transacting diplomatic matters with the king which concerned both countries, or Norway only, the Norwegian minister of state in attendance upon the king at Stockholm should be present. This arrangement has not always proved satisfactory to the Norwegians, especially as the Swedish foreign minister cannot be held responsible to the Norwegian Government or Parliament; but in the meanwhile this state of affairs has been allowed to drift on, and gradually the Swedish foreign minister has come to be looked upon as the foreign minister for Norway also. But this is not sanctioned by any paragraph in the constitution or the Act of Union, neither has it been confirmed by any act of the Storthing, and the Norwegians maintain that Norway has not enjoyed equal rights in the union and equal share in the transaction of diplomatic affairs with Sweden, as, according to the Act of Union, it had a right to demand.

The question of diplomatic representation.

By a change in the Swedish constitution in 1885 the ministerial council, in which diplomatic matters are discussed, came to consist of the Swedish foreign minister and two other members of the cabinet on behalf of Sweden, and of the Norwegian minister at Stockholm on behalf of Norway. The king, wishing to remedy this disparity, proposed that the composition of the council should be determined by an additional paragraph in the Act of Union. The representatives of the Norwegian Government in Stockholm proposed that three members of the cabinet of each country should constitute the ministerial council, to which the Swedish Government were willing to agree, but on the assumption that the minister of foreign affairs should continue to be a Swede as before, which the Norwegians, of course, would not accept. The matter was in consequence shelved, and remained in abeyance for some time, but continued to be discussed in the press and at public meetings.

The Norwegian claim.

At the king's instigation the negotiations with the Swedish Government were resumed at the beginning of 1891, and the Stang ministry succeeded in coming to an agreement with the Swedish Government that a measure should be introduced by which the Norwegians would practically obtain what the Storthing of 1886 had asked for, while the question of the nationality of the minister of foreign affairs was left for settlement in the near future. The Swedish Riksdag, however, rejected the proposal, while the Norwegian Storthing insisted upon "Norway's right, as an independent kingdom, to full equality in the union, and therewith her right to watch over her foreign affairs in a constitutional manner."

The Stang ministry then resigned, and a Liberal ministry, with Steen, the recognized leader of the Liberal party after Sverdrup's withdrawal from politics, as prime minister, was appointed. In the same year the provision in the constitution empowering the king to instal the crown prince as regent in Norway was repealed, and the resolution was sanctioned by the king.

The new ministry had placed the question of a separate minister of foreign affairs for Norway prominently in their programme, but little progress was made during the next few years. Another and more important question for the country, as far as its shipping and commerce are concerned, now came to the front. The Storthing had in 1891 appointed a committee to inquire into the practicability of establishing a separate Norwegian consular service, instead of the existing combination with Sweden, with which the Norwegians maintain they have had reason to be dissatisfied. In 1892 the Storthing, acting upon the committee's report, determined to establish a consular service in accordance with a plan prepared by the department of the interior. The king, no doubt influenced and supported by public opinion in Sweden, which was against the proposed separation of the consular services, refused his sanction, and the Norwegian Government in consequence sent in their resignation, whereupon a complete deadlock ensued. This was terminated by a compromise to the effect that the ministry would return to office on the understanding that the question be postponed by common consent. The following year the Storthing again passed a resolution calling upon the Norwegian Government to proceed with the necessary measures for establishing the proposed consular service for Norway, but the king again refused to take any action in the matter. Upon this the Liberal ministry resigned (May 1893), and the king appointed a Conservative Government, with E. Stang as its chief. Thus matters went on till the end of 1894, when the triennial elections took place, with the result that the majority of the electors declared in favour of national independence on the great question then before the country—that of separate consuls for Norway, and eventually of a separate responsible minister of foreign affairs for the country. The ministry did not at once resign, but waited till the king arrived in Christiania to open the Storthing (January 1895). The king would not accept their resignation there and then, but kept the country for over four months without a responsible Government, during which time the crisis had become more acute than ever. A coalition ministry was at last formed, with Professor Hagerup as prime minister. A new committee, consisting of an equal number of Norwegians and Swedes, was appointed to consider the question of separate diplomatic representation; but after sitting for over two years the committee separated without being able to come to any agreement, having, like the two previous "union committees," proved the impossibility of the two countries coming to an understanding in this important question. While the committee was sitting the disputes concerning the political relations between the two countries were allowed to lie in abeyance.

Question of separate consular service.

The elections in 1897 proved again a great victory for the Liberal party (79 Liberals *v.* 35 Conservatives), and in February 1898 the Hagerup ministry was replaced by a Liberal, once more under the premiership of Steen. Soon afterwards the Bill for the general adoption of the national or "pure" flag, as it was called, was carried for the third time, and became law without the king's sanction. By this act the device or mark of union in the upper corner of the flag was abolished, but is still retained on men-of-war and fortifications. In 1898 universal political suffrage for men was passed by a large majority (75 *v.* 36), while the proposal to include women received the support of only 33 votes. In 1901 universal municipal suffrage was given both to men and women; to the latter, however, with certain limitations. In January 1902 a committee was appointed to consider the consular question, and it was hoped that at last it would be settled. In April 1902 Steen, the prime minister, resigned and retired into private life. He was succeeded by Otto Albert Blehr. (H. L. B.)

III. Literature since 1885.

The political crisis of 1884–85, which produced so remarkable an effect upon the material and social life of Norway, was not without its instant influence upon literature. There had followed to the great generation of the 'sixties, led by Ibsen and Björnson, a race of entirely prosaic writers, of no great talent, much exercised with "problems," disturbed by the theories of Zola and Maupassant, which they failed to comprehend, and ruined for the higher imaginative spheres of work by their obstinately doctrinaire attitude towards life. What strikes us as of high interest in the movement which began in 1885 is, firstly, that it brought back the fine masters of a previous imaginative age; secondly, that it silenced the problem-setters; and thirdly, that it encouraged into eager production a whole generation of new men, realists of a healthier sort, individualists, idealists, and poets. In 1885, then, the field was still held by the three great writers who are the three main names of modern Norse literature — Ibsen, Björnson, and Lie. Henrik Ibsen (born 1828) (*q.v.*) proceeded deliberately with his labours. During the period under review he produced seven dramas, including what many critics hold to be his *chef-d'œuvre*, *The Master Builder*. His tendency was to turn more and more definitely back again towards the poetic and symbolic manner of his youth, and his name has at the same time steadily grown in reputation and influence. The advance of Björnstjerne Björnson (born 1832) (*q.v.*) was not so regular, because it was disturbed by political issues; but he published one of the most remarkable of his novels, *In God's Way*, and various tales and dramas. Moreover, his early peasant tales have once more, after having suffered great neglect, grown to be a force, and Björnson's example has done much to revive an interest in the art of verse, which had entirely died out in Norway in the previous decade. Jonas Lie (born 1833) (*q.v.*), still without a rival as the most popular novelist of Norway, continued to publish his pure, fresh, and eminently characteristic stories. Of these, eight or ten appeared after 1885, among them the most prominent being perhaps *The Commodore's Daughter* and *Dyre Rein.* Lie is not a great creative artist, but he contrived to win the ear of his country by his sincerity, his skill in narrative, and his remarkable power of identifying himself with the peculiarities of Norwegian feeling. His style, colloquial almost to a fault, has neither the charm of Björnson nor the art of some of the latest generation. Ibsen, Björnson, and Lie continue, however, to be the three representative authors of their country, and in their old age they grew to be the objects of extreme reverence and curiosity. Ibsen's mother-in-law, the venerable novelist, Magdalene Thoresen (born 1819), who long resided in Denmark, published nothing new for many years. Of the generation which followed hers, Kristofer Janson (born 1841) survived in 1902. In 1882 he left Norway to settle in America as a Unitarian minister, and from this exile he sent home in 1885 what is perhaps the best of his books, *The Saga of the Prairie.* Janson went back to reside in Norway, and published in 1901 the most successful of his recent productions, *Mediæval Tales.* He writes in dialect, and has essayed lyric and drama, as well as prose fiction. Kristian Gloërsen (born 1838), though still living in 1902, had not written for many years past. Frithiof Foss (1820–1899) had long been silent before his death.

During the transition an author appeared, Alexander Kielland (born 1849), from whom for a time much was expected, and whose writings were treated with exaggerated attention. From 1878 to about 1887 Kielland published in rapid succession a series of novels and short stories, in which he showed himself a rather naïve imitator of Guy de Maupassant. He had no real vocation for letters, however, and civic ambition took the place of literary ardour; Kielland was made burgomaster of Stavanger, and has been heard of no more. A far more important talent of the transitional time was that of Arne Garborg (born 1851). He was brought up under sternly pietistic influences in a remote country parish, the child of peasant parents, in the south-west corner of Norway, and the gloom of these early surroundings has tinged all his writings. The early novels of Garborg were written in the peasant dialect, and for that reason, perhaps, attracted little attention. It was not until 1890 that he addressed the public in ordinary language, in his extraordinary novel, *Tired Men*, which produced a deep sensation. This was an analysis of the passive type of intelligent decadent, the thinking man without a will, who becomes more and more a feature of modern society. Of late Garborg has returned, with violence, to the cultivation of the peasant language, and has taken a foremost part in the *maalstræv.* A novelist of considerable crude force is Amalie Skram, settled in Denmark, who continues to write novels destitute of literary beauty, but excellent in their local colour, dealing with life in Bergen and the west coast. But the most extravagant product of the prosaic period was Hans Jaeger (born 1854), who accepted the naturalistic formulas wholesale, and outdid Zola himself in the harshness of his pictures of life. The suit brought against his preposterous novel, *Kristiania-Bohêmen*, in 1885, was the signal for a reaction, and marks the moment of crisis. An author of more talent, in whom many of the qualities of the "problem" school are still to be discovered, is Knud Hamsun (born 1860), who has been remarkable for his egotism, and for the bitterness of his attacks upon his own fellow-writers and upon the great classic names of literature. He is more pleasantly contemplated in his own novels, which, however, are commonly deformed by a cynical violence and ugliness; Hamsun is seen at his best in the powerful romance called *Hunger* (1888). A writer of a much more pleasing, and in its quiet way of a much more original order, is Hans Aanrud (born 1863), in whom the new influences of sweetness and light first made themselves felt. His humour, applied to the observation of the Östland peasants—Aanrud himself comes from the Gulbrandsdal—is exquisite; he is by far the most amusing of recent Norwegian writers, a race whose fault it is to take life too seriously. His story, *How Our Lord made Hay at Asmund Bergemellum's*, is a little masterpiece. His latest volume is *The Seminarist* (1901). Peter Egge (born 1869) is a young novelist and playwright from Trondhjem, who is steadily coming to the front with very careful studies of types of Norwegian temperament. In his *Jacob and Christopher* (1901) Egge also proved himself a successful writer of comedy. Gunnar Heiberg (born 1857), although older than most of the young generation, has but lately come into prominence. His poetical drama, *The Balcony*, made a sensation in 1894, but ten years earlier his comedy of *Aunt Ulrica* should have awakened anticipation. Heiberg is ardent and sensual, filled with the joy of life; his dialogue is brilliant, but it might be possible to wish that it were made the ornament of less momentary issues. He is an author from whom much is expected. Two young writers of great promise have been removed in the very heyday of success, Gabriel Finne (1866–1899) and Sigbjörn Obstfelder (1866–1900). The last-mentioned was much under the sway of the latest mysticism, and not unbiassed by Maeterlinck. But in two books published in 1897, *The Red Drops* and *The Cross*, he achieved an independent effect, obscure but attractive, and giving promise of something quite new in Norwegian literature. Obstfelder, who died in a hospital in Copenhagen in August 1900, left an important book in MS., *A Priest's Diary* (1901).

Verse was not merely neglected, but absolutely banished from Norwegian literature, during the years that immediately preceded 1885. The credit of restoring it is given to a writer named Sigurd Bödtker, who wrote an extremely naturalistic piece called *Love*, in the manner of Heine. The credit of being the earliest real poet of the new generation belongs, however, without question to Niels Collett Vogt (born 1864), who published a little volume of *Poems* in 1887. In 1891 was printed in a magazine Vilhelm Krag's (born 1871) very remarkable poem called *Fandango*, and shortly afterwards a collection of his lyrics. Vogt and V. Krag continued to be the leading lyrical writers of the period, and although they have many imitators, they cannot be said to have found any rivals. Vilhelm Krag has of late turned to prose fiction, and his novels *Isaac Seehuusen* (1900) and *Isaac Kapergast* (1901) are excellent studies of Westland life. More distinguished as a novelist, however, is his brother, Thomas P. Krag (born 1868), who has published a series of romantic novels, of which *Ada Wilde* (1897) is the most powerful; he has great charm of presentment, but seems unhappily not to be able to escape from a curious monotony of subject and treatment. His short stories are full of delicate charm;

the latest collection of them is *The Happy Corner* (1901). Hans E. Kinck (born 1865) is an accomplished writer of short stories from peasant life, written in dialect. He has published ten volumes, from *The Fairy* (1892) to *Spring Nights* (1901). Bernt Lie is the author of nine or ten popular works of fiction, mainly for the young; the latest of these is *Sister Judith* (1901). Sven Nilssen (born 1864) began to publish sketches and stories in 1894, and is the author of a very successful novel, *The Barque Franciska* (1901). With him may be mentioned the popular dramatist and memoir-writer, John Paulsen (born 1851), author of *The Widow's Son*. Jakob Hilditch (born 1864) has written many stories and sketches of a purely national kind, and is the anonymous author of a most diverting parody of banal provincial journalism, *Tranviksposten* (1900–1). Criticism made some advance in these last years. The leading critics are Carl Nærup (born 1864) and Hjalmar Christensen (born 1869), each of whom has published valuable collections of essays dealing with the aspects of recent Norwegian literature. The sudden death of the leading bibliographer and lexicographer of Norway, Jens Braage Halvorsen (1845–1900), inflicted a blow upon the literary history of his country; his *Dictionary of Norwegian Authors*, 1885–1900—still unhappily incomplete—is one of the most elaborate works of its kind ever undertaken. It is to be finished by Halfdan Koht. Among recent historians of Norway much activity has been shown by Ernst Sars (born 1835) and Yngvar Nielsen (born 1843). In Norwegian systematic theology no one has arisen to take the place of Carl Paul Caspari (1814–1892), or even of Gisle Johnson (1822–1894). The great historian of Northern jurisprudence was L. M. B. Aubert (1838–1896), and in this connexion T. H. Aschehoug (born 1822) must also be mentioned. The leading philosopher of Norway in these years has been the Hegelian Marcus Jakob Monrad (born 1816), whose *Æsthetics* of 1889 is his masterpiece.

The close of 1899 and the beginning of 1900 were occupied by a discussion, which drowned all other interests, and in which every Norwegian author took part, as to the adoption of the *landsmaal*, or composite dialect of the peasants, as the national language in place of the *rigsmaal* or Dano-Norwegian. Political prejudice greatly embittered the controversy, but the proposition that the *landsmaal*, which dates from the exertions of Ivar Aasen (*q.v.*) in 1850, should oust the language in which all the classics of Norway are written, was opposed by almost every philologist and writer in the country, particularly by Björnson and Sophus Bugge (born 1833). On the other side, Arne Garborg's was almost the only name which carried any literary weight. The *maal* has no doubt enriched the literary tongue of the country with many valuable words and turns of expression, but there the advantage of it ends, and it is difficult to feel the slightest sympathy with a movement in favour of suppressing the language in which every one has hitherto expressed himself, in order to adopt an artificial dialect which exists mainly on paper, and which is not the natural speech of any one body of persons throughout the whole of Norway. (E. G.)

Norwich, a city and municipal, county (1888), and parliamentary borough of England, forming a county of itself, situated on the Wensum, a little above its junction with the Yare, in Norfolk, 103 miles from London by rail. "A fine old city, truly, is that, view it from whatever side you will; but it shows best from the east, where the ground, bold and elevated, overlooks the fair and fertile valley in which it stands. . . . At the foot of the heights flows a narrow and deep river, with an antique bridge communicating with a long and narrow suburb, flanked on either side by rich meadows of the brightest green, beyond which spreads the city; the fine old city, perhaps the most curious specimen at present extant of the genuine old English town. Yes, there it spreads from north to south, with its venerable houses, its numerous gardens, its thrice twelve churches, its mighty mound. . . . There is a grey old castle upon the top of that mighty mound; and yonder, rising 300 [215] feet above the soil, from among those noble forest trees behold that old Norman master-work, that cloud-encircled cathedral spire, around which a garrulous army of rooks and choughs continually wheel their flight" (George Borrow, *Lavengro*, chap. xiv.). Very many of the churches were restored, either wholly or in part, during the last sixteen years of the 19th century, *e.g.*, the cathedral in 1892 and 1900; St Peter Mancroft, St Andrew's, St Michael's at Coslany, and its Thorp chapel; St John Maddermarket, St Augustine's, St George's, St James's, St John the Baptist's, St Margaret's, St Martin at Oak, St Mary the Virgin, St Michael's at Plea, St Michael at Thorn. St Thomas's was consecrated in 1888. St Peter at Southgate was taken down in 1887. The Roman Catholic cathedral of St John the Baptist, begun in 1884 from designs by Mr G. G. Scott, occupies a commanding site outside St Giles's Gate. In 1884 the corporation purchased the castle, which had been used as a prison, and—a new gaol having been built on Mousehold Hill—converted it (1894) into picture galleries and rooms for the museum. The more notable public buildings and institutions which have come into existence since 1884 are—the volunteer drill hall, the new barracks on Mousehold Heath, the gaol there, the Blind Asylum and schools, the Norwich and Ely Diocesan Training College, the Soldiers' and Sailors' Institute, the Jenny Lind Infirmary for Sick Children (1900), and the Municipal Technical Institute, amalgamated with the School of Science and Art (1901). The Norfolk and Norwich Library was burnt down in 1899, but was re-erected and opened in 1900. Mousehold Heath has been acquired by the corporation, and laid out as a public recreation ground. Chapel Field Gardens and Castle Gardens are laid out as public recreation grounds. In 1899 the resewering of the city was completed. The numerous and varied industries retain their importance. The municipal and county borough, which is coextensive with the parliamentary borough, and has an area of 7558 acres, is administered by a mayor, 16 aldermen, and 48 councillors. It returns two members to the House of Commons. Population (1891), 100,970; (1901), 111,728. Birth-rate, 29·1 (1899); death-rate, 17·3 (1899).

See Rev. W. HUDSON, *How the City of Norwich grew into Shape* (Norwich, 1897), and other works by the same; also, books quoted under NORFOLK.

Norwich, a city of Connecticut, U.S.A., capital of New London county, on the Thames river, 14 miles above New London, in the south-eastern part of the state. Its plan is very irregular, it has an excellent water-supply, the works of which are owned and operated by the city, and an excellent sewerage system. It has a good harbour and much coastwise commerce, having daily steamers to New York. It is on the New York, New Haven, and Hartford (New England) and the Central Vermont railways. The capital invested in manufactures was, according to the census of 1900, $8,566,437, and the value of the products was $8,388,343. Population (1890), 16,156; (1900), 17,251.

Norwich, a village of New York, U.S.A., capital of Chenango county, in lat. 42° 32′, long. 75° 31′, on the Chenango river and the Delaware, Lackawanna, and Western and the New York, Ontario, and Western railways, at an altitude of 987 feet. It is in a farming and dairying region and contains some manufactures, including the works of the New York, Ontario, and Western Railway. Population (1890), 5212; (1900), 5766.

Norwood, a village of Hamilton county, Ohio, U.S.A., a few miles north-east of Cincinnati, of which it is a suburb. Population (1900), 6480, of whom 718 were foreign-born and 80 negroes.

Nossi Bé, an island and French colony off the north-west coast of Madagascar. It has an area of 130 square miles, and bristles with volcanoes. The climate is similar to that of Mayotte (see COMORO ISLANDS), and the neighbouring island of Nossi Comba serves for a sanatorium. The population, consisting of Sakalavas, increased from 7800 to 9500 between 1888 and 1898. Since 1896 Nossi Bé has been under the authority of the governor of Madagascar. It has an administrator at Hellville (population, 1100), the capital, a port of call for the Messageries steamships from France, and an important centre for the coasting trade along the western shores of Madagascar. There is excellent anchorage at this port, which has a magnificent pier 800 feet long; two important German mercantile houses have been established, and there are twenty factories for sugar and rum. The soil of the island is very fertile, and yields coffee, sesame, the sugar-cane, vanilla, and tobacco. The trade with France in 1898 amounted to only £22,120, of which £16,000 was for imports, but the total trade exceeded £120,000.

Noto, a town and bishop's see of the province of Syracuse, Sicily, Italy, 27 miles south-west of Syracuse on the railway to Licata. It possesses a fine town hall and cathedral, a convict prison, and antiquarian and numismatic collections. It manufactures vegetable fibre, macaroni, and olive oil, quarries limestone, and produces wine. Population (1881), 16,262; (1899), 18,500.

Nottingham, a north midland county of England, bounded on the E. by Lincoln, on the S. by Leicester, on the W. by Derby and York, and on the N. by York.

Area and Population.—In 1891 the area of the ancient (geographical) county was 539,752 acres, and the population 445,823, of whom 214,199 were males and 231,624 females, showing an increase of 54,008 since 1881, an increase at the rate of 12·1 per cent., as compared with an increase at the rate of 17·3 per cent. during the ten years 1871–81. In 1901 the population was 514,537, showing an increase of 68,714, or at the rate of 15·4 per cent. since 1891. In 1901 there were 0·95 persons to an acre and 1·04 acres to a person. The area of the registration county in 1891 was 616,285 acres, and the population 505,311, of whom 245,338 were males and 259,973 females; and in 1901, 596,668. Particulars of the birth-rate, death-rate, and the number of persons married per thousand inhabitants, as well as the illegitimacy-rate per thousand births, are given in the annexed table:—

	1871–80.	1881–90.	1889–98.	1899.
Birth-rate	36·9	36·1	32·5	32·2
Death-rate	21·4	19·6	17·9	18·8
Illegitimacy-rate	64	54	54	48
Marriage-rate	17·8	16·3	16·3	17·6

In 1891 the county contained 1734 persons of Scottish birth, 1454 of Irish birth, and 1295 foreigners. At the same date there were 390 blind persons, 200 deaf and dumb, and 1474 insane.

Administration.—For parliamentary purposes the ancient county is divided into four divisions (Bassetlaw, Newark, Rushcliffe, and Mansfield), each returning one member, and the parliamentary borough of Nottingham, which returns one member for each of its three divisions (West, East, and South). The administrative county embraces the three municipal boroughs of East Retford, Mansfield, and Newark, and the county and municipal borough of Nottingham. There are one court of quarter sessions and seven petty sessional divisions. The boroughs of East Retford, Newark, and Nottingham have separate commissions of the peace, also separate courts of quarter sessions. The administrative county contained 259 and the county borough of Nottingham 9 entire civil parishes in 1891; there were also four parishes which were partly situated in the county and partly in the county borough, and three others which were partly in other administrative counties. Since 1897 the nine parishes and four parts of parishes comprised within the county borough have been constituted one civil parish. The ancient county contains 220 entire ecclesiastical parishes and districts, and parts of six others; it is situated principally in the diocese of Southwell and partly in the diocese of York.

Education.—University College at Nottingham was attended during the session 1899–1900 by 1914 students; the college was opened in 1881. Associated with it is a day training college for schoolmasters and schoolmistresses. At Nottingham there are also the Midland Institution for the blind and a school for deaf-mutes. On 31st August 1900 the county contained 245 elementary schools, namely, 60 board schools and 185 voluntary schools, the latter including 164 National Church of England schools, 8 Wesleyan, 5 Roman Catholic, and 8 "British and other." The average attendance during the year amounted to 42,873, out of a total of 53,066 on the register. The total school board receipts during the year were £188,355, inclusive of £563 earned under the Technical Instruction Act and £2669 under the Agricultural Rates Act.

Agriculture.—Since 1885 there has been an increase in the area of the meadow-lands, but a decrease in the areas sown with corn and devoted to fallows; also an increase in the acreage of permanent grass. The area cultivated by tenants increased from 378,429 acres in 1889 to 385,319 acres in 1895, and to 395,003 acres in 1900; the area cultivated by owners decreased from 76,650 in 1889 to 62,918 acres in 1895, and to 52,686 in 1900.

The following table shows the areas under the different kinds of crops at the periods named:—

Year.	Area in Cultivation.	Area under Corn Crops.	Area under Green Crops.	Area of Bare Fallow.	Area under Permanent Grass.
1880	450,862	149,162	51,834	24,232	...
1885	455,077	135,047	51,781	16,304	190,193
1890	455,739	126,691	49,733	13,366	204,333
1895	448,237	119,794	49,987	9,811	208,531
1900	447,689	123,663	51,115	8,418	209,274

The next table shows the number of the live stock at the periods named:—

Year.	Cows and Heifers.	Other Cattle.	Total Cattle.	Horses.	Sheep.	Pigs.
1880	23,735	53,884	77,619	20,348	258,120	23,026
1885	28,636	59,619	88,255	20,456	229,983	26,605
1890	28,474	53,533	82,007	21,087	231,417	32,333
1895	26,834	54,318	81,152	22,836	221,642	33,649
1900	28,405	57,686	86,091	22,405	196,680	28,295

Industries.—During the year 1897 the number of hands employed in the factories and workshops of the county amounted to 67,556, of whom 9410 were engaged in making machinery, implements, &c., 8986 in the clothing industries, 8955 in lace-making, 6961 in making hosiery, 4396 in bleaching and dyeing, 3299 in the paper and printing trades, 2965 in the cotton and woollen manufacture, 2852 in manufacturing tobacco and cigars, 1772 in the metal industries, 1549 in the wood industries, and 1460 in brewing, &c. Coal is the principal mineral mined, chiefly on the south-west border of the county, near Mansfield, and near Nottingham. In 1900 the output was 8,626,177 tons of coal (valued at £4,708,455), 397,073 tons of clay, 133,610 tons of gravel and sand, 77,492 tons of gypsum, 95,790 tons of limestone, and 6582 tons of sandstone; the total value of all the mineral products being £4,784,322. In the same year 28,009 persons were employed in the mines and quarries.

See J. T. GODFREY. *Notes on the Bibliography of Nottinghamshire.* Ratcliffe-on-Trent, 1891.—J. WARD. *Descriptive Catalogue of Books relating to Nottinghamshire.* Nottingham, 1892.

(J. T. BE.)

Nottingham, a municipal, county, and parliamentary borough of England, officially styled (by letters patent of 7th August 1897) "the City of Nottingham and County of the Same City," with a present area of 10,935 acres; on the Trent, 124 miles from London by rail. Connexion with the London and North-Western line was opened in 1888, and with the Great Central in 1899, the station on the latter railway costing over a million sterling. By the Borough Boundaries Act of 11th June 1887 the parishes or districts of Sneinton, Lenton, Radford, Bulwell, Standard Hill, the Castle, Brewhouse Yard, and parts of Wilford, West Bridgford, and Gedling were incorporated in the municipal borough, which is now administered by a mayor, 16 aldermen, and 48 councillors, and has its own commission of the peace and a separate court of quarter sessions. Of modern churches may be mentioned St Catherine's, in the Perpendicular style, St George's, St Emmanuel's, St Stephen's (1898), and St Bartholomew's, erected in 1899. The following have been restored since about 1875: St Mary's, St James's, St Mark's, and St Peter's. In addition to their cathedral, the Roman Catholics own the church of St Edward's and the Church of Our Lady and St Patrick. Altogether there are over 90 Nonconformist places of worship. In 1899–1900 University College was attended by 1914 students, whilst 16,951 class tickets were issued. There are two technical schools in connexion with the school board. The more notable public buildings are the Guildhall and City Sessions Courts (1887), the post office, and the poor law offices. The county gaol was enlarged in 1894. The Free Library and the Free Museum of Natural History have been housed in the University College buildings since 1881; the former has 13 branches. In 1886 a new cattle market, covering 7 acres, was opened. New corporation and private baths have been built in Gedling Street, and a new wing added to the Midland Institution for the Blind. There is a high school for girls; and in 1882 the Midland Baptist College was transferred to Nottingham. The city is supplied with water from waterworks at Papplewick, Bestwood, Bellevue, Mapperley, and Burton Joyce, and there is a reservoir at Boughton. The principal industries still remain the same as in 1884, but the cycle trade is now largely carried on here and in the locality. The city returns three members to the House of Commons, being divided for parliamentary purposes into the West, East, and South divisions. Population (1891), 213,877; (1901), 239,753. Area, 10,935 acres. Death-rate, 20·0 (1899); birth-rate, 28·8 (1899).

See *Records of the Borough of Nottingham*, 4 vols. (1882–89).

Nouzon, town, arrondissement of Mézières, department of Ardennes, France, 4 miles north of Mézières by rail, picturesquely situated at the confluence of the Gontelle and the Mardreuil with the Meuse. It has numerous foundries and forges turning out all kinds of iron goods. One of the establishments is said to be the largest foundry for malleable metal in France. Steam tramways connect Nouzon with Neufmanil, 6 miles, and Gespunsart, 8 miles distant, where also are important iron-works. Population (1891), 6473; (1901), 7795.

Novaliches, Manuel Pavia y Lacy (1814–1896), 1st Marquis de, Spanish marshal, was born at Granada on 6th July 1814. He was the son of Colonel Pavia, and after a few years at the Jesuit school of Valencia he entered the Royal Artillery Academy at Segovia. In 1833 he became a lieutenant in the guards of Queen Isabella II., and distinguished himself so much during the Carlist war from 1833 to 1840 that he rose to the rank of general of division in the latter year at the early age of twenty-six. He was offered the post of war minister before he reached his thirtieth year. He then began to take part in politics with the Moderate party, who made him war minister in 1847, and sent him to assume the command in Catalonia, where the great severity he displayed in his efforts to put down a Carlist rising was not attended with success. He had been made a senator in 1845, and marquis in 1848. Despite his reluctance, he was sent out to Manila in 1852 as captain-general of the Philippine Islands. In April 1854 he crushed with much sternness a formidable insurrection, shot or hanged all the ringleaders, and carried out many useful reforms after he had pacified the colony. On his return to Spain he married the countess of Santa Isabel, and commanded the reserves in the Peninsula during the war with Morocco. He refused the war portfolio twice offered him by Marshals O'Donnell and Narvaez, and undertook to form a cabinet of Moderates in 1864 that lived but a few days. He volunteered to assist in crushing the insurrection in the streets of Madrid on 22nd June 1866, and when the revolution broke out decisively in September 1868 he accepted the command of Queen Isabella's troops. At their head he was defeated by Marshal Serrano at the bridge of Alcolea 28th September 1868, and was so badly wounded in the face that he was disfigured for life. He kept apart during the revolution, and went to meet King Alphonso XIII. when he landed at Valencia in January 1875. The Restoration made the marquis de Novaliches a senator, and the new king gave him the Golden Fleece. He died in Madrid on 22nd October 1896.

Novara, a town, episcopal see, and capital of the province of the same name, Piedmont, Italy, 31 miles by rail west of Milan. The town possesses a new theatre (1888), a museum of Roman antiquities, a notaries' school, and a technical school; and is adorned by a bronze statue of Garibaldi and an equestrian monument of Victor Emmanuel (1881). There are two schools of the industrial arts. The principal industry is the carding and spinning of silk; there are, further, iron-works and foundries, cotton mills, rice-husking mills, organ factories, dye-works, and printing works. Population (1881), 25,181; (1901), 44,928.

Nova Scotia.—A province of the Dominion of Canada, lying between 43° 25′ and 47° N. and 59° 40′ and 66° 10′ W. The Lower Cambrian formation, which forms an almost continuous belt along the Atlantic coast, where extensive gold-mining operations are carried on, varies in width from 10 to 75 miles and covers an area estimated at 8500 square miles. This belt is interrupted by large masses of intrusive granite, which occupy about 3500 square miles, leaving 5000 square miles of gold-bearing rocks. This part of the province presents a rough, rugged, and sterile appearance, abounding in small lakes and peat bogs. North of this area rocks of Ordovician, Silurian, and Devonian ages occur, which are also interrupted by great masses of felspathic and granitic rocks. These formations are capped in places by the Carboniferous and Permian, including two large areas of productive coal measures in Cumberland and Pictou counties respectively. The Carboniferous area is divided into Carboniferous limestone or gypsiferous series, the Millstone Grit and the Coal Measures. The Cobequid Mountains, rising to a height of about 1050 feet and extending from the Bay of Fundy along the shores of Minas Channel and Basin to the vicinity of Pictou, form the most prominent physical feature of this part of the province. The surface of the greater part is, however, undulating, with fertile uplands and exceedingly rich valleys and marshes. Along the coast of the Bay of Fundy and at Minas Basin and Channel are bright, soft red sandstones of Triassic age associated with masses of contemporaneous trap rich in zeolites. The ridge of trap extending along the coast from Minas Channel to Briar Island is called the North Mountain, and rises about 700 feet high. Besides gold, already referred to, coal, gypsum, grindstones, building stone, and many minerals of economic importance are found in the province. (See Breton, Cape.)

The following statistics relate to the whole province, including Cape Breton.

Climate.—Owing to its insular position, Nova Scotia enjoys a more temperate climate than New Brunswick. The average summer temperature is 65° F. and the winter 25° F. The average rainfall for twenty-seven years (1874–1900) was

38·1 inches, and the snowfall for the same period was 75·4 inches; total precipitation, 45·6 inches.

Game.—Large and small game abound, owing to the strict enforcement of the laws, but the wolf has become extinct.

Area and Population.—The area of the province is about 21,068 square miles, and the population is now (1901) 459,574. Population per square mile, 21·8. The population was 440,572 in 1881; in 1891, 450,396. In 1901 there were 89,106 families; average number per family, 5; number of males, 233,642, and the number of females, 225,932. In 1891 the occupations were thus distributed: agriculture, fishing, and mining, 83,233; domestic and personal service, 23,468; manufactures and mechanical industries, 26,548; professional, 6100; trade and transportation, 18,117; non-productive, 2619. In the census of 1901 the origin of the people is given as follows: English, 162,141; Irish, 55,830; Scottish, 142,207; Welsh, 1199; Dutch, 2941; French, 45,067; German, 38,854; Indians, 1543; negroes, 5984; Swiss, 1004; all other nationalities, 2804. Of the whole population, 457,948 were either born in Canada or are now naturalized citizens.

Constitution and Government.—The provincial executive now consists of three ministers with salaries and six without portfolios, and the members elected to the House of Commons have been reduced from twenty-one to twenty.

Religion.—In 1901 the principal religious denominations and their adherents were as follows: Church of England, 66,067; Church of Rome, 129,578; Presbyterians, 106,319; Methodists, 57,490; Baptists, 83,333; Congregationalists, 2938; Lutherans, 6572; Adventists, 1494; Disciples of Christ, 1412; Salvation Army, 1251.

Education.—In 1901 there were 2387 schools in operation, attended by 98,410 pupils, 91,114 of whom were in the common schools and 7296 in the high schools. There were 2492 teachers, and the total expenditure for public education was $844,762, the cost per pupil in annual enrolment being $8·58, and the cost per pupil daily present on an average $15·75. The following table shows the increase in attendance by decades, the figures giving the average of the summer and winter terms:—

Year.	Teachers.	Pupils.	Total Cost.
1880	1809	76,393	$584,959
1890	2214	85,482	709,312
1900	2557	100,129	887,852

Finance.—The total revenue for the year 1901 was $1,090,230, and the expenditure $1,088,927; the gross debt $3,771,167, and the assets $1,368,655. Succession duties have been imposed on estates above a certain value.

Defence.—The militia consists of an active cavalry, garrison artillery, and infantry force of 307 officers and 3742 non-commissioned officers and men. There are important fortifications at Halifax, where British regiments were formerly stationed, but since 1900 their place has been occupied by Canadian troops.

Minerals and Mining.—There has been a steady increase in the output of gold and coal, which have about doubled since 1882. The mineral production in 1901 was valued at $8,335,000, including gold, 26,057 oz., $546,963; iron ore, 18,169 tons, $46,548; coal, 4,158,068 tons, $6,496,982; gypsum, 170,100 tons, $136,947.

Agriculture.—In common with other provinces of Canada, Nova Scotia has made considerable progress in butter and cheese manufacture. In 1901 there were in operation eight creameries, seven cheese factories, and six factories where both butter and cheese were made, producing 316,180 ℔ of cheese and 266,109 ℔ of butter, valued at $83,761. This is exclusive of large quantities of home-made butter and cheese. Increased attention has been given to the cultivation of small fruits, and also to the shipping of apples to the English market. In 1891 the total occupiers of land were 64,643; of these 60,069 were owners, 4413 tenants, and 161 employés. Total lands occupied, 6,080,695 acres; improved, 1,993,697 acres; under crop, 969,548 acres; in pasture, 994,113 acres; woodland and forest, 4,086,998 acres; garden and orchards, 30,036 acres. The principal crops raised were oats, buckwheat, potatoes, turnips, and other roots. Of animals and their products there were in 1891: horses, 65,047; oxen, 28,424; milch cows, 141,684; other horned cattle, 154,664; sheep, 331,492; swine, 48,048; domestic fowl, 792,184; butter, 9,011,118 ℔; cheese, 589,363 ℔; wool, 1,072,234 ℔.

Fisheries.—Under an Act passed by the Dominion Government $160,000 is annually distributed among the fishermen and fishing vessels; of this amount Nova Scotia received $101,448 in 1900, divided among 525 vessels (22,474 tons) and 5352 men, 6927 boats and 10,645 men. In the same year the total number of vessels employed in the fisheries was 557 (26,064 tons), manned by 5816 men, and 14,766 boats with 19,396 men; 6447 persons were employed in the lobster canneries. The total value of vessels, boats, nets, lobster factories, fish-houses, and all other material used in the fisheries in the whole province was $3,278,623. The total value of the fisheries was $7,809,153: lobsters, $1,898,725; cod, $2,294,160; haddock, $489,668; mackerel, $1,248,626; herring, $376,476; halibut, $163,950; and fish products, $443,298, were the largest items.

Manufactures.—Among the new industries may be mentioned five pulp mills, with a capacity of 100 tons every twenty-four hours; one factory for condensing milk, and works for the manufacture of railway carriages; boot and shoe factory, &c. In 1891 there were engaged in manufactures as follows:—Industrial establishments, 10,496; total capital employed, $19,821,986; hands employed, 34,965; wages paid, $7,240,611; value of raw material, $16,099,229; value of articles produced, $31,043,392.

Commerce.—The volume of trade is shown in the following table:—

	1875.	1885.	1895.	1901.
Exports . .	$6,979,130	$8,894,085	$11,723,534	$12,720,343
Imports . .	11,531,956	8,418,826	9,270,414	12,146,882
Entered for consumption .	10,672,981	8,192,381	8,991,559	12,041,185
Duty . .	1,493,149	1,751,637	1,160,101	2,091,537

In 1901 Nova Scotia shipped to transatlantic ports 136,537,100 superficial feet of deals, &c., and the total value of all the products of the forest exported was $2,367,125 (1899).

Shipping.—The registry books of the Dominion show that in 1900 Nova Scotia owned 2121 sailing vessels and steamers—net tonnage, 226,817; of these 155 were steamers—gross tonnage, 18,243. In the same year 117 vessels and steamers were built—net tonnage, 9416.

Roads and Railroads.—Road-making machines are employed for the improvement of the ordinary highways, and substantial steel bridges are replacing the wooden structures. Besides the main intercolonial railway from Halifax to Amherst, a branch line runs from Truro to Sydney, and another from Oxford Junction to Pictou and Stellarton. The Dominion Atlantic Railway extends from Windsor Junction, near Halifax, to Yarmouth; the Nova Scotia Central Railway from Lunenburg to Middleton on the Dominion Atlantic Railway; and the Dominion Coal Company's railway connects Sydney and Louisburg. There are also several branches connecting the trunk lines with outlying towns and villages. Two lines have been completed—one from Windsor to Truro, and another from Point Tupper to Broad Cove; and two lines are in course of construction—one from Port Hawkesbury to Louisburg, and the other from Halifax to Yarmouth, both along the Atlantic coast. In 1901 there were 943 miles of railway in operation. Telegraph and telephone lines extend all over the province, and there are two cable stations, one at Canso and the other at Sydney.

The *chief cities and towns* are:—Halifax (40,832, 1901), the capital; Yarmouth (6430); Pictou (3235); Stellarton (1422); Westville (2250); New Glasgow (4447); Sydney (9909); North Sydney (4646); Liverpool (1937); Lunenburg (2916); Windsor (3398); Annapolis (1019); Amherst (4963); Antigonish (1526); Shelburne (1300); Dartmouth (4806); Springhill (5178); Truro (5993); Kentville (1731); Digby (1150); Wolfville (1412); Oxford (1266); Baddeck (1000); Port Hood (1500); Glace Bay (6945); Louisburg (1588); Sydney Mines (3191); Parrsboro (2705); Canso (1734); Bridgewater (1816).

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(W. J. W.)

Novaya Zemlya. See POLAR REGIONS.

Novelda, a town of Spain, in the province of Alicante, on the right bank of the river Vinalopó, and on the railway from Madrid to Alicante. The population was 9648 in 1887 and 9955 in 1897. The country around is flat and fertile, producing much wine, oil, saffron, aniseed, and cereals. In the town there are tanneries, and manufactures of alcohol, chocolate, and soap. Five miles off are sulphurous and saline springs. The streets are regular, and there are several squares, with a fine town hall and a palace of the marquess de la Romana. To the north are the ruins of the Mola Castillo, where Alvaro de Luna was imprisoned.

Novgorod, a government of north Russia, bounded on the S.W. by Pskoff, on the N.W. by St Petersburg and Olonets, and on the S.E. by Vologda, Yaroslav, and Tver. Area, 47,236 square miles. Its population was, in 1897, 1,392,933, of whom 720,237 were women, and only 84,947 lived in towns. The chief occupation, agriculture, becomes less and less able to satisfy the needs of the population, the average crop of rye being (about 1895) 0·6 quarter per head of population below the real wants; that is, the yield amounted to 703,300 quarters, as against 943,000 quarters in 1860. The yield of the crops in 1894–99 was: rye, 4,135,300 cwts.; oats, 3,847,000; all cereals, 8,514,000 cwts. There were, in 1897, 248,500 horses, 475,000 horned cattle, and 275,000 sheep.

Various trades are on the increase, and about 35,000 people find occupation in them (building, smith-work, fishing, shipbuilding, &c.), as also a variety of domestic industries, giving occupation to about 40,000 families. The industries are, however, slow to develop, the aggregate production of all the factories (mainly distilleries, glass, matches, saw-mills), which employed only 11,850 persons in 1898, hardly reaching £1,000,000. Considerable efforts have been made by the local government to improve both agriculture and education, there being on an average over 52,000 pupils in 1200 schools, as also to organize the medical help in the villages. For this purpose there are 47 hospitals, and over 276,000 persons receive every year free medical advice and help. The chief towns of the eleven districts into which the government is divided are: Novgorod (26,095 inhabitants), the capital of the government, now connected by rail with Chudovo on the St Petersburg to Moscow line (45 miles), and with Staraya Russa, also in regular steam communication down the Volkhov with Novaya Ladoga; Borovichi (9421), Byelozersk (6012), Cherepovets (6916), Demiyansk (1647), Kiriloff (4304), Krestsy (2587), Staraya Russa (15,234), Tikhvin (6631), Ustyuzhna (5109), and Valdai (3525).

Novograd-Volhynsk, a district town of Russia, government of Volhynia, 64 miles north-west of Zhitomir, on the Sluch river. It has iron-works, tanneries, and soap-works, and its fairs are animated. It is a very old town, mentioned in the annals in 1257 under the name of Zwiagel, when it belonged to the Vladimir–Volhynia principality. Later it fell into the hands of Lithuania, and was annexed to Russia in 1793. From 7500 in 1865 its population increased to 16,873 in 1897.

Novorossiysk, a seaport and district town of Caucasia, Russia, in the Chernomorsk or Black Sea government, on a bay of the same name (also named Tsemes), on the north-east coast of the Black Sea. This bay, nearly 3½ miles wide at its entrance, and 5 miles deep from east to west, is exposed to the north-east wind (*bora*), which sweeps down from the mountains with such violence that the town is drenched with the spray of the waves, and in winter the thick layer of ice formed on the rigging of the ships becomes a danger. A mole has been constructed at a cost of about £700,000, to provide protection from the sea. Novorossiysk is connected by a branch railway to Tikhoryetskaya (169 miles) with the main Caucasus line, which crosses the Volga near Tsaritsyn. Since this connexion was established, Novorossiysk has become an important port for the export of corn, over 600,000 tons being exported every year; and since the naphtha wells of Groznyi have been tapped it has also become an entrepôt for the export of naphtha. It is visited annually by about 375 sea-going vessels and about 350 coasting vessels. Large grain elevators have been built, and altogether a new commercial town has grown up. It is, however, unhealthy, on account of malaria. Population (1897), 16,208.

Novouzensk, a district town of Russia, government and 242 miles south-south-west of Samara, on the Uzeñ river. It was founded in the 18th century by Nonconformists, who had much to suffer from Kirghiz and Kalmuck raids, until forts were founded to protect them both at this village and along the whole line to the Volga. In 1897 it had a population of 13,475, and is a centre for the trade with the Kirghiz Steppe. It has four animated fairs. It stands on a branch of the railway which connects Saratoff, on the Volga, with Uralsk, 88 miles south-east of the Urbach junction.

Novozybkoff, a district town of Russia, government and 101 miles north-north-east of Chernigov. It was founded in the 17th century by Nonconformists in the forests of Starodub, and became in the 18th century a centre of Russian Dissent. It is situated on the Bryansk–Gomel railway, 129 miles from the former town, and is the junction for the Novgorod–Syeversk branch. It is surrounded by ponds and marshes, which render it unhealthy. There are several tallow-melting works and tanneries, and it has trade in hemp, hemp-seed oil, cattle, preserved meat, tallow, and leather. Population (1897), 15,480.

Nowgong, a town and district of British India, in the Brahmaputra Valley division of Assam. The town is situated on the Kalang river. Population (1891), 4815; municipal income (1897–98), Rs.11,781. The Government high school had 159 pupils in 1896–97.

The district of Nowgong has an area of 3258 square miles; population (1881), 310,579; (1891), 344,141; (1901), 261,634, showing an increase of 11 per cent. between 1881 and 1891, but a decrease of 24 per cent. between 1891 and 1901; average density, 180 persons per square mile. Classified according to religion, Hindus in 1891 numbered 214,425; Mahommedans, 14,137; hill tribes, 115,044; Christians, 417, of whom 63 were Europeans; "others," 118. The land revenue is Rs.59,49,105, the incidence of assessment being Rs.2 : 8 : 9 per acre; number of police, 162; number of boys at school (1896–97), 5527, being 20·72 per cent. of the male population of school-going age; registered death-rate (1897), 50·4 per thousand. The soil and climate are not so favourable for tea cultivation as in Upper Assam. In 1897 there were 50 gardens, with 12,659 acres under tea, employing 21,397 persons (of whom 7508 had been imported under contract), and yielding just over 4 million ℔, or at the rate of 355 ℔ per acre. The section of the Assam–Bengal railway, now under construction from Gauhati to the hills, passes through part of the district, but not very near Nowgong town; and feeder roads to the stations are being made from the main road that runs parallel to the Kalang river.

Nowgong, a town of India, headquarters of the Bundelkhand agency and a military cantonment, in the native state of Chhatarpur, on the border of the British district of Jhansi. Population (1891), 7492. It has accommodation for a force of all arms. Rajkumar College, founded in 1875 in memory of Lord Mayo, for the education of young chiefs on the model of an English public school, had 17 pupils in 1897–98. There are a high school, a dispensary, and a gaol. The number of police is 50 men. The expenditure on public works in 1897–98 was Rs.1269. It is proposed to connect Nowgong by a branch line with Harpalpur on the East Indian Railway.

Nowo-Radomsk, or Radomsko, a district town of Russian Poland, government and 28 miles by rail south of Piotrków. It has factories for bent-wood furniture, woollens, and cloth, tanneries and saw-mills, and is the centre of a very active trade. Population (1897), 12,407.

Noya, a coast town of Spain, in the province of Corunna, on the left bank of the Rio de Muros y Noya. Population, 9357 in 1887, and 9156 in 1897. Quantities of wheat, hemp, and fruit are produced, and much live stock is reared in the neighbourhood. The local industries include manufactures of paper, soap, preserves, lace, and linen. Noya is a very ancient town, and was of more importance in the Middle Ages than at present. Its estuary and port are only accessible to fishing-boats and coasters. The town was a fief of the dukes of Alba, and many noble families once lived in it. The parish church is a stately Gothic pile. There are several convents, schools, an asylum for old people, a bull-ring, and a theatre.

Nubar Pasha (1825–1899), Egyptian statesman, was born at Smyrna in January 1825, the son of an Armenian merchant named Moghreditch, who had married a relative of Boghos Bey, the influential minister of Mehemet Ali. Boghos had promised to interest himself in the future of his young relative, and at his suggestion he was sent first to Vevey, and then to Toulouse, to be educated by the Jesuits, from whom he acquired a very perfect knowledge of French, and perhaps that singular suppleness and subtlety of character by which he was mainly distinguished. Before he was eighteen he went to Egypt, and after some eighteen months' training as secretary to Boghos, who was then Minister of both Commerce and Foreign Affairs, he was made second secretary to Mehemet Ali, whom he used to read to sleep with Thiers's *Histoire du Consulat et de l'Empire*. In 1845 he became first secretary to Ibrahim Pasha, the heir apparent, and accompanied him on a special mission to Europe, a period to which Nubar always referred with horror, declaring that he was in continual danger of his life, from the paroxysms of rage with which his master was afflicted. Abbas Pasha, who succeeded Ibrahim in 1848, maintained Nubar in the same capacity, and sent him in 1850 to London as his representative to resist the pretensions of the Sultan, who was seeking to evade the conditions of the treaty under which the viceroyalty of Egypt was secured to the family of Mehemet Ali. Here he was so completely successful that he was made a bey; in 1853 he was sent to Vienna on a similar mission, and remained there until the death of Abbas in July 1854. The new viceroy, Said, at once dismissed him from office, but two years afterwards appointed him his chief secretary, and later gave him charge of the important transport service through Egypt to India. Here Nubar was mainly instrumental in the completion of railway communication between Cairo and Suez, and exhibited strong organizing ability combined with readiness of resource. After a second time falling a victim to Said's caprice and being dismissed, he was again sent to Vienna, and returned as principal secretary to Said, a position he held till Said's death in January 1863.

On the accession of Ismail Pasha, Nubar Bey was in the prime of life. He was already on friendly terms with him; he even claimed to have saved his life—at all events, it was a coincidence that the two had together refused to travel by the train the accident to which caused the death of the Prince Ahmed, who would otherwise have succeeded Said. Ismail, himself a more capable man than his immediate predecessors, at once recognized the ability of Nubar, and charged him with a mission to Constantinople, not only to notify his accession, but to smooth the way for the many ambitious projects he already entertained, notably the completion of the Suez Canal, the change in title to that of Khedive, and the change in the order of succession. In the first of these he was completely successful; the Sultan, believing as little as every one else that the canal was anything more than a dream, gave his consent at a price the moderation of which he must afterwards have regretted. The gratified Ismail created Nubar a pasha, and the Sultan himself, persuaded to visit Cairo, confirmed the title so rarely accorded to a Christian. Half the work was, however, yet to be done, and Nubar was sent to Paris to complete the arrangements, and to settle the differences between Egypt and the Canal Company. In what he used to call "an expensive moment of enthusiasm," he left these differences to the arbitration of the Emperor Napoleon III., and cost Egypt four millions sterling. On his return he was made Egypt's first Minister of Public Works, and was distinguished for the energy which he threw into the creation of a new department; but in 1866 he was made Minister of Foreign Affairs, and at once went on a special mission to Constantinople, where he succeeded in the other two projects that had been left in abeyance since his last visit. In June 1867 Ismail was declared Khedive of Egypt, with succession in favour of his eldest son. Great as had been Nubar's successes, they had as yet been gained only over the Sultan. Oriental methods of statecraft he had shown that he understood; in his one negotiation with a European Power he had gained only a Pyrrhic victory, and now he had to undertake a very different task. The antiquated system of "capitulations" which had existed in the Ottoman Empire since the 15th century, had grown in Egypt to be a practical creation of seventeen *imperia in imperio*: seventeen consulates of seventeen different Powers administered seventeen different codes in courts before which alone their subjects were amenable. A plaintiff could only sue a Frenchman in the French court, with appeal to Aix; an Italian in the Italian court, with appeal to Ancona; a Russian in the Russian court, with appeal to Moscow. Had it been limited to the Great Powers, or even to European Powers, it would hardly have been tolerable, but a Brazilian claimed the same rights, and in many cases it was practically an impossibility to contemplate judicial action at all. Nubar's bold design, for which alone he deserves the credit, was to induce these seventeen Powers to consent to abandon their jurisdiction, to substitute mixed International Courts and a uniform code binding on all. That in spite of the jealousies of all the Powers, in spite of the opposition of the Porte, he should have succeeded, places him at once in the first rank of statesmen of his period. Those who have lived to see the European Concert of four or five Powers reduced almost to impotence before China, Turkey, and Greece, can appreciate the genius of the man who, single-handed as the almost unknown representative of a mere vassal state, brought the seventeen chancelleries into line and induced them voluntarily to surrender, without *quid pro quo*, privileges which they had acquired and maintained during five centuries. Nubar's fame might rest upon this alone, and perhaps it was rather by accident than by design—though he always attributed it to his prescience—that the establishment of the mixed courts had consequences far greater than could have been foreseen. Into the codes was inserted the famous article which rendered Ismail "justiciable" before the Tribunals, and it was this article which ultimately caused in 1879 the deposition of Ismail and the substitution of his son Tewfik.

The extravagant administration of Ismail, for which perhaps Nubar can hardly be held wholly responsible, had brought Egypt to the verge of bankruptcy, and Ismail's disregard of the judgments of the Court at last compelled Great Britain and France to interfere (spurred thereto by Bismarck, who perhaps hoped that Egypt might embitter the relations between the two Western Powers). Under pressure, Ismail, who began to regret the establishment of the International Courts, assented to a mixed ministry under Nubar, with Rivers Wilson as Minister of Finance and de Blignières as Minister of Public Works. Nubar, finding himself supported by both Great Britain and France, tried to reduce Ismail to the position of a constitutional monarch, and Ismail, with an astuteness worthy of a better cause, took advantage of a somewhat injudicious disbandment of certain regiments to incite a military rising against the ministry. The Governments of Great Britain and France, instead of supporting the ministry against the Khedive, weakly consented to Nubar's dismissal; but when this was shortly followed by that of Rivers Wilson and de Blignières they realized that the situation was a critical one, and they succeeded in obtaining from the Sultan the deposition of Ismail and the substitution of his son Tewfik as Khedive (1879). Nubar remained out of office until 1884.

In the interval Great Britain had intervened in Egypt —the battle of Tel-el-Kebir had been fought, Arabi had been banished, and Sir Evelyn Baring (afterwards Earl of Cromer) had succeeded Sir Edward Malet. The British Government, under the advice of Baring, insisted on the evacuation of the Sudan, and Sherif having resigned office, the more pliant Nubar was induced to become Premier, and to carry out a policy of which he openly disapproved, but which he considered Egypt was forced to accept under British dictation. At this period he used to say, "I am not here to govern Egypt, but to administer the British government of Egypt. I am simply the greaser of the official wheels." It might have been well if Nubar had confined himself to this modest programme, but it was perhaps hardly to be expected of a man of his ability and restless energy. In justice to him, it must be admitted that some of the tools he was given to work with made his task a difficult one. Sir Benson Maxwell and Mr Clifford Lloyd were zealous but impracticable officials, and when after the suppression of *Le Bosphore Egyptien* Nubar was forced to apologize in person to the French Minister, he may not unnaturally have felt that when he had to bear all the responsibility he ought to be allowed some of the power. Apart from this, however, it must be admitted that the characters of Nubar and Lord Cromer were not formed to run in harness, and it was with no surprise that the public learnt in June 1888 that he had resigned office. The ministry of Riaz Pasha, who succeeded him, lasted for nearly six years, and Nubar returned to office in April 1894. By that time Lord Cromer had more completely grasped the reins of administration as well as of government, and Nubar had realized more clearly the rôle which an Egyptian minister was called on to play: the former was the real ruler of Egypt, and the death of Tewfik in 1890 had necessitated a more open exercise of British authority. In November 1896 Nubar had completed his fifty years of service, and, accepting a pension, retired from office. He lived little more than two years longer, spending his time between Cairo and Paris, where he died in January 1899 at the age of seventy-four. (C. F. M. B.)

Nuevitas, a small land-locked seaport on the north coast of the province of Puerto Principe, Cuba. Many historians assert that this was the site of Columbus's first landing in Cuba. Population (1899), 4228.

Nuevo Leon, a state of Mexico, bounded on the N., N.W., and W. by the state of Coahuila, on the S. and S.W. by San Luis Potosi, and on the E., N.E., and S.E. by Tamaulipas. Area, 24,324 square miles. Population in 1879, 203,284; and in 1900, 326,940. Agriculture has been steadily progressing, rising in value from \$717,450 in 1872 to \$5,000,000 in 1899. The value of the live stock is estimated at \$6,000,000. The mercantile movement is estimated at \$15,000,000 annually. The Mexican National Railway crosses Nuevo Leon from west to north-east, and the Monterey and Gulf of Mexico Railway crosses it from west to south. There are 13 miles of tramways, all starting from Monterey; also fine waggon roads in all directions. The state is divided into 48 municipalities. The capital is Monterey, with 56,326 inhabitants in 1900. The principal towns are Linares (7220), Lampazos (5197), Santiago, Cadereyta, and Garcia.

Number.—1. The most elementary process of thought involves a distinction within an identity—the A and the not-A within the sphere throughout which these terms are intelligible. Again, A may be a generic quality recognizable in different modes, which may be represented by Aa, Ab, Ac, &c. Thus the notions of "one," "two," and the vague "many" are fundamental, and must have impressed themselves on the human mind at a very early period; evidence of this fact is afforded, for instance, by the grammatical distinction of singular, dual, and plural which we find in very ancient languages. A more definite idea of number seems to have been gradually acquired by realizing the equivalence, *quâ* plurality, of different concrete groups, such as the fingers of the right hand and those of the left. This led to the invention of a set of names which in the first instance did not even suggest a numerical system, but denoted certain recognized forms of plurality, just as blue, red, green, &c., denote recognized forms of colour. Eventually the conception of the series of natural numbers became sufficiently clear to lead to a systematic terminology, and the science of arithmetic was thus rendered possible. But it is only in quite recent times that the notion of number has been submitted to a critical analysis; it is, in fact, one of the most characteristic results of modern mathematical research that the term *number* has been made at once more precise and more extensive.

2. *Manifolds.*—Let us assume the possibility of constructing a permanent system of things such that (1) the system includes all objects to which a certain definite quality belongs; (2) no object without this quality belongs to the system; (3) each object of the system is permanently recognizable as the same thing, and as distinct from all other objects of the system. Such a system is called a *manifold;* the separate objects belonging to it are called its *elements.* A manifold may consist of a single element.

It is further assumed to be possible to select, by a definite process, one or more elements of any manifold A at pleasure; these selected elements form another manifold B. If any element of A remains unselected, B is said to be a part of A (in symbols, $B \prec A$); if not, B is identical with A. Every element of A is a part of A. If $B \prec A$, and $C \prec B$, then $C \prec A$.

When a correspondence can be established between two manifolds A and B in such a way that to every element of A corresponds one and only one element of B, and conversely, A and B are said to have the same *power*, or to be *equivalent;* in symbols, $A \backsim B$. If $A \backsim B$ and $B \backsim C$, then $A \backsim C$. It is possible for a manifold to be equivalent to a part of itself; the manifold is then said to be *infinite.*

3. Suppose that when any two elements a, b of a manifold A are taken there can be established, by a definite criterion, one or other of two alternative relations, symbolized by $a<b$ and $a>b$, subject to the following conditions:—(1) If $a>b$, then $b<a$; and if $a<b$, then $b>a$; (2) If $a>b$ and $b>c$, then $a>c$. In this case the criterion is said to arrange the manifold in order. A manifold which can be arranged in order may be called *ordinable.* An ordinable manifold may, in general, by the application of different criteria, be arranged in order in a variety of ways. According as $a<b$ or $a>b$ we shall speak of a as anterior or posterior to b. These terms are chosen merely for convenience, and must not be taken to imply any meaning except what is involved in the definition of the signs $>$ and $<$ for the particular criterion in question. The consideration of a succession of events in time will help to show that the assumptions made are not self-contradictory. A manifold arranged in order by a definite criterion will be called an *ordered* manifold. Let

a, b be any two elements of an ordered manifold, and suppose $a<b$. All the elements c (if any) such that $a<c<b$ are said to fall within the interval (a, b). If an element b, posterior to a, can be found such that no element falls within the interval (a, b), then a is said to be isolated from all subsequent elements, and b is said to be the element next after a. So if $b'<a$, and no element falls within the interval (b', a), then a is isolated from all preceding elements, and b' is the element next before a. For any assigned element a, either, neither, or both of these cases may occur.

4. *The Natural Scale.*—It will be convenient to use the term *progressive manifold*, or simply *progression*, for an ordered manifold in which (1) there is one element anterior to all the rest, and (2) every element a is followed by a definite next element a', so that $a<a'$ and no element falls within the interval (a, a'). The generic idea common to all progressions (which are obviously equivalent) is the scale of natural numbers. Thus a natural number is an element of an ideal manifold defined solely by the conditions (1) and (2) above stated. The essence of the natural scale consists in the arrangement of its elements; if we try to abstract this there is nothing left. Any such scheme as 1, 11, 111, 1111 . . . . or 1, 2, 3, 4 . . . is merely a conventional symbolism by which the natural scale can be suggested to the mind. Any manifold equivalent to the whole or a part of the natural scale is said to be *numerable*. Any element of the natural scale is said to be "the number of" things in the group which consists of itself and all anterior elements, or of any group equivalent thereto. Counting a given set of objects means establishing its equivalence to a set consisting of a natural number and all those preceding it.

The natural scale is an infinite manifold. For each element a may be associated with the next succeeding element a', while the elements a' (symbolized by 2, 3, 4 . . .) form a part of the manifold. Conversely to every element a' corresponds a definite element a.

5. *Arithmetical Operations.*—When the natural scale (N) has once been obtained, it is comparatively easy to define the arithmetical operations of addition, multiplication, and involution, as applied to natural numbers. It can be proved that these operations are free from ambiguity and obey certain formal laws of commutation, &c., which need not be discussed here. Each of the three direct operations leads to an inverse problem which cannot be solved except under certain implied conditions. Let a, b denote any two assigned natural numbers: then it is required to find natural numbers x, y, z such that

$$a=b+x, \quad a=by, \quad a=z^b$$

respectively. The solutions, when they exist, are perfectly definite, and may be denoted by $a-b$, a/b and $\sqrt[b]{a}$; but in order that these symbols may be intelligible it is necessarily implied in the first case that $a>b$, in the second that a is a multiple of b, and in the third that a is a perfect bth power. It is found to be possible, by the construction of certain elements, called respectively *negative*, *fractional*, and *irrational numbers*, and *zero*, to remove all these restrictions.

6. There are certain properties, common to the manifolds with which we have next to deal, analogous to those possessed by the natural scale, and consequently justifying us in applying the term *number* to any one of their elements. They are stated here, once for all, to avoid repetition; the verification, in each case, will be, for the most part, left to the reader. Each of the manifolds in question (A, suppose) is an ordered manifold. If α, β are any two elements of A, they may be combined by two definite operations, represented by + and ×, so as to give two definite elements of A represented by $\alpha+\beta$ and $\alpha\times\beta$ (or $\alpha\beta$); these operations obey the formal laws satisfied by those of addition and multiplication. The manifold A contains one[1] element ι, such that if α is any element of A (ι included), then $\alpha+\iota>\alpha$, and $\alpha\iota=\alpha$. Thus A contains the elements ι, $\iota+\iota$, $\iota+\iota+\iota$, &c., or, as we may write them, ι, 2ι, 3ι, . . . $m\iota$ . . . such that $m\iota+n\iota=(m+n)\iota$ and $m\iota\times n\iota=mn\iota$; also $\iota<2\iota<3\iota$ . . . We may express this by saying that A contains an *image* of the natural scale. The element denoted by ι may be called the *ground element* of A.

7. *Negative Numbers.*—Let any two natural numbers a, b be selected in a definite order a, b (to be distinguished from b, a, in which the order is reversed). In this way we obtain what we shall call a *couple*, or more precisely, if necessary, an *ordered couple* (a, b). These couples may be associated with an ordered manifold according to the following rules:—

Two couples (a, b), (a', b') are said to be equal if $a+b'=a'+b$. In other words (a, b), (a', b') are then taken to be equivalent symbols for the same thing.

If $a+b'>a'+b$, we write $(a, b)>(a', b')$; and if $a+b'<a'+b$, we write $(a, b)<(a', b')$.

The symbols + and × are defined by the formulæ

$$(a, b)+(a', b')=(a+a', b+b')$$
$$(a, b)\times(a', b')=(aa'+bb', ab'+a'b)$$

The manifold thus defined will be denoted by $\bar{N}$; it may be called the scale of relative integers.

If ι denotes (2, 1) or any equivalent couple, $(a, b)+\iota=(a+2, b+1)>(a, b)$ and $(a, b)\times\iota=(2a+b, a+2b)=(a, b)$. Hence ι is the ground element of $\bar{N}$. By definition, $2\iota=\iota+\iota=(4, 2)=(3, 1)$: similarly, we find that $3\iota=2\iota+\iota=(5, 2)=(4, 1)$, and hence by induction $m\iota=(m+1, 1)$. Conversely every element (a, b) in which $a>b$ can be expressed by the symbol $(a-b)\iota$. If $\iota'=(1, 2)$, it may be proved in the same way that $m\iota'=(1, m+1)$, and that every element (a, b) in which $b>a$ can be expressed by the symbol $(b-a)\iota'$.

8. It follows as a formal consequence of the definitions that $\iota+\iota'=(2, 1)+(1, 2)=(3, 3)$. Now couples of the type (a, a) cannot properly be said to be *ordered*: still it is convenient to admit these symbols and associate them all with a definite element of $\bar{N}$ which we call *zero*, and denote by 0. Thus finally $\iota+\iota'=0$, and we can represent $\bar{N}$ by the scheme—

$$\ldots 3\iota', 2\iota', \iota', 0, \iota, 2\iota, 3\iota \ldots$$

in which each element is obtained from the next before it by the addition of ι. With this notation the rules of operation may be written (m, n, denoting natural numbers)—

$$m\iota+n\iota=(m+n)\iota \qquad m\iota'+n\iota'=(m+n)\iota'$$
$$m\iota+n\iota'=(m-n)\iota \text{ if } m>n$$
$$=(n-m)\iota' \quad m<n$$
$$m\iota\times n\iota=mn\iota,\ m\iota'\times n\iota'=mn\iota,\ m\iota\times n\iota'=mn\iota',$$

with the special rules for zero, that if α is any element of $\bar{N}$,

$$\alpha+0=\alpha,\ \alpha\times 0=0.$$

To each element, α, of $\bar{N}$ corresponds a definite element α' such that $\alpha+\alpha'=0$; if $\alpha=0$, then $\alpha'=0$, but in every other case α, α' are different and may be denoted by $m\iota$, $m\iota'$. The natural number m is called the *absolute value* of $m\iota$ and $m\iota'$.

9. If α, β are any two elements of $\bar{N}$, the equation $\xi+\beta=\alpha$ is satisfied by putting $\xi=\alpha+\beta'$. Thus the symbol $\alpha-\beta$ is always interpretable as $\alpha+\beta'$, and we may say that within $\bar{N}$ subtraction is always possible. On

[1] There cannot be more than one such element.

the other hand, α/β is intelligible only if the absolute value of α is a multiple of the absolute value of β.

The manifold $\bar{N}$ has no least element and no greatest element. At the same time it is numerable, as we see, for instance, by associating the elements 0, $a\iota$, $b\iota'$ with the natural numbers 1, $2a$, $2b+1$ respectively, thus—

$$(N)\ 1,\ 2,\ 3,\ 4,\ 5,\ 6,\ \ldots$$
$$(\bar{N})\ 0,\ \iota,\ \iota',\ 2\iota,\ 2\iota',\ 3\iota\ \ldots$$

It is usual to write $+a$ (or simply a) and $-a$ for $a\iota$ and $a\iota'$ respectively; that this should be possible without leading to confusion or ambiguity is certainly remarkable.

10. *Fractional Numbers.*—Starting as before with ordered couples chosen from N, we may form a set of symbols $[a, b]$, and associate them with the elements of an ordered manifold R by the following rules:—

The symbols $[a, b]$, $[a', b']$, are equivalent if $ab' = a'b$.

If $ab' > a'b$ we write $[a, b] > [a', b']$; and if $ab' < a'b$ we write $[a, b] < [a', b']$.

The symbols $+$ and $\times$, as applied to elements of R, are defined by the formulæ

$$[a, b] + [a', b'] = [ab' + a'b,\ bb']$$
$$[a, b] \times [a', b'] = [aa',\ bb'].$$

Symbols of the type $[a, a]$ are admissible. It follows from the definitions that they are all equivalent, and that, if we denote $[1, 1]$ by v, then $[a, b] + v = [a+b, b] > [a, b]$, $[a, b] \times v = [a, b]$. Hence v is the ground element of R.

By definition, $2v = v + v = [2, 1]$; similarly $3v = 2v + v = [3, 1]$, and by induction $mv = [m, 1]$. It also follows that if a is a multiple of b, say mb, the element corresponding to $[a, b]$ may be denoted by the equivalent symbol mv.

11. The manifold R differs in one important respect from N and $\bar{N}$, and from any other ordered manifold in which isolated elements occur. No element of R is isolated either from subsequent or preceding elements: this follows at once from the fact that if $[a, b] = \alpha$ and $[a', b'] = \alpha'$ are the symbols of any two elements of R, the element denoted by $[a+a', b+b']$ falls within the interval (α, α'). On account of this property R is said to be *dense*. Strange as it appears at first sight, R is a numerable manifold—a fact first proved by G. Cantor. To see this, observe that every element of R may be represented by a "reduced" couple $[a, b]$, in which a, b are prime to each other. If $[a, b]$, $[c, d]$ are any two reduced couples, we will say that $[a, b]$ is anterior to $[c, d]$ if either (1) $a+b < c+d$, or (2) $a+b = c+d$, but $a < c$. This gives a criterion by which the elements of R can be arranged in the progression

$[1, 1]$, $[1, 2]$, $[2, 1]$, $[1, 3]$, $[3, 1]$, $[1, 4]$, $[2, 3]$, $[3, 2]$, $[4, 1]$...

which is equivalent to the natural scale.

R agrees with $\bar{N}$ in having no least and no greatest element; for if α denotes any element $[a, b]$, then $[2a-1, 2b] < \alpha$, while $[2a+1, 2b] > \alpha$.

12. The division of one element of R by another is always practicable; for by definition

$$[c, d] \times [ad, bc] = [acd, bcd] = [a, b],$$

and consequently $[a, b] \div [c, d]$ is always interpretable as $[ad, bc]$. As a particular case $[m, 1] \div [n, 1] = [m, n]$, so that every element of R is expressible in one of the forms mv, mv/nv. When m is a multiple of n, $mv/nv = (m/n)v$. It is usual to omit the symbol v altogether, and to represent the element $[m, n]$ by m/n, whether m is a multiple of n or not. This does not lead to any confusion, if it is borne in mind that the symbols 1, 2, 3, &c., when used to represent elements of R, really have a meaning distinct from that assigned to them when they represent elements of N.

13. Within the manifold R subtraction is not always practicable; but this limitation may be removed by constructing a manifold $\bar{R}$ related to R in the same way as $\bar{N}$ to N. This may be done in two ways which lead to equivalent results. We may either form symbols of the type (α, β), where α, β denote elements of R, and apply the formulæ of § 7; or else form symbols of the type $[\alpha, \beta]$, where α, β denote elements of $\bar{N}$, and apply the formulæ of § 10. The final result is that $\bar{R}$ comprises a zero element, 0, a ground element v, an element v' such that $v + v' = 0$, and a set of elements representable by the symbols $(m/n)v$, $(m/n)v'$. In this notation the rules of operation are—

$$\frac{m}{n}v + \frac{m'}{n'}v = \left(\frac{mn' + m'n}{nn'}\right)v, \quad \frac{m}{n}v' + \frac{m'}{n'}v' = \left(\frac{mn' + m'n}{nn'}\right)v';$$

$$\frac{m}{n}v + \frac{m'}{n'}v' = \frac{mn' - m'n}{nn'}v, \text{ or } \frac{m'n - mn'}{nn'}v', \text{ as } mn' > \text{or} < m'n;$$

$$\frac{m}{n}v \times \frac{m'}{n'}v = \frac{mm'}{nn'}v = \frac{m}{n}v' \times \frac{m'}{n'}v', \quad \frac{m}{n}v \times \frac{m'}{n'}v' = \frac{mm'}{nn'}v';$$

$$\frac{m}{n}v \div \frac{m'}{n'}v = \frac{m}{n}v' \div \frac{m'}{n'}v' = \frac{mn'}{m'n}v, \ \frac{m}{n}v \div \frac{m'}{n'}v' = \frac{m}{n}v' \div \frac{m'}{n'}v = \frac{mn'}{m'n}v';$$

$$\alpha - \beta = \alpha + \beta', \text{ where } \beta + \beta' = 0;$$

$$\alpha + 0 = \alpha,\ \alpha \times 0 = 0;$$

α and β denoting any two elements of $\bar{R}$. If $\beta = (m/n)v$, then $\beta' = (m/n)v'$, and if $\beta = (m/n)v'$, then $\beta' = (m/n)v$.

14. When $\bar{R}$ is constructed by means of couples taken from $\bar{N}$, we must put $[m\iota, n\iota] = [m\iota', n\iota'] = (m/n)v$, $[m\iota, n\iota'] = [m\iota', n\iota] = (m/n)v'$, and $[0, \alpha] = 0$, if α is any element of $\bar{N}$ except 0. The symbols $[0, 0]$ and $[\alpha, 0]$ are inadmissible; the first because it satisfies the formal definition of equality with every symbol $[\alpha, \beta]$, and is therefore indeterminate; the second because, according to the rule of addition (§ 10)—

$$[\alpha, 0] + [\iota, \iota] = [\alpha\iota, 0] = [\alpha, 0],$$

which is inconsistent with $\xi + v > \xi$.

In the same way, if 0 denotes the zero element of $\bar{R}$, and ξ any other element, the symbol $0/0$ is indeterminate, and $\xi/0$ inadmissible, because, by the formal rules of operation, $\xi/0 + v = \xi/0$, which conflicts with the definition of the ground element v. It is usual to write $+\frac{m}{n}$ $\left(\text{or simply } \frac{m}{n}\right)$ for $\frac{m}{n}v$, and $-\frac{m}{n}$ for $\frac{m}{n}v'$. Each of these elements is said to have the absolute value m/n. The ultimate ordering criterion of the manifold $\bar{R}$ is that, if ξ, η are any two elements of it, $\xi > \eta$ when $\xi - \eta$ is positive; that is to say, when it can be expressed in the form $(m/n)v$.

15. The manifold $\bar{R}$ is very important, because it is the simplest type of a *domain of rationality*, or *corpus*. An algebraic corpus is a manifold, such that its elements are representable by symbols α, β, &c., which can be combined according to the laws of ordinary algebra; every algebraic expression obtained by combining a finite number of symbols by means of a finite chain of rational operations $(+, -, \times, \div)$, being capable of interpretation as representing a definite element of the manifold, with the single reservation that division by zero is inadmissible. Since, by the laws of algebra, $\alpha - \alpha = 0$, and $\alpha/\alpha = 1$, every algebraic corpus must contain $\bar{R}$, or, more properly, a manifold which is an image of $\bar{R}$.

16. *Irrational Numbers.*—Let α denote any element of $\bar{R}$; then α and all anterior elements form a manifold, A say; the remaining elements form another manifold A', which we shall call complementary to A, and we may write $\bar{R} = A + A'$. Now the essence of this separation of $\bar{R}$ into the parts A and A' may be expressed without any reference to α as follows:—

I. The manifolds A, A' are complementary; that is, their elements, taken together, make up the whole of $\bar{R}$.

II. Every element of A is less than every element of A'.

III. The manifold A' has no first element. (This last condition is artificial, but saves a distinction of cases in what follows.)

Every separation $\bar{R} = A + A'$ which satisfies these conditions is called a *cut*, and will be denoted by (A, A'). We have seen that every rational number α is associated with a definite cut. Conversely, a cut (A, A') in which A has a last element α is perfectly definite, and specifies α without ambiguity. But there are other cuts in which A has no last element. For instance, all the elements (α) of $\bar{R}$ such that either $\alpha \leqslant 0$, or else $\alpha > 0$ and $\alpha^2 < 2$, form a manifold A, while those for which $\alpha > 0$ and $\alpha^2 > 2$ form the complementary manifold A'. This separation is a cut in which A has no last element; because if p/q is any positive element of A, the element $(3p+4q)/(2p+3q)$ exceeds p/q, and also belongs to A. *Every cut (A, A') of this kind is said to define an irrational number.* The justification of this is found in the following propositions:—

(1) A cut is a definite concept, and the *ensemble* of cuts is a manifold according to definition; the generic quality of the manifold being the separation of $\bar{R}$ into two complementary parts, without altering the order of its elements.

(2) The manifold of cuts may be arranged in order by the rule that $(A, A') < (B, B')$ if A is a part of B.

(3) This criterion of arrangement preserves the order of gnitude of all rational numbers.

(4) Cuts may be combined according to the laws of algebra, and, when the cuts so combined are all rational, the results are in agreement with those derived from the rational theory.

As a partial illustration of proposition (4) let (A, A'), (B, B') be any two cuts; and let C' be the manifold whose elements are obtained by forming all the values of $\alpha' + \beta'$, where α' is *any* element of A' and β' is any element of B'. Then if C is the complement of C', it can be proved that (C, C') is a cut; this cut is said to be the sum of (A, A') and (B, B'). The difference, product and quotient of two cuts may be defined in a similar way. If $\mathfrak{n}$ denotes the irrational cut chosen above for purposes of illustration, we shall have $\mathfrak{n}^2 = (C, C')$ where C' comprises all the numbers $\alpha'\beta'$ obtained by multiplying *any* two elements α', β' which are rational and positive, and such that $\alpha'^2 > 2$, $\beta'^2 > 2$. Since $\alpha'^2\beta'^2 > 4$ it follows that $\alpha'\beta'$ is positive and greater than 2; it can be proved conversely that every rational number which is positive and greater than 2 can be expressed in the form $\alpha'\beta'$. Hence $\mathfrak{n}^2 = 2$, so that the cut $\mathfrak{n}$ actually gives a real arithmetical meaning to the positive root of the equation $x^2 - 2 = 0$; in other words, we may say that $\mathfrak{n}$ defines the irrational number $\sqrt{2}$. The theory of cuts provides, in fact, a logical basis for the treatment of all numerical irrationalities, and enables us to justify all arithmetical operations involving the use of such quantities.

17. Since the manifold of cuts ($\mathfrak{N}$ say) has an order of magnitude, we may construct cuts in this manifold. Thus if $\mathfrak{a}$ is any element of $\mathfrak{N}$, and $\mathfrak{A}$ is the manifold which consists of $\mathfrak{a}$ and all anterior elements of $\mathfrak{N}$, we may write $\mathfrak{N} = \mathfrak{A} + \mathfrak{A}'$, and now $(\mathfrak{A}, \mathfrak{A}')$ is a cut in which $\mathfrak{A}$ has a last element $\mathfrak{a}$. It is a remarkable fact that no other kind of cut in $\mathfrak{N}$ is possible; in other words, *every conceivable cut in $\mathfrak{N}$ is defined by one of its own elements.* This fact is expressed by saying that $\mathfrak{N}$ is a *continuous* manifold, and $\mathfrak{N}$ itself is referred to as *the numerical continuum.* The property of continuity must be carefully distinguished from that of density; a continuous manifold is necessarily dense, but a dense manifold is not always continuous. The manifold $\mathfrak{N}$ is not numerable.

18. Another way of treating the theory of irrational numbers is by means of *sequences.* A sequence is an unlimited succession of rational numbers

$$a_1, a_2, a_3 \ldots a_m, a_{m+1} \ldots$$

the elements of which can be assigned by a definite rule of calculation, and such that when any rational number ϵ, however small, has been fixed upon, it is possible to find an integer m, so that for *all* positive integral values of n the absolute value of $a_{m+n} - a_m$ is less than ϵ. Under these conditions the sequence may be taken to represent a definite number, which is, in fact, the limit of a_m when m increases without limit. Every rational number a can be expressed as a sequence in the form $(a, a, a, \ldots)$, but this is only one of an infinite variety of such representations, for instance—

$$1 = (\cdot 9, \cdot 99, \cdot 999, \ldots) = \left(\frac{1}{2}, \frac{3}{4}, \frac{7}{8}, \ldots \frac{2^n - 1}{2^n} \ldots\right)$$

and so on. The essential thing is that we have a mode of representation which can be applied to rational and irrational numbers alike, and provides a very convenient symbolism to express the results of arithmetical operations. Thus the rules for the sum and product of two sequences are given by the formulæ

$$(a_1, a_2, a_3, \ldots) + (b_1, b_2, b_3, \ldots) = (a_1 + b_1, a_2 + b_2, a_3 + b_3 \ldots)$$

$$(a_1, a_2, a_3, \ldots) \times (b_1, b_2, b_3, \ldots) = (a_1 b_1, a_2 b_2, a_3 b_3 \ldots)$$

from which the rules for subtraction and division may be at once inferred. It has been proved that the method of sequences is ultimately equivalent to that of cuts. The advantage of the former lies in its convenient notation, that of the latter in giving a clear definition of an irrational number without having recourse to the notion of a limit.

19. *Transfinite Numbers.*—In the course of his researches in the theory of manifolds, G. Cantor has been led to the construction of the very subtle calculus of transfinite numbers. This has not yet been fully developed, and the terminology is still fluctuating; hence only a very brief account can be attempted here. It has been observed (§ 4) that a manifold which can be "counted" may be associated with an element of the natural scale, which is called "the number of" the elements of the manifold. An infinite manifold cannot be counted in the ordinary sense; but if it is numerable, there is some criterion by which its elements may be represented by the scheme

$$u_1 \quad u_2 \quad u_3 \ldots u_n \ldots$$

or

$$1' \quad 2' \quad 3' \ldots n' \ldots$$

When the elements of a manifold are arranged according to the scheme $1', 2', 3' \ldots$ it may be said to be *similar*, or to be *arranged similarly*, to the natural scale. Now, just as the number 3 may be associated with the succession 1, 2, 3, or with any equivalent manifold similarly arranged, we may invent a new symbol ω, and associate it with the whole of the natural scale, or with any equivalent manifold *similarly arranged.* For convenience we shall call ω the *index* of the natural scale, thus—

$$\omega = \text{ind. } N = \text{ind. } (u_1, u_2, u_3, \ldots)$$

when u_1, u_2, u_3, &c. is any manifold arranged similarly to the natural scale.

20. There is no logical difficulty in constructing a scheme

$$u_1, u_2, u_3 \ldots \mid v_1,$$

where the progression $u_1, u_2, u_3 \ldots$ is immediately followed by an element v_1. Any manifold represented by this scheme is associated with the index $\omega+1$; and in like manner we may form arranged manifolds associated with the indices

$$\omega+2, \omega+3 \ldots \omega+n,$$

where n is any element of N. The scheme

$$u_1, u_2, u_3 \ldots \mid v_1, v_2, v_3 \ldots$$

is associated with $\omega+\omega=\omega 2$; the scheme

$$u_{11}, u_{12}, u_{13} \ldots \mid u_{21}, u_{22}, u_{23} \ldots \mid \ldots \mid u_{n1}, u_{n2} \ldots \mid \ldots$$

with $\omega . \omega$ or ω^2; and so on. Thus we may construct arrangements of manifolds corresponding to any index of the form

$$\phi(\omega)=\omega^n a+\omega^{n-1}b+\ldots+\omega k+l,$$

where $n, a, b, \ldots l$ are any elements of N.

We are thus led to the construction of a scheme of symbols—

$$\begin{array}{ll}
\text{I.} & 1, 2, 3, \ldots n \ldots \\
\text{II.} & \left\{\begin{array}{l}\omega, \omega+1, \ldots \omega+n, \ldots \\ \omega 2, \omega 2+1, \ldots \omega 2+n, \ldots \\ \vdots \\ \omega^2, \omega^2+1, \omega^2+2 \ldots \omega^2+n, \ldots \\ \vdots \\ \phi(\omega), \phi(\omega)+1, \ldots \phi(\omega)+n, \ldots \\ \vdots \end{array}\right. \\
\text{III.} & \left\{\begin{array}{l}\omega^\omega, \omega^\omega+1, \ldots \omega^\omega+n, \ldots \\ \vdots \\ \omega^{\phi(\omega)}, \omega^{\phi(\omega)}+1, \ldots \omega^{\phi(\omega)}+n, \ldots \\ \vdots \end{array}\right.
\end{array}$$

where the first element of any row is supposed to follow immediately all the elements of the row next before it, and other elements of the row are obtained by successive additions of 1. The first elements of the parts of the scheme denoted by I., II., III. &c., are $1, \omega, \omega^\omega$, &c. All the symbols in which ω occurs are called *transfinite ordinal numbers.*

21. The index of a finite manifold is a definite integer, however the manifold may be arranged: we may take this index as a symbol for the power of the manifold. But the index of an infinite ordinable manifold depends upon the way in which its elements are arranged; for instance, ind. $(1', 2', 3', \ldots)=\omega$, but ind. $(1', 3', 5', \ldots \mid 2', 4', 6', \ldots)=\omega 2$. Or, to take another example, the scheme—

$$\begin{array}{l}
1, 3, 5, \ldots (2n-1) \ldots \\
2, 6, 10, \ldots 2(2n-1) \ldots \\
4, 12, 20, \ldots 4(2n-1) \ldots \\
\vdots \quad \vdots \quad \vdots \\
2^m, 2^m.3, 2^m.5, \ldots 2^m(2n-1) \ldots \\
\vdots
\end{array}$$

in which each row is supposed to follow the one before it gives a permutation of any manifold $(u_1, u_2, u_3 \ldots)$ by which the index is changed from ω to ω^2. It may be proved that if M is any numerable manifold, there is a permutation of M for which the index is $\phi(\omega)$, any assigned element of (II.); and that, conversely, if the index of any arranged manifold is $\phi(\omega)$, the manifold is numerable. Thus the power of all manifolds which can be associated with indices of the class (II.) is the same as that of the natural scale; this power is indicated by $\aleph_0$. Since $\aleph_0$ is associated with all manifolds of a particular power, independently of the arrangement of their elements, it is analogous to the integers 1, 2, 3, &c., when used to denote powers of finite manifolds; for this reason it is called "the least transfinite cardinal number."

22. There are manifolds (for instance, $\mathfrak{R}$) which are of higher power than $\aleph_0$; the next higher power $\aleph_1$ belongs to manifolds which can be associated with transfinite indices of the class (III.). It is not unlikely that there is a natural progression of powers $\aleph_0, \aleph_1, \aleph_2$, &c., belonging to manifolds which can be associated with indices of the classes II., III., IV., &c., and that every ordinable manifold may be associated with one and only one of the cardinal numbers $\aleph_i$. It has also been conjectured that $\aleph_1$ is the proper symbol for the power of the numerical continuum; but this still awaits demonstration or disproof. Again, it may be asked whether any meaning can be attached to such a symbol as $\aleph_\omega$, or, more generally, $\aleph_\psi$, where ψ is any ordinal number of the nth class.

23. Transfinite numbers, both ordinal and cardinal, may be combined by operations which are so far analogous to those of ordinary arithmetic that it is convenient to denote them by the same symbols. But the laws of operation are not entirely the same; for instance, $\omega 2$ and 2ω have different meanings: the first has been explained, the second is the index of the scheme $(a_1 b_1 \mid a_2 b_2 \mid a_3 b_3 \mid \ldots \mid a_n b_n \mid \ldots)$ or any similar arrangement

24. *Complex Numbers.*—If a is an assigned number, rational or irrational, and n a natural number, it can be proved that there is an element of $\mathfrak{R}$ satisfying the equation $x^n=a$, except when n is even, and a is negative; in this case the equation is not satisfied by any element of $\mathfrak{R}$. The difficulty is removed by the construction of a manifold of ordered couples $\{x, y\}$ where x, y are any elements of $\mathfrak{R}$: this may be arranged by the criterion that $\{x, y\}<\{x', y'\}$ if $x<x'$, or if $x=x'$ and $y<y'$. The rules of operation are

$$\{x, y\}+\{x', y'\}=\{x+x', y+y'\};$$
$$\{x, y\}\times\{x', y'\}=\{xx'-yy', xy'+x'y\}.$$

Hence the manifold has the ground element $\{1, 0\}$, which we may denote by σ; and, if we write τ for the element $\{0, 1\}$,

$$\tau^2=\{-1, 0\}=-\sigma.$$

Whenever m, n are rational $\{m, n\}=m\sigma+n\tau$, and we are thus justified in writing, if we like, $x\sigma+y\tau$ for $\{x, y\}$ in all circumstances. A further simplification is gained by writing x instead of $x\sigma$, and regarding τ as a symbol which is such that $\tau^2=-1$, but in other respects obeys the ordinary laws of operation. It is usual to write i instead of τ; we thus have a manifold $\mathfrak{Z}$ of complex numbers $x+yi$. In this manifold, which includes an image of $\mathfrak{R}$, not only the four rational operations (excluding division by zero), but also the extraction of roots, may be effected without any restriction. Moreover (as first proved by Gauss and Cauchy), if $a_0, a_1, \ldots a_n$ are any assigned elements of $\mathfrak{Z}$, the equation

$$a_0 z^n+a_1 z^{n-1}+\ldots+a_{n-1}z+a_n=0$$

is always satisfied by precisely n elements of $\mathfrak{Z}$, with a proper convention as to multiple roots. Thus any algebraic function of any finite number of elements of $\mathfrak{Z}$ is also contained in $\mathfrak{Z}$. In this sense $\mathfrak{Z}$ is a closed arithmetical domain, just as $\mathfrak{R}$ is when we restrict ourselves to rational operations. The power of $\mathfrak{Z}$ is the same as that of $\mathfrak{R}$.

25. *Algebraic Numbers.*—As explained in the article NUMBERS, THEORY OF (*Ency. Brit.* vol. xvii. p. 614), Gauss distinguished as *integral* those elements $x+yi$ of $\mathfrak{Z}$ in which x, y are ordinary integers; and Kummer extended Gauss's conception by introducing "complex integers" of the form

$$\psi(\eta)=a\eta+a_1\eta_1+\ldots+a_{e-1}\eta_{e-1},$$

where $\eta, \eta_1, \ldots \eta_{e-1}$ are the Gaussian periods of f terms associated with the roots of the equation $(x^p-1)/(x-1)=0$, p being a prime, and $ef=p-1$. The remarkable fact that an integer $\psi(\eta)$ may be resolvable in more ways than one into the product of irresolvable factors of the same type, appeared to involve the complete failure of the ordinary laws of divisibility so far as these new integers were concerned; but Kummer succeeded in restoring a complete analogy by his invention of ideal numbers.

Kronecker and Dedekind independently generalized the results of Gauss and Kummer, and thus laid the foundations of a perfectly general theory of algebraic numbers, which is one of the most beautiful results of analysis. In the brief outline which follows, Dedekind's notation and point of view will be adopted.

26. If

$$f(\theta)=a_0\theta^n+a_1\theta^{n-1}+\ldots+a_n=0,$$

where $a_0, a_1, \ldots a_n$ are ordinary integers, is an irreducible equation in the domain N (that is, if $f(\theta)$ cannot be resolved into the product of two integral functions with rational integral coefficients), the n roots $\theta, \theta', \theta'' \ldots \theta^{(n-1)}$ are said to form a set of conjugate algebraic numbers of the nth order. If $a_0=1$, the roots are said to form a set of conjugate algebraic *integers*. Every algebraic number can be expressed in the form ω/a_0 where a_0 is a natural number and ω an algebraic integer; in all that follows it will be supposed that $a_0=1$, and consequently θ is integral.

Associated with θ we have a corpus $\Omega=R(\theta)$ consisting of all rational functions of θ with real rational coefficients; and in like manner we have the conjugate corpora $\Omega'=R(\theta')$, $\Omega''=R(\theta'')$ . . . $\Omega^{(n-1)}=R(\theta^{(n-1)})$ associated with $\theta', \theta'' \ldots \theta^{(n-1)}$ respectively. The manifold of integers contained in Ω is denoted by $\mathfrak{o}$.

Every element of Ω can be put into the form

$$\omega=c_0+c_1\theta+\ldots+c_{n-1}\theta^{n-1},$$

where $c_0, c_1, \ldots c_{n-1}$ are real and rational. If the c-s are integral, ω is an integer; but the converse is not necessarily true. It is possible, however, to find a set of integers $\omega_1, \omega_2, \ldots \omega_n$ belonging to Ω, such that every integer in Ω can be uniquely expressed in the form

$$\omega=h_1\omega_1+h_2\omega_2+\ldots+h_n\omega_n,$$

where $h_1, h_2, \ldots h_n$ are real integers, which may be called the *co-ordinates* of ω with respect to the *base* $(\omega_1, \omega_2, \ldots \omega_n)$. The conjugate numbers $\omega_1^{(i)}, \omega_2^{(i)}, \ldots \omega_n^{(i)}$ form a base of the manifold $\mathfrak{o}^{(i)}$, which comprises all the integers in $\Omega^{(i)}$. There exists an infinite number of equivalent bases of $\mathfrak{o}$.

The quantity

$$\Delta(\Omega)=\begin{vmatrix} \omega_1, & \omega_2, & \ldots & \omega_n \\ \omega_1', & \omega_2', & \ldots & \omega_n' \\ \omega_1'', & \omega_2'', & \ldots & \omega_n'' \\ \vdots & & & \\ \omega_1^{(n-1)}, & \omega_2^{(n-1)}, & \ldots & \omega_n^{(n-1)} \end{vmatrix}^2$$

is a rational integer called the *discriminant* of the corpus. Its value is the same whatever base $(\omega_1, \omega_2, \ldots \omega_n)$ is chosen.

If α is any integer in Ω, the product of α and its conjugates is a rational integer called the *norm* of α, and written $N(\alpha)$. Thus—

$$N(\alpha)=\alpha\alpha'\alpha'' \ldots \alpha^{(n-1)}=\alpha\alpha_1,$$

where α_1 is an integer in Ω. It follows from the definition that if α, β are any two integers in Ω, then $N(\alpha\beta)=N(\alpha)N(\beta)$.

27. *Ideals.*—That form of the theory which has been developed by Dedekind is based upon the notion of an *ideal*, which is defined by the following properties:—

(I.) An ideal $\mathfrak{m}$ is a manifold of integers belonging to Ω.

(II.) If μ, μ' are any two elements of $\mathfrak{m}$ (the same or different), then $\mu+\mu'$ and $\mu-\mu'$ are also elements of $\mathfrak{m}$.

(III.) If μ is any element of $\mathfrak{m}$, and ω any element of $\mathfrak{o}$, then $\omega\mu$ is an element of $\mathfrak{m}$.

It is clear that ideals exist: for instance, $\mathfrak{o}$ itself is an ideal. Again, all integers in Ω which are divisible by a given integer α (in $\mathfrak{o}$) form an ideal; this is called a *principal ideal*, and is denoted by $\mathfrak{o}\alpha$. In any ideal $\mathfrak{m}$ a set of elements $\mu_1, \mu_2, \ldots \mu_n$ can always be found, such that every element of $\mathfrak{m}$ is expressible in the form $\Sigma h_i\mu_i$, where h_i is a rational integer. In other words, every ideal has a base (and therefore, of course, an infinite number of bases). If $\mathfrak{a}, \mathfrak{b}$ are any two ideals, and if we form all the products $\alpha\beta$ obtained by multiplying each element of $\mathfrak{a}$ by each element of $\mathfrak{b}$, then these products and sums of such products constitute an ideal which is called the product of $\mathfrak{a}$ and $\mathfrak{b}$ and written $\mathfrak{ab}$. In particular $\mathfrak{oa}=\mathfrak{a}$, $\mathfrak{o}^2=\mathfrak{o}$, $\mathfrak{o}\alpha.\mathfrak{o}\beta=\mathfrak{o}\alpha\beta$. This law of multiplication is commutative and associative. It is clear that every element of $\mathfrak{ab}$ is contained in $\mathfrak{a}$. It can be proved that, conversely, if every element of $\mathfrak{c}$ is contained in $\mathfrak{a}$, there exists an ideal $\mathfrak{b}$ such that $\mathfrak{c}=\mathfrak{ab}$. In particular, if α is any element of $\mathfrak{a}$, there is an ideal $\mathfrak{a}'$ such that $\mathfrak{o}\alpha=\mathfrak{aa}'$. A *prime ideal* is one which has no divisors except itself and $\mathfrak{o}$. It is a fundamental theorem that every ideal can be resolved into the product of a finite number of prime ideals, and that this resolution is unique. It is the decomposition of a principal ideal $\mathfrak{o}\alpha$ into the product of prime ideals that takes the place of the decomposition of an integer into its prime factors in the ordinary theory. It may happen that all the ideals in Ω are principal ideals; in this case every resolution of an ideal into factors corresponds to the resolution of an integer into actual integral factors, and conversely, so that the introduction of ideals is not absolutely necessary. But in every other case the introduction of ideals, or some equivalent notion, is indispensable. When two ideals have been resolved into their prime factors, their greatest common measure and least common multiple are determined by the ordinary rules. Every ideal may be expressed (in an infinite number of ways) as the greatest common measure of two principal ideals.

28. There is a theory of congruences with respect to an ideal modulus. Thus the congruence $\alpha\equiv\beta \pmod{\mathfrak{m}}$ means that $\alpha-\beta$ is an element of $\mathfrak{m}$. With respect to $\mathfrak{m}$, all the integers in Ω may be arranged in a finite number of classes such that any two elements of the same class are congruent, while no two elements of different classes are congruent. The number of these classes is called the *norm* of $\mathfrak{m}$, and written $N(\mathfrak{m})$. The norm of a prime ideal $\mathfrak{p}$ is some power of a real prime; if $N(\mathfrak{p})=p^f$, $\mathfrak{p}$ is said to be a prime ideal of degree f. If $\mathfrak{m}, \mathfrak{n}$ are any two ideals, then $N(\mathfrak{mn})=N(\mathfrak{m})N(\mathfrak{n})$. If $N(\mathfrak{m})=m$, then $m\equiv0 \pmod{\mathfrak{m}}$, and there is an ideal $\mathfrak{m}'$ such that $\mathfrak{o}m=\mathfrak{mm}'$. The norm of a principal ideal $\mathfrak{o}\alpha$ is equal to the absolute value of the norm of α as defined in § 26.

The number of incongruent residues prime to $\mathfrak{m}$ is—

$$\phi(\mathfrak{m})=N(\mathfrak{m})\Pi\left(1-\frac{1}{N(\mathfrak{p})}\right),$$

where the product extends to all prime factors of $\mathfrak{m}$. If ω is any element of $\mathfrak{o}$ which is prime to $\mathfrak{m}$,

$$\omega^{\phi(\mathfrak{m})}\equiv1 \pmod{\mathfrak{m}}.$$

29. *Ideal Classes.*—If $\mathfrak{m}$ is any ideal, another ideal $\mathfrak{n}$ can always be found (for instance, $N(\mathfrak{m})/\mathfrak{m}$) such that $\mathfrak{mn}$ is a principal ideal. Two ideals $\mathfrak{m}, \mathfrak{m}'$ are said to be *equivalent* ($\mathfrak{m}\backsim\mathfrak{m}'$), or to belong to the same class, if an ideal $\mathfrak{n}$ can be found such that $\mathfrak{mn}, \mathfrak{m}'\mathfrak{n}$ are both principal ideals. It can be proved that two ideals each equivalent to a third are equivalent to each other, and that all ideals in $\mathfrak{o}$ may be distributed into a *finite* number, h, of ideal classes. That class which contains all principal ideals is called the principal class, and denoted by O.

If $\mathfrak{a}, \mathfrak{b}$ are any two ideals belonging to the classes A, B, then $\mathfrak{ab}$ belongs to a definite class which depends only upon A, B and may be denoted by AB or BA. Thus the symbols of the classes form an Abelian group of order h, in which O is the unit element. All the known properties of Abelian groups are immediately applicable: thus there is a system of "base classes" $A_1, A_2, \ldots A_k$ such that every class is representable by a symbol $A_1^a . A_2^b . \ldots A_k^l$, and so on. Every class satisfies an equation $A^f = O$, where f is some factor of h. Hence, also, some power of every ideal is a principal ideal. In the case of a quadratic corpus ideal classes correspond to classes of quadratic forms; and the multiplication of ideals or of ideal classes corresponds to the composition of quadratic forms.

30. The discriminant of a corpus enjoys some very remarkable properties. Thus its value is always different from ± 1; there can only be a finite number of corpora of order n which have a given discriminant d; and the rational prime factors of $\Delta(\Omega)$ are precisely those rational primes which are divisible, in Ω, by the square (or some higher power) of a prime ideal.

31. Every element of $\mathfrak{o}$ which is not contained in any other ideal is an *algebraic unit*. If the conjugate corpora $\Omega, \Omega', \ldots \Omega^{(n-1)}$ consist of r_1 real and $2r_2$ imaginary corpora, there is a system of units $\epsilon_1, \epsilon_2 \ldots \epsilon_\mu$, where $\mu = r_1 + r_2 - 1$, such that every unit in Ω is expressible in the form $\epsilon = \rho\, \epsilon_1^a\, \epsilon_2^b \ldots \epsilon_\mu^l$, where ρ is a root of unity contained in Ω and $a, b, \ldots l$ are natural numbers. This theorem is due to Dirichlet.

The norm of a unit is $+1$ or -1; and the determination of all the units contained in a given corpus is in fact the same as the solution of a diophantine equation

$$F(h_1, h_2, \ldots h_n) = \pm 1.$$

For a quadratic corpus the equation is $h_1{}^2 - Dh_2{}^2 = \pm 1$, and the theory of this is complete; but, except for certain special cubic corpora, little has been done towards solving the important problem of assigning a definite process by which, for a given corpus, a system of fundamental units may be calculated. The researches of Jacobi, Hermiti, and Minkowski seem to show that a proper extension of the method of continued fractions is necessary.

32. *Normal Corpora.*—The special properties of a particular corpus Ω are closely connected with its relations to the conjugate corpora $\Omega', \Omega'', \ldots \Omega^{(n-1)}$. The most important case is when each of the conjugate corpora is identical with Ω; the corpus is then said to be *Galoisian* or *normal*. The manifold $R(\theta, \theta', \ldots \theta^{(n-1)})$ of all rational functions of the conjugate numbers $\theta, \theta', \ldots \theta^{(n-1)}$ is a Galoisian corpus; so that every arithmetical corpus of order n is either normal, or is contained in a normal corpus. The roots of an equation $f(\theta) = 0$ which defines a normal corpus are associated with a group of substitutions; if this is Abelian, the corpus is called Abelian; if it is cyclic, the corpus is called cyclic. A cyclotomic corpus is one the elements of which are all expressible as rational functions of roots of unity; in particular the complete cyclotomic corpus C_m is the corpus (of order $\phi(m)$) which consists of all rational functions of a primitive mth root of unity. To Kronecker is due the very remarkable theorem that all Abelian corpora are cyclotomic; in other words, if the roots of a rational equation $f(\theta) = 0$ are connected by a set of relations $\theta_2 = \phi(\theta_1)$, $\theta_3 = \phi(\theta_2) \ldots \theta_n = \phi(\theta_{n-1})$, $\theta_1 = \phi(\theta_n)$, where $\phi(\theta)$ is an integral function of θ with rational coefficients, then all the roots $\theta_1, \theta_2, \ldots \theta_n$ can be expressed as rational integral functions, with rational coefficients, of some root of unity. The first published proof of this was given by H. Weber.

33. It may be observed that in the theory of an arithmetical corpus we are not concerned with the actual values (as complex numbers) of its elements; the symbols are in fact mere *umbræ*, serving as regulators, so to speak, of operations which are actually performed on rational integers. When we have once obtained a base of $\mathfrak{o}$, and have constructed the "multiplication table," expressing the products $\omega_i\omega_j$ as linear functions of $\omega_1, \omega_2, \ldots \omega_n$, every integer in Ω is expressible by an abstract symbol $[h_1, h_2, \ldots h_n]$, where $h_1, h_2, \ldots h_n$ are rational integers (called in § 26 the co-ordinates of the number). Then we have rules for combining these symbols, of the form

$$[h_1, h_2, \ldots h_n] + [k_1, k_2, \ldots k_n] = [h_1 + k_1, h_2 + k_2, \ldots h_n + k_n]$$

$$[h_1, h_2, \ldots h_n] \times [k_1, k_2, \ldots k_n] = [p_1, p_2, \ldots p_n]$$

where $p_1, p_2, \ldots p_n$ are lineo-linear functions of the h-s and k-s. The divisibility of $[h_1, h_2, \ldots h_n]$ by an ideal $\mathfrak{m}$ may be expressed by one or more ordinary linear congruences satisfied by $h_1, h_2, \ldots h_n$. For instance, if $[x, y]$ stands for $x + yi$, the rules of operation are those given in § 24, and if $\mu = a(b + ci)$, where a, b, c are real integers, and b, c are prime to each other, the divisibility of $[x, y]$ by μ is expressed by the congruences

$$bx + cy \equiv 0, \quad cx - by \equiv 0 \quad (\text{mod } a(b^2 + c^2)),$$

which may be replaced by other equivalent conditions. This point of view is indicated by Kummer.

Every linear associative algebra suggests a corresponding arithmetical theory.

34. *Transcendental Numbers.*—The manifold of real algebraic numbers is numerable. Hence immediately follows the proposition (first proved by Liouville) that there are numbers, both real and complex, which cannot be defined by any combination of a finite number of equations with rational integral coefficients. Such numbers are said to be *transcendental*. Hermite first completely proved the transcendent character of e. Lindemann, by a similar method, proved the transcendence of π. Thus it is now finally established that the quadrature of the circle is impossible, not only by rule and compass, but even with the help of any number of algebraic curves of any order when the coefficients in their equations are rational. (See Hermite, "Sur la fonction exponentielle," *C.R.* t. lxxvii. 1873; and Lindemann, "Ueber die Zahl π," *Math. Ann.* xx. 1882.)

35. It is especially noteworthy that the science of arithmetic has now reached a stage where all its definitions, processes, and results are demonstrably independent of any theory of variable or measurable quantities such as those which are postulated in geometry and mathematical physics; even the notion of a limit may be dispensed with, although this idea, as well as that of a variable, is often convenient. For the questions which arise in the application of arithmetic to geometry and analysis the reader is referred to the article on FUNCTIONS OF REAL VARIABLES.

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NUMISMATICS.

I. Coins.

Ancient.

SINCE 1870 a very great advance has been made in the study of the coinages of the ancient world, and also of mediæval and more recent times. In the Greek series not only has great progress been made in its geographical classification, but also in ascertaining the chronological sequence of the numerous coinages. This last result has been effected by a careful examination of the principal centres of coinage, by a close study of style and the art displayed, and by a minute inquiry into the various metrical systems of the ancients. The phases of art as illustrated by Greek coins have been defined within certain chronological divisions or periods, the characteristics of which enable the student to group at sight his coins within well-ascertained limits. Whilst this classification by style has been of great service to the chronology of other objects of antiquity, especially of Greek sculpture, gems, &c., it has served to raise ancient coins to a position which their science had not before attained. In Roman numismatics the progress is not so marked, the scope for inquiry being perhaps much more limited. Mommsen's chronological arrangement of the Roman republican series has not been superseded; and no serious attempt has been made to treat the imperial series in a similar manner; but until this is done Roman coins as historical records must lose their chief value. In the mediæval section the early issues of the Merovingians, the Visigoths, the Anglo-Saxons, the feudal princes of France, the early rulers of Germany, and the Latin princes of the East, have all received much attention, and these have thrown much light on a difficult portion of the world's history. The same may also be said of the various Oriental sections, especially in the case of the early coinages of India, of which till recently our knowledge was very vague. The bibliography at the end of this article will give a few of the more important recent works in each branch.

Modern.

Turning to the coinages of the present day, we shall note the more important changes which have occurred since 1870; and it is a singular fact that there are but very few countries in any quarter of the globe which have not made some radical change in this respect.

The United Kingdom.—No fundamental alteration has, however, occurred in the case of the British coinage. The standard of gold and silver has remained unchanged for over two hundred years, and until 1887 the denominations were practically the same as instituted at the great recoinage of 1816. The substitution of a bronze for a copper currency had already taken place in 1860. On the occasion of Queen Victoria's Jubilee in 1887 it was determined to mark the event by a new coinage of gold and silver, and to make the royal portrait more suitable to her Majesty's then age. Two new denominations of five and two pounds were added to the gold series, and the double florin to the silver. For the reverse type of all the gold and of the five-shilling piece, Pistrucci's design of St George and the Dragon was used, and former types of Anne and George IV. were revived for the double florin, florin, half-crown, and sixpence; that of the last was, however, soon abandoned. This new coinage did not meet with general approval, especially as regards the portrait of the Queen, and in consequence a third portrait was adopted for the gold and silver in 1893, new reverse types were prepared for the half-crown, florin, and shilling, and the issue of the double florin was discontinued. The new portrait of the Queen was the work of the sculptor, Mr Thomas Brock, R.A. (Fig. 1), who was careful to avoid the defects which had been somewhat severely criticized in Sir J. Edgar Boehm's design of 1887. The new type for the half-crown, a spade-shaped shield within the garter, was also executed by Mr Brock; and those for the florin and shilling, three shields placed triangularly, were by Sir Edward Poynter. In 1895 a new issue of bronze money was ordered, when the Queen's bust of 1893 was adopted, and a slight alteration made in the reverse type, the representation of a lighthouse and a ship, which had been added to the design in 1860, being eliminated.

Fig. 1.—Sovereign (gold), England: Queen Victoria (obverse by Brock).

The coinage of Edward VII. (Fig. 2) differs but slightly from that of Queen Victoria. The denominations are the same; but on the obverse the head of the king (by Mr G. W. de Saulles, engraver to the Mint) is represented bare, and the title "Britanniarum" is changed to "Britanniarum Omnium Rex," and the reverse of the florin shows Britannia standing on a ship, and that of the shilling the royal crest, the lion on a crown, as on the so-called "lion shillings" of 1826.

Fig. 2.—Sovereign (gold), England: King Edward VII. (obverse by de Saulles.)

France.—On the establishment of the Third Republic in France in 1870, the coinage was continued on the same lines as before, the types only being altered. The silver franc of 5 grammes (78 grains) as ordered in 1793 and confirmed by the Latin Monetary Union of 1865, which included Belgium, Italy, and Switzerland, and subsequently in 1868 Greece, has remained the unit of value. The denominations ordered were, in *gold*, the 100, 50, and 20 francs; in *silver*, the 5, 2, and 1 franc, and 50 and 20 centimes; and in bronze, the 10, 5, 2, and 1 centime. The types adopted were those which had been used previously—thus for the gold that of a genius inscribing the tables of the law, as designed by Augustin Dupré for the reverse of the constitutional coinage of Louis XVI.; for the silver and copper the head of the Republic as executed by Oudiné for the money of 1848. Subsequently, in 1871, the type of the 5 francs was changed for that of Hercules leaning on Liberty and Strength, as made by Dupré for the First Republic. In 1889 the 10 francs in gold was added to the list, having the head of the Republic crowned with corn, the work of Merley for the Republic of 1848; but only a small number of these coins was struck in that year and in 1895. No further alteration was made till after 1895, when, in consequence of suggestions that the types should be modified so as to mark the Third Republic, the artists MM. Chaplain, Roty, and Dupuis were commissioned to execute new designs—the first for the gold, the second for the silver, and the last for the bronze. The types approved were: for the gold 20 francs, the head of the Republic with a Phrygian cap, and the Gallic cock (Fig. 3); for the silver 2 and 1 franc and 50 centimes, the sower sowing with the rising sun, and a laurel wreath (Fig. 4);

and for the bronze, the bust of the Republic wearing a Phrygian cap, and on the reverse France seated amidst clouds, holding a branch and a flag, and accompanied by a genius. These coins were not issued simultaneously—the 50 centimes appearing in 1897, the 2 and 1 franc and 10, 5, 2, and 1 centime in 1898, and the 20 francs in 1899. These new coins all show considerable skill in their designs, and are characteristic of French medallic art of the present time, which has a strong tendency to imitate that of Italy of the 16th century. We cannot help thinking, however, that a mistake has been made in giving in some instances the surface of the coin a "blurred" or "cloudy" appearance, such as a cast medal would have before it was tooled or chased. This is contrary to all precedent in the art of coinage, and as it seems to lend itself to forgery and imitation, it is an open question whether it will meet with general favour.

Fig. 3.—Twenty Francs (gold), France (Chaplain).

Fig. 4.—Two Francs (silver), France (Roty).

Belgium.—Of the other states which formed the Latin Monetary Union, Belgium had already in 1832 adopted the French decimal and bimetallic system, with the franc as the unit of value. Her accession to the Union, therefore, only entailed a slight modification of type and denominations, which latter were the same as in France, except that the only gold coin was the 20 francs, the 25 centimes in silver was not issued, and the pieces of 10 and 5 centimes are now in nickel. The gold and silver coins have for types the head of the king and the royal shield, those in nickel the Belgic lion and mark of value, and those in bronze the royal monogram and the lion holding the tables of the constitution. Some of the silver coins have the inscriptions in Flemish.

Switzerland.—Like Belgium, Switzerland had before her adhesion to the Latin Monetary Union adopted the French system, with the franc of 100 centimes or rappen as the unit of value. The denominations in gold and silver were the same as issued for Belgium, but no gold was struck before 1883. The coins of baser metal were the 20, 10, and 5 centimes in billon, which metal was in 1879 changed for nickel, and in copper the 2 and 1 centime. Certain changes of type have from time to time occurred. The first issue of the 20 francs in 1883 shows the head of the Republic and the shield of the Confederation; but this was changed in 1897 for the head of Helvetia above a range of mountains, and on the reverse a wreath with mark of value. On the silver coins from 1874 Helvetia is represented standing instead of seated, and on the nickel money of 1879 the shield of the Republic is replaced by the head of Helvetia. The mark of value and a wreath form the general reverse type of all the silver, nickel, and copper coins (Fig. 5). Since 1888 a 5-franc piece, similar in type to the 20 francs of 1883, has been issued.

Fig. 5.—Twenty Centimes (nickel), Switzerland.

Italy.—When Italy joined the Latin Monetary Union in 1865, she adopted as the unit of her coinage the lira of 100 centesimi, equal to the franc. The coins were of gold, silver, and bronze, and of the same denominations as those struck in Belgium and Switzerland. In 1894 a nickel coinage of 20 centesimi was ordered. The general type for all the coinage is the head of the king and the royal arms (Fig. 6), but on the reverse of the copper is the mark of value; and the nickel money has on the reverse a crown with a wreath. The coinages of all the small Italian states, including the Papal, have now passed out of currency.

Fig. 6.—Two Lire (silver), Italy.

Greece.—A special stipulation was made, when Greece was enrolled in the Latin Monetary Union in 1868, that all her money should be struck at a French mint. The unit of the coinage is the drachm of 100 lepta, which, like the lira, is equivalent to the franc. The denominations are—in *gold*, the 100, 50, 20, 10, and 5 drachms; in *silver*, the 5, 2, and 1 drachm, and 50 and 20 lepta; and in *bronze*, the 10, 5, 2, and 1 lepton. In 1893 nickel was substituted for bronze, and coins of the value of 20, 10, and 5 lepta were issued in this metal. The types of the coins of Greece are similar to those of Italy.

Germany.—Since 1871 the coinage of the German Empire has been entirely remodelled. By a convention in 1857 between the States of Germany, north and south, and Austria a general coinage of a silver standard was established on the basis of the new pound of 500 grammes as sanctioned by the *Zollverein.* The contracting countries were divided into three sections, North Germany, South Germany, and Austria. From the pound of fine silver of 500 grammes the Northern States struck 30 thalers, Austria 45 florins, and the Southern States $52\frac{1}{2}$ florins; their relation being 1 North German thaler $= 1\frac{1}{2}$ Austrian florins $= 1\frac{3}{4}$ South German florins. The free towns of Hamburg, Lübeck, and Bremen did not join the convention. The first reform in the coinage of the German Empire occurred in 1871, when a new gold money was introduced, which had for its unit the silver mark (a money of account) of 100 pfennigs weighing 5·555 grammes. The new gold pieces were of the value of 10 and 20 marks, called crowns and double crowns, and the fineness was $\frac{9}{10}$ pure to $\frac{1}{10}$ alloy. This new issue necessitated a readjustment of the current values of the various silver coinages in circulation. In 1873 a further step was made by the introduction of an entirely new silver coinage throughout the empire, which was also based on the silver mark, and of a new base metal coinage in nickel and bronze. The silver coins were the 5, 2, and 1 mark and 50 and 20 pfennigs; those in nickel the 10 and 5 pfennigs, and in bronze the 2 and 1 pfennig. The silver coins were, like the gold, $\frac{9}{10}$ fine, so that 90 marks were struck to the pound of pure metal. The gold 5 marks was struck in 1877 and 1878, and the 20 pfennigs in silver was replaced by a coin of the same value in nickel in 1886. The reverse type for all the coins is the imperial eagle, but that of the obverse varies; the gold and silver showing the portrait of the reigning king or prince (Fig. 7), but the mark, and all lesser denominations, the current value. An exception was made in the case of the coinage of the Free Towns struck at Hamburg, which has the arms of the city instead of a portrait. Each state retained its full rights of coinage, and the various mints throughout the empire with their special marks are:—Berlin, A; Hanover, B; Frankfort, C; Munich, D; Dresden (removed since 1877 to Müldner-Hütte), E; Stuttgart, F; Karlsruhe, G; Darmstadt, H; and Hamburg, J. In 1876 a gold standard was proclaimed, and henceforth no person was legally bound to accept in payment more than 20 marks in silver and the value of 1 mark in nickel or bronze.

Fig. 7.—Twenty Marks (gold), Germany.

Austria-Hungary.—After the convention of 1857 with Germany (see above), when Austria based her coinage on the silver standard of the florin, two series were issued—(i.) Vereinsmünzen (money of the union), in *gold*, the crown and half-crown; in *silver*, the double thaler (=3 florins) and thaler; (ii.) Landesmünzen (money of the state), in *gold*, the 4 and 1 ducat; in *silver*, the double florin and florin; in *billon*, the 20, 10, and 5 kreuzers; and in *copper*, the 4, 3, 1, and ½ kreuzer. In 1868 Austria abandoned the convention, but made no change in her money; and in the same year the coinage of Hungary was made uniform with that of the empire, both in standard and denominations. In 1870 the Vereinsmünzen crown and half-crown were discontinued, and their place was taken by 8 and 4 florin pieces which were of the current value of 20 and 10 francs. In 1892 the monetary system of Austria-Hungary was entirely reformed on a gold standard, the unit of account being the crown of 100 hellers. This is a decimal coinage, and the denominations are, in *gold*, the 20 crowns (of 164 from the kilogramme of fine gold), 10 crowns, and ducat (=9 silver crowns 60 hellers); in *silver*, the crown and half-crown; in *nickel*, the 20 and 10 hellers; and in *bronze*, the 2 and 1 heller. The gold ducat was a trade-money (handelsmünze) of the current value of 10 francs, and it displaced the 8 and 4 florin pieces of 1870. The types of the Austrian and Hungarian coins somewhat vary (Fig. 8).

Fig. 8.—Florin (silver), Austria-Hungary.

The Austrian gold coins show the head of the emperor and the two-headed eagle, but those of Hungary a full-length figure of the emperor and the national shield surmounted by the crown of St Stephen held by angels. The silver coins of both series have the head of the emperor and the mark of value under the imperial or royal crown. The nickel and bronze money of Austria displays the imperial eagle on the obverse, whilst that of Hungary has the crown of St Stephen. The legends are respectively in Latin and Magyar.

Spain.—The unit of the Spanish coinage from 1864 to 1868 was the silver escudo of 200 grains divisible into 10 reals. On the dethronement of Isabella in 1868 the provisional government adopted the principles of the Latin Monetary Union and made the peseta the unit of account, this coin being equivalent to the franc. The coins struck during 1869–70 were, in *gold*, the 100 pesetas; in *silver*, the 5, 2, and 1 peseta, and the 50 and 20 centimos; and in *bronze*, the 10, 5, 2, and 1 centimo. The obverse type of each metal varied; on the gold Spain is standing; on the silver she is reclining; and on the bronze she is seated. During his short reign (1870–73) Amadeus I. struck only gold coins of 100 and 25 pesetas and silver of 5 pesetas, and there was practically no money issued during the Republic which followed his abdication. Don Carlos during the insurrection of 1874–75 struck 5 pesetas in silver and 10 and 5 centimos in bronze bearing his portrait and title "Carolus VII." After the restoration of Alphonso XII. the coinage consisted of 25 and 10 pesetas in gold; 5, 2, and 1 peseta and 50 centimos in silver; and 10 and 5 centimos in bronze; and this coinage was continued by his son Alphonso XIII., who, however, in 1887 substituted the 20 pesetas in gold for the 25 pesetas, and in 1897 struck large coins of 100 pesetas. The types show the head of the king on the obverse and the shield with (Fig. 9) or without the pillars of Hercules on the reverse; but in the case of Alphonso XIII. changes have been made in the portrait suitable to his age.

Fig. 9.—Peseta (silver), Spain.

Portugal.—A gold standard was adopted by Portugal in 1854, the unit of value being the milreis of 1000 reis. The coins are, in *gold*, the crown or 10 milreis and the half, fifth, and tenth crown or milreis; in *silver*, the 5, 2, 1, and ½ testoon or 50 reis; and in *bronze*, the 20, 10 and 5 reis. The general type of the gold and silver is the head or bust of the king and the royal shield; but the bronze varies in having on the obverse a shield and on the reverse the mark of value.

Denmark, Sweden, and Norway.—Previous to 1872 in Denmark the unit of value was the silver *rigsbankdaler* of 96 skillings; in Sweden, the *rigsdaler* of 100 öre; and in Norway, the *speciesthaler* of 120 skillings; but in that year a monetary convention was concluded between these countries establishing a decimal coinage, which had for its unit the krone of 100 öre, and of which the standard was gold. The denominations are, in *gold*, the 20, 10, and 5 kroner; in *silver*, the 2 and 1 krone, and 50, 25, and 10 öre; and in *bronze*, the 5, 2, and 1 ör. The gold and silver money of Sweden and Norway to the 50 öre bears the head of the king and the royal shield; the silver of smaller denominations and the bronze, the monogram of the king and the mark of value. In Denmark the gold and silver have the head of the king, and for reverse type, a figure of Denmark, a shield, or the mark of value. The bronze coins are similar to those of Norway and Sweden.

Russia.—The Russian coinage previous to 1885 was based on the silver rouble of 278 grains of pure metal; but during the greater part of the reign of Alexander II. (1855–81) the currency consisted almost entirely of paper money. In 1885 Alexander III. determined to place the coinage on a proper footing, and introduced the rouble of 100 copeks as the unit of account, with a relative value of gold and silver of 1 to 15½. The coins issued were, in *gold*, the imperial of 10 roubles, and the half-imperial; in *silver*, the rouble, and the 50, 25, 20, 15, 10, and 5 copeks; and in *copper*, the 5, 3, 2, 1, ½, and ¼ copek. In 1897 the relative value of gold and silver was advanced to 1 to $23\frac{1}{4}$, thus raising the current value of the imperial to 15 roubles; but no change was made in the weights of the coins, and the silver rouble remained the unit of account. In the same year a piece of 5 roubles, called the one-third imperial, was added to the gold coins. The general types of the gold (Fig. 10) and silver show the head of the emperor and the imperial eagle; and of the copper, the imperial eagle and mark of value.

Fig. 10.—Seven and one half Roubles (gold), Russia.

Georgia, Poland, and Finland.—The separate issues of Georgia and Poland were suppressed in 1833 and 1847 respectively; but Finland in 1878 established a decimal coinage of gold, silver, and bronze on the principles of the Latin Monetary Union, having the *markhaa* (=1 franc) as its unit of value. Russia having since 1899 deprived Finland of her autonomy, her separate coinage will probably disappear.

Turkey.—There has been practically no change in the money of the Ottoman empire since the reforms of Abdul-Medjid in 1844, when the piastre, or 40-para piece, of the current value of $2\frac{1}{4}$d., was made the unit of the coinage, and of which 100 go to the gold medjidieh or pound. The denominations are, in *gold*, the 500, 250, 100, 50, and 25 piastres; in *silver*, the 20, 10, 5, 2, 1, and $\frac{1}{2}$ piastre; and in *copper*, the 40, 20, 10, 5, and 1 para. The type in all metals is, on the obverse, the Sultan's *tughra*, or cipher, and on the reverse, a wreath, and the name of the mint, date, &c.

Balkan States.—Since the dismemberment of the Ottoman empire the kingdoms of Rumania and Servia, and the principality of Bulgaria, have each adopted the decimal system of the Latin Monetary Union. In Rumania the unit of account is the *leu* of 100 *bani*; in Servia, the *dinar* of 100 *paras*; and in Bulgaria, the *lev* of 100 *stotinki*—each of these units being the equivalent of the franc. All these states issue gold and silver money; but the last two have adopted nickel instead of a bronze coinage.

United States.—Turning to the West, we find that in the United States the most important event connected with the coinage has been a change of standard. Previous to 1873 the standard was silver, having for its unit the dollar of $412\frac{1}{2}$ grains of $\frac{9}{10}$ fine; but in that year a gold standard was adopted, the gold dollar of 25·8 grains and $\frac{9}{10}$ fine being the sole unit of value. This change of standard was accompanied by a slight modification of the denominations, which were, in *gold*, the double-eagle, eagle, half, and quarter eagle, three dollars, and dollar; in *silver*, the half and quarter dollar, 20 cents, and dime; in *nickel*, the 5 and 3 cents; and in *bronze*, the cent. In addition to these a silver piece called the "trade dollar" of 420 grains was struck, not for circulation in the States, but for export to China. The following changes have since occurred:—In 1878 the silver dollar of $412\frac{1}{2}$ grains was resumed, and the 20 cents discontinued; in 1887 the issue of the "trade dollar" was suspended; and in 1890 the same fate befell the three dollars and dollar in gold, and the three cents in nickel. The types are—*gold*, head of Liberty and eagle; *silver*, head of Liberty, or Liberty seated, and eagle, except the dime, which has the mark of value; *nickel*, shield (5 cents) and head of Liberty (3 cents); *bronze*, head of an Indian; with reverse types for either metal, the mark of value.

Canada.—The currency for the Dominion of Canada, which includes Nova Scotia, New Brunswick, and British Columbia, is of silver and bronze, based on the system of the United States. The denominations are 50, 25, 20, 10, and 5 cents in silver, and the cent in bronze; and they also have a uniform type of the sovereign's head and mark of value. The same system prevails in Newfoundland, which also issues the double dollar in gold: this is the only gold coin issued in a British colony whose standard is not the same as that of the mother country. There is a separate coinage for Jamaica, but of nickel only, and consisting of the penny, halfpenny, and farthing. Hitherto all the Canadian coins have been struck at the Royal Mint, or by Messrs Heaton of Birmingham, but it is proposed to establish a separate mint at Montreal.

Mexico, &c.—We need not give any detailed account of the coins of Mexico, and of the various states of Central and South America, in nearly all of which there have been radical changes since 1870. Most of them have adopted the decimal system, with a gold, silver, or bi-metallic standard; the unit of value in the gold standard being generally the peso of 3·225 grammes, and in the silver also the peso, but of silver of 20, 25, or 27 grammes.

India.—As to the coins of the East and Far East, we will limit our remarks to the more important countries. In British India the rupee of silver of 150 grains is still the unit of value, but of late years serious steps have been taken to establish a gold currency also, and at present there appears some prospect of this being carried out.

Persia.—In Persia since 1879 a decimal system in conformity with the principles of the Latin Monetary Union has been adopted, having for its unit the *krân* weighing 78 grs, thus being equivalent to the franc, but since reduced to 71 grs. or even less. The denominations are: in *gold*, the 10, 5, 2, 1, $\frac{1}{2}$, and $\frac{1}{4}$ toman (the toman = 10 krâns); in *silver*, the 5, 2, and 1 krân (= 20 shahis), and the 10 and 5 shahis; and in copper, the 4, 2, and 1 shahi (= 2 pals), and the pal.

Japan.—Since 1871 Japan has formed its coinage on the European decimal system in place of the ancient national coins, the *obangs* and *itsibus*, the unit being the *yen* of 100 *sen*. The standard was bi-metallic, and the relation of gold and silver stood at 1–16·17. In 1898 a gold standard was adopted, the issue of the silver yen was suspended, and the weight of the gold money was reduced by one-half. The coins issued since that date are, in *gold*, the 20, 10, and 5 yen; in *silver*, the 50, 20, and 10 sen; in *nickel*, the 5 sen; and in *bronze*, the sen and half-sen. There is one general type for all the silver, nickel, and bronze coins, being the dragon on the obverse and a wreath of flowers with mark of value on the reverse. The gold varies in having flags and flowers on the reverse. On the silver and bronze coins the legends are in English as well as in Japanese.

China.—In 1890 China followed the example of Japan, but only to a limited extent, and instituted a silver coinage having as its unit a dollar of the same value as the United States silver dollar and the Japanese yen. It is calculated in fractions of the *tael*, a money of account of the value of 2s. $11\frac{3}{4}$d. The coins are the dollar, and the 50, 25, 10, and 5 cents, with the Chinese dragon and inscriptions, mint and mark of value in English on the obverse, and on the reverse the mark of value in Chinese and Manchu. They were first struck at Canton and Wei-Chang, but later other mints have been established.

Hong Kong.—The only other Asiatic coinage we shall note is that of Hong Kong, where in 1866 was established a coinage, which was also based on the United States standard, having the silver dollar as its unit. The denominations are the dollar and 50, 20, and 5 cents in silver, and the cent and mill in bronze; and, with the exception of the mill, they all have for type the sovereign's head and the mark of value. In connexion with this coinage there has been issued since 1895 a "trade dollar" for special currency in the Straits Settlements

Fig. 11.—"Trade Dollar" (silver), Hong Kong.

and Hong Kong in lieu of the Mexican dollar, the scarcity of which was a considerable hindrance to trade. This coin, which is struck at the Bombay mint, shows on the obverse Britannia holding a trident and shield, and on the reverse within an ornamental design the denomination in Chinese and Malay (Fig. 11).

Egypt.—Glancing cursorily at the coinage of Africa, it may be noted that since 1885 Egypt has adopted a gold standard with the gold pound of 100 piastres as the unit of account. The piastre is no longer divisible into 40 paras, but into 10 *ochr-el-guerche* or tenths. The types are similar to the Turkish money, and though bearing the legend "struck at Cairo" the coins are really manufactured at some European mint.

Abyssinia.—In Abyssinia since 1893 there has been a silver coinage formed on the basis of the Austrian Maria Theresa dollar. The coins are, in *silver*, the *talari* (= dollar), $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$ *talari*, and in *copper*, the *guerche* and $\frac{1}{2}$ and $\frac{1}{4}$ *guerche*. They show on one side the head of the king, and on the other a lion holding a banner.

Zanzibar.—Zanzibar has also issued a dollar of the fixed value of 2 rupees and 2 annas, and a copper coin called a *pessa* (= 136th dollar).

Sudan.—The African coinages which have attracted exceptional attention are those of the Sudan and the South African Republic. The former dates from 1885, when the Mahdi struck the pound of 100 piastres in gold and the 20 piastres in silver, of the same type as the Egyptian coins, but on the silver piece were placed the words "By order of the Mahdi," but no mint name. His successor, Abdullah, struck pieces of 20, 10, 5, 2, and 1 piastre in silver and 10 paras in copper, but no gold. They bear the name of the mint, Omdurman, and the word *makbul, i.e.*, accepted. At first the silver coins were of 6 parts silver and 2 copper, but in a few years they were so debased that they degenerated into mere pieces of copper washed with silver. The last issue is dated 1897 (A.H. 1315).

Transvaal.—The first attempt at a separate coinage in the Transvaal was in 1874, when President Burgers issued sovereigns or pounds showing his portrait on the obverse and the shield of the Republic on the reverse. They were struck by Messrs Heaton of Birmingham, but as each piece of the current value of 20s. cost 26s. to strike, only £680 worth was issued, and but few of these passed into circulation, being preserved as curiosities. No further attempt was made till 1891, when President Kruger induced the Raad to order a coinage in gold, silver, and bronze after the English standard. The first issue occurred in 1892, and consisted of the pound and half-pound in gold; the crown, half-crown, florin, shilling, sixpence, and threepence in silver; and the penny in bronze. They are all of the same type as the pound of 1874, but with the portrait of President Kruger on the obverse. The first issue of the pound, half-pound, and crown was minted at Berlin, and a curious mistake was made in the arms of the state, the waggon being represented with two shafts instead of with one. This blunder was soon noticed, and a recoinage took place in the same year at Pretoria.

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(H. A. G.)

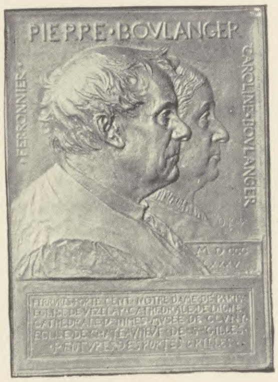
II. Medals.

The art of the medallist developed during the last thirty years of the 19th century beyond most of the other fine arts, consequent on the growing taste of the public and the critics. The medal—as it is understood to-day—enjoys a life entirely independent of the coin on the one hand, and, on the other, of the sculptured medallion, or bas-relief; and its renascence is one of the phenomena in art witnessed by the present generation. It is in France that it has risen to the greatest perfection, as it is in that country most widely appreciated and most effectually supported. Its popularity there is well-nigh universal; it is esteemed for its appropriateness not only for memorials of popular events and of public men, but also for private celebrations of all kinds, and, through religious allusion (communions, fêtes, saints' days, and the like), for the gratification of the pious. Other nations, in a degree far inferior, are producing medallists and medals in number, but none approaches in excellence—in artistic feeling, treatment, and sensitiveness of execution—the artists and the achievements of France. In England, although the Royal Academy seeks to encourage its students to practise the art, the prize it offers commonly induces no competition. The art of the medallist is not properly appreciated or understood, and receives little or no support. The prevailing notion concerning it is that it consists in stamping cheap tokens out of white metal or bronze, on which a design, more or less vulgar, stands out in frosty relief from a dazzling, glittering background. These works, even the majority of military and civic medals, demonstrate how the exquisite art of the Renaissance had been degraded in England—almost without protest or even recognition—so that they are, to a work by Roty or Chaplain, what a nameless daub would be to a picture by Rembrandt or Velasquez.

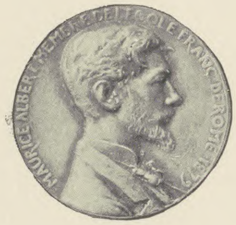
It is probable that Jacques Wiener (died 1899), of Belgium, was the last of the medallists of note who habitually cut his steel dies entirely with his own hand without assistance, though others in some measure do so still. The fact is that although most modern workers, exclusively medallists, have themselves cut dies, they nowadays take

DUPLESSIS PLAQUETTE.
ROTY.

STUDY. ROTY.



BOULANGER PLAQUETTE.
ROTY.



MAURICE ALBERT
PORTRAIT. ROTY.

WEDDING MEDAL. ROTY.

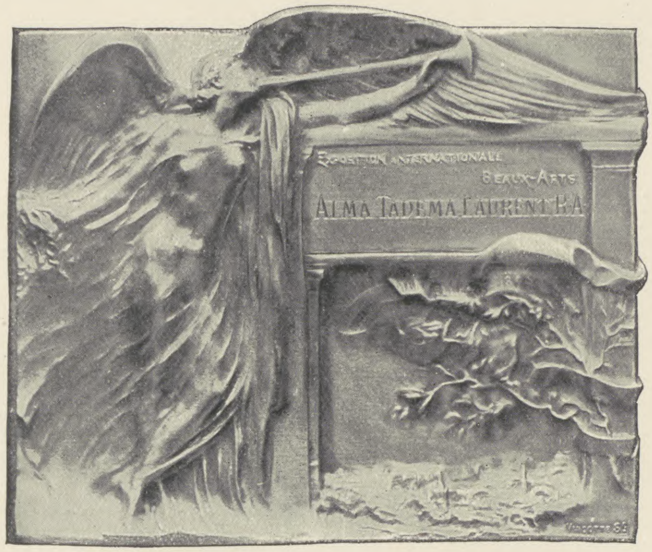
AMBROISINE MERLIN.
From the Medal by
MICHEL CAZIN.

MEDALS AND PLAQUETTES. JULES CHAPLAIN.

Henri Dubois.

Medal of Award for the Cope and Nicol School of Painting. F. Bowcher.

France, 1870. Roty.



Great Gold Medal, Brussels, 1898. Designed by P. Wolfers. Engraved by Vinçotte.

Gold Medal, Vienna, 1894. By Joseph Tautenhayn.

Paris Universal Exhibition, 1889. By Louis Bottée.

International Exhibition, Chicago, 1893. By Augustus St Gaudens.

advantage of the newest methods; and the *graveur en médailles* has become simply a *médailleur.* His knowledge of effect is the same—though the effect sought is different: in earlier times the artist thought chiefly of his *shadows*; nowadays he mainly regards his *planes.* Otherwise his aims are not dissimilar; but he sees no object in pursuing the slow, laborious system that was formerly practised, when he can gain freedom, save time, and increase effect by seizing the advantages offered by recent inventions. At the present day the medallist, after making conscientious studies from life (as if he were about to paint a picture), commonly works out his design in wax, or similar substance, upon a disc of plaster about 12 or 14 inches in diameter. From that advanced model a simple mould, or matrix, is made, and a plaster cast is taken, whereupon the artist can complete his work in the utmost perfection. Then, if a struck medal is required, a steel cast is made, and from that a reduction to the size required for the final work is produced by means of the machine—the *tour à réduire.* It is this machine which has made possible the modern revival, and has revolutionized the taste of designers and public alike. It was invented by Contamin, who based it upon that *tour à portrait* which Houlot produced in 1766, and which helped to fame several engravers now celebrated. This machine was first exhibited in Paris in 1839, and was sold to the Munich Mint; while a similar invention, devised at the same time by the English engraver Hill, was acquired by Wyon for £2000, and was ultimately disposed of to a private mint in Paris. From that city comes the machine, based by the French inventor M. Ledru upon the two already referred to, now in use at the Royal Mint in London. A well-served medallist, therefore, need trouble himself nowadays about little beyond the primary modelling and the final result, correcting with his own hand only the slightest touches—refining, perfecting—but sometimes merely confining himself to giving his directions to the professional engraver.[1]

The great majority of the artistic medals at present in the world (in the great collection of France there is a total of not fewer than 200,000 medals) are cast, not struck. There is in them a charm of surface, of patina, of the metal itself, which the struck medal, with all the added beauties which it allows of delicate finish and exquisite detail, can hardly give. On the other hand, the production of the cast medal is much slower, much more uncertain; and the number of fine copies that can be produced is infinitely smaller. All the early medals were cast, being first modelled in wax, and then cast by the *cire perdue* (waste wax) process, and were usually worked over by the chaser afterwards; indeed, it was not until the beginning of the 16th century that dies, hitherto used only for coins executed in low relief, were employed for larger and bolder work. The medallists of those days always cast in bronze or lead, and only proceeded to use silver and gold as a luxurious taste began to demand the more precious metals. There is little doubt that the material to be preferred is dull silver (*mat* or *sablé*—sand-blasted), as the work, with all its variations of light and shade, can be better seen in the delicate grey of the surface.

The medal, properly considered, is not sculpture. Vasari was happy in his definition when he described the medallic art as the link between sculpture and painting, that is to say, painting in the round with the colour left out. Less severe than sculpture, it need not be less dignified; it is bound down by the conventions of low relief, and by compulsions of composition and design, dependent on shape, from which sculpture, even when the relief is the lowest, is in a great measure free. In the medal, otherwise than in sculpture, elaborate perspective and receding planes are not out of place. The genius of the modern Frenchman rebelled against the rule that commonly governed the medal during the decadence, and has triumphed in his revolt, justifying the practice by his success. The modern medal and the *plaquette* aim at being decorative yet vigorous, reticent and dignified, delicate and tender, graceful and pure; it may be, and often is, all these in turn. Imagination, fancy, symbolism, may always be brought into play, allied to a sense of form and colour, of arrangement and execution. By the demonstration of these qualities the artist is to be differentiated from the skilful, mechanical die-sinker, who spreads over the art the blight of his heavy and insensitive hand and brain. So with portraiture. Accurate likeness of feature as well as character and expression are now to be found in all fine works, such as are seized only by an artist of keenly sensitive temperament. It is thus that he casts the events and the actions of to-day into metallic history, beautifully seen and exquisitely recorded; thus that the figure on the medal is no longer a mere sculpturesque symbol, but a thing of flesh and blood, suave and graceful in composition, and as pleasing in its purely decorative design as imagination can inspire or example suggest. It is thus that the art, while offering easy means of permanent memorial, has afforded to men of restricted means the eagerly seized opportunity of forming small collections of masterpieces of art at a small outlay.

France.—In France the example of Oudiné, coming after that of David d'Angers, did much to revolutionize the spirit animating the modern medallist, but Chapu, by his essentially modern treatment, did more. To Ponscarme (pupil of Oudiné) is chiefly due the idea of rendering *mat* the ground as well as the subject on the medal, the suppression of the raised rim, and the abandonment of the typographic lettering hitherto in vogue, together with the mechanical regularity of its arrangement. Degeorge, with his semi-pictorial treatment, was followed by Daniel Dupuis, whose delicate and playful fancy, almost entirely pictorial, makes us forget alike the material and the die. J. C. Chaplain is unsurpassed as a modeller of noble heads, including those of four presidents of the French Republic—Macmahon, Casimir-Perier, Faure, and Loubet—and his allegorical designs are finely imagined and admirably worked out (see Plate); but L. Oscar Roty (pupil of Ponscarme) is at the head of the whole modern school, not only by virtue of absolute mastery of the technique of his art, but also of his originality of arrangement, of the poetic charm of his symbolism and his allegories, the delicate fancy, the exquisite touch, the chasteness and purity of taste—wedding a modern sentiment to an obvious feeling for the Greek. Though expressly less virile than Chaplain, Roty is never effeminate. To Roty belongs the credit of having first revived the form of the *plaquette,* or rectangular medal, which had been abandoned and forgotten along with many other traditions of the Renaissance (see Plate). Others there are of great talent who do not occupy so high a position. Alphée Dubois, Lagrange, and Borrel must be mentioned among those who are understood to engrave their own dies. Followers are to be found in Mouchon, Lechevrel, Vernon, Henri Dubois, Patey,

[1] The method of preparing the dies, &c., is the same for medals as for coins, save that for larger and heavier work more strokes are required, as in the case of L. Coudray's popular "Orphée"—rather a sculpture-relief than a medal. The dies are capable of a great yield before becoming quite worn out; it is said that no fewer than three million copies were struck of Professor J. Tautenhayn's Austrian jubilee medal of the Emperor Francis Joseph. In France, Thonelier's perfected machine, substituting the lever for the screw, has been in use for coins since 1844; but for the striking of medals the same old-fashioned screw-press is retained which had till then been employed both for coins and medals since the time of Louis XIV. In its present form the machine consists of an iron or bronze frame, of which the upper part is fitted with a hollow screw wherein works an inner screw. This screw, moved by steam or electricity, drives the dies, set in iron collars, so that they strike the blank placed between them. So docile is this powerful machine in the hands of the operator, that it can deliver a strong blow to produce a high relief, or a delicate touch to add the finest finish. In the Paris mint, where the striking of the beautiful modern medals of France is an important undertaking, yielding considerable profits, fourteen screw-presses are at work, and the biggest and most recent machine can strike large medals with comparative ease and rapidity. A hydraulic press of nearly two million pounds pressure is utilized for testing the dies.

Bottée (see Plate)—all sterling artists if not themselves innovators. Medallists of more striking originality but less finish, and of far less elegance, are Michel Cazin, Levillain (who loves as much as Bandinelli to make over-display of his knowledge of muscular anatomy), Charpentier, and their school, who aim at a manner which makes less demand of highly educated artistry such as that of Roty or of Chaplain. It is learned and accomplished in its way, but lumpy in its result; breadth is gained, but refinement and distinction are in a great measure lost. It may be added—in order to give some idea of the industry of the modern medallist, and the encouragement accorded to him—that between 1879 and 1900 M. Roty executed more than 150 pieces, each having an obverse and a reverse.

Austria.—The two leading medallists of the Austrian school are Josef Tautenhayn (see Plate) and Anton Scharff, both highly accomplished, yet neither displaying the highest qualities of taste, ability, and "keeping," which distinguishes the French masters. About 330 pieces have come from the hand of Anton Scharff. Stefan Schwartz, Franz Pawlik, Staniek, Marschall, and J. Tautenhayn, junior, are the only other artists who have risen to eminence.

Germany.—A characteristically florid style is here cultivated, such as lends itself to the elaborate treatment of costume, armorial bearings, and the like; but delicacy, distinction, and the highest excellence in modelling and draughtmanship—qualities which should accompany even the most vigorous or elaborate designs—are lacking in a great degree. Profs. Hildebrand and Kowarzik have wrought some of the most artistic works there produced.

Belgium.—Although sculpture so greatly flourishes in Belgium, medal work shows little promise of rivalling that of France. The influence of the three brothers Wiener (Jacques, Léopold, and Charles)—good medallists of the old school—has not yet been shaken off. The remarkable architectural series by the first named, and the coinage of the second, have little affinity with the spirit of the modern medal. Lemaire has perhaps done as well as any, followed by Paul Dubois, J. Dillens (a follower of the French), G. Devreese, and Vinçotte (see Plate)—whose *plaquette* for the Brussels Exhibition award (1887) is original, but more admirable in design than in finish.

Holland.—In Holland not very much has been done. Patriotism has called forth many medals of the young queen, and the best of them are doubtless those of Bart van Hove and Wortman. Baars is a more virile artist, who follows Chaplain at a distance. Wienecke is interesting for the sake of his early Netherlandic manner; the incongruity is not unpleasant.

Switzerland.—The medal is also popular in Switzerland. Here Bovy is the leader of the French tradition, and Hans Frei of a more national sentiment. The last-named, however, is more remarkable as a revivalist than as an original artist.

Great Britain.—In England only two medallists of repute can be counted who practically confine themselves to their art—G. W. de Saulles, of the Royal Mint, best known by the Diamond Jubilee medal of Queen Victoria and by his medal of Sir Gabriel Stokes, and Frank Bowcher (see Plate) by that of Thomas Huxley. These artists both cut their own dies when necessary. Emil Fuchs, working in England in the manner of the French medallists, but with greater freedom than is the wont of the older school, has produced several examples of the art: the medals commemorative of the South African war and of Queen Victoria (two versions), all of 1900; and many portrait medals and plaquettes of small size have come from the same hand. Besides these, the leading English sculptors have produced medals—Lord Leighton, P.R.A., Sir Edward Poynter, P.R.A., Hamo Thornycroft, R.A., T. Brock, R.A., Onslow Ford, R.A., G. Frampton, A.R.A., and Goscombe John, A.R.A.; but, practising more continually in sculpture, they do not claim rank as medallists, nor have they sought to acquire that class of dexterity which constant habit alone can give. Alphonse Legros, who has cast a certain number of portrait medals, is usually included in the French school.

United States.—Among American medallists Augustus St Gaudens (see Plate) is perhaps the most prominent; but he is not, strictly speaking, a medallist, but a sculptor who can model in the flat.

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Nuneaton, a market town in the Nuneaton parliamentary division of Warwickshire, England, 22 miles east by north of Birmingham by rail. Stone is quarried in the neighbourhood, in which are also coal and ironstone mines. Recent buildings include public offices (1897) and free library (1899). The making of drain-pipes, tiles, and blue and red bricks is a considerable industry, besides those for which the town is more generally known. Population of parish (an urban district) (1891), 11,580: of the extended urban district (Nuneaton and Chilvers Coton) (1891), 15,297; (1901), 24,995.

Nupe. See NIGERIA.

Nuremberg, a town of Bavaria, Germany, district of Middle Franconia, on the Pegnitz, a tributary of the Main, and 124 miles by rail north by west of Munich. The town has lost a good deal of its mediæval character through the demolition of large portions of its walls, though considerable sections of them still remain. In 1898 and 1899 more than a dozen outlying communes were incorporated, with a total population of 33,448, namely, Sündersbühl (3871), Erlenstegen (1031), Giebitzenhof-Lichtenhof (5077), Glaishammer (5378), Grossreuth (two communes of 711 and 1363), Kleinreuth (1053), Höfen (1944), Mögeldorf (2414), Schniegling (2263), Schoppershof (2271), Schweinau (2640), Thon (403), and Wetzendorf (3029), thus extending the area of the town from 2805 to 13,700 acres. Amongst modern structures are the new building (1894–96) for the Bavarian Industrial Museum, the new wing (1884–89) of the town hall, Christ's Church in the suburb of Steinbühl, the post office in the Sebald quarter, the market hall in the Rag (*Trödel*) Market, the massive bridge connecting the suburb of St Johannis with the suburb of Gostenhof, the industrial arts school, the monument to Behaim (1890), and three artistic fountains. The Walpurgis chapel, a portion of the Burggravian castle, destroyed in 1420, was restored in 1892. The Germanic National Museum has developed into one of the largest and most important institutions of its kind in all Germany. The most notable of its treasures embrace prehistoric remains, sculptured monuments of the 15th and 16th centuries, a picture gallery containing especially German works of the 15th and 16th centuries, and collections of domestic furniture, dress, plaster casts of sculptured monuments and tombs, instruments of torture, glass and pottery, weapons and armour, musical instruments, scientific and mathematical instruments, industrial models, and so forth. The municipal library now contains 70,000 volumes and 2000 MSS. Amongst the educational and charitable foundations should be mentioned the natural history museum, the Rothermundt collection of antiquities and plaster casts, the municipal archives, a technical, an industrial art, and a commercial school, and blind and deaf and dumb asylums. The ancient linden tree in the castle courtyard died in 1893. There are two parks, the town park and Rosenau. The industries of greatest importance are those concerned with the production of goldsmiths' work (1100 operatives), machinery (2500 operatives), pencils, colours, and brushes (3200), lithography, &c. (1500), mathematical and scientific instruments (1000), and toys (700). Many industrial establishments have moved outside the city, so as to get the advantage of the electric generating works on the river Pegnitz below the town. In 1882, and again in 1896, a large industrial and art exhibition was held at Nuremberg, and in 1885 an international metal exhibition. Nuremberg still remains the chief hop market in the middle of Europe, and also has a large wool market. Population (1890), 142,590; (1900), 261,022.

Nursing.—The development of sick-nursing, which has brought into existence a large, highly-skilled, and organized profession, is one of the most notable features of modern social life. To deal adequately with the subject in all its aspects would require a treatise, which still remains to be written, though Sir Henry Burdett's various publications go far to supply the want. Only the more salient points can be touched upon here.

History.

The evolution of the sick-nurse is mainly due to three very diverse influences—religion, war, and science—to name them in chronological order. It was religion which first induced ladies, in the earlier centuries of Christianity, to take up the care of the sick as a charitable duty distinct from domestic nursing, which is one of the natural functions of women in all ages and among all races. The earliest forerunner of the great sisterhood of nurses of whom we have any record was Fabiola, a patrician Roman lady, who in A.D. 380 founded a hospital in Rome with a convalescent home attached, and devoted herself and her fortune to the care of the sick poor. She had a rival in the Empress Flaccilla, the pious consort of Theodosius I. (A.D. 379–395), who also personally visited the hospitals and attended on the sick. Some sort of hospital, or at least dispensary, system, with medical attendance by public officers, can be traced to a far earlier date in Egypt, India, Greece, and Rome; but that is a different question. Organized nursing does not appear to have formed any part of medical treatment, except in so far as the deacons of the Church attended on the poor, until the 4th century of the Christian era. After that date the employment of women for this purpose must have developed rapidly, for in the reign of Honorius (A.D. 395–423) six hundred women were engaged in the hospitals of Alexandria. These institutions were managed by the clergy, and throughout the Dark and Middle Ages the hospital and nursing systems were connected with religious bodies. Nurses were provided by the male and female monastic orders, an arrangement which still continues in most Roman Catholic countries, though it is gradually being abandoned through the increasing demands of medical science, which have led the hospitals to establish training schools of their own. The names of the oldest foundations which still survive, such as the Hôtel Dieu in Paris, St Thomas's and St Bartholomew's in London, the order of St Augustine, and (in the form of a modern revival) that of St John of Jerusalem, sufficiently indicate the original religious connexion. The order of St Vincent de Paul, founded in 1633 for the express purpose, is still the largest nursing organization in the world. Even in Protestant England, where purely secular training schools have reached their highest development, the generic title of Sister, alike prized by its holders and honoured by the public, remains the popular and professional synonym for head nurse, and perpetuates the old association. Nursing, as a popular or fashionable occupation, is not a modern invention. Sir Henry Burdett quotes an order, dated 30th May 1578, directing the Master and the Prior of the Hôtel Dieu "not to receive henceforth any novices without speaking of it to the company, because there are an excessive number of nuns and novices, who cause great expense to the said Hôtel Dieu." He infers that they suffered from a plethora of nurses, or, as one might say, "a plague of women." In Protestant countries a secular nursing system came in with the Reformation. The staff appointed for St Bartholomew's, on its re-establishment by Henry VIII. in 1544, consisted of a matron and twelve nurses, who were engaged in domestic occupations when off duty. Thus nursing became a menial office and an inferior means of livelihood, adopted by women of the lower orders without any training or special skill; and so it continued down to the middle of the 19th century, when a new movement began which was destined to revolutionize the status of the nurse.

Its distinctive feature was the systematic training of nurses for their vocation. Previously a certain amount of regular instruction had no doubt been given here and there by individual physicians and surgeons; lectures to nurses were delivered in the New York Hospital as early as 1790. But these were isolated efforts. Such skill as nurses possessed was picked up in the wards. No qualifications were required, nor indeed would they have been forthcoming, so low had the calling sunk in public estimation. The credit of inaugurating the new order of things belongs to Germany, and here again the religious influence came into play. The beginning of the modern system dates from the foundation of the institute for training deaconesses at Kaiserswerth by Pastor Fliedner in 1836. It is true that State training schools for male nurses had previously existed in Prussia, the oldest having been founded at Magdeburg in 1799; but the employment of men in hospital wards is a feature of the German system which has not been copied by other advanced countries, and seems to be in process of abandonment in Germany. It is a heritage from the Middle Ages, when the Knights Hospitallers undertook for men the duties discharged in female institutions by the nuns. The male schools therefore stand somewhat apart, though they mark a stage in the evolution of nursing as the earliest regular training establishments. The Kaiserswerth Institute, on the contrary, had a far-reaching and lasting influence, and may fairly claim to be the mother of the modern system. England, in particular, owes much to it, for there Florence Nightingale acquired the practical knowledge which enabled her afterwards to turn her remarkable gift of organization to such brilliant account. The example of Kaiserswerth was soon followed, and not in Germany only. In 1838 the Society of Friends founded a nursing organization in Philadelphia, and in 1840 Mrs Fry, a member of the same community, started the Institution of Nursing Sisters in London. In 1857 the nurses attached to it numbered ninety. They received their practical training at Guy's and St Thomas's Hospitals. On the Continent institutes for nursing deaconesses were founded at Strasburg, Utrecht, Berlin, Breslau, Königsberg, and Carlsruhe between 1842 and 1851. In London a Church of England training institution (St John's House) was opened in 1848. There were three classes—(1) sisters, (2) probationers, (3) nurses. The nursing at King's College Hospital was for many years undertaken by this society, whose members were trained at the hospital.

The training system, thus inaugurated on a semi-religious basis, received a new impetus from the Crimean war, which was further emphasized by the Civil War in America and the subsequent great conflicts on the Continent. There is, of course, a natural connexion between nursing and war, which provides a large supply of surgical cases in need of ministration; and the Crusades, in particular, had raised the care of wounded warriors and toil-worn pilgrims to the level of a pious duty. But the Crimean war had an unprecedented effect on public opinion. This was due to several causes. One of the most important was the publicity given by the press, and notably by *The Times* newspaper, to the details of the campaign. It brought home to every one the realities of warfare and the enormous loss of life through sickness, besides disclosing grossly defective organization. The despatch of Miss Nightingale, with a staff of trained nurses, to superintend the administration of the military hospitals was the direct result, and it formed a new departure which riveted the eyes of the civilized world. The work undertaken and accomplished by this lady was far more important than the mere nursing of sick and wounded soldiers. She had grasped the principles of hygiene, which were then beginning to be understood, and she applied them to the reform of the hospital administration; but the sentimental aspect of the experiment was that which chiefly arrested popular attention. The picture of the delicate lady smoothing the sick soldier's pillow did much to elevate the hospital nurse's calling in public estimation, and in a measure revived the fervour of earlier centuries, though with less lofty motives. The same stimulus was felt in Russia, where ladies also devoted their services to the military hospitals. It would be outside the scope of this article to trace the effect of the movement so begun on the care of the sick and wounded in war. That belongs more properly to the subject of war. It must suffice to say that, while on the popular side the Crimea led to the Red Cross organization, on the official side its lessons have largely been forgotten, especially in relation to the prevention of disease among armies in the field. In civil life it had a marked effect in stimulating the training movement and raising the status of the nurse; but substantial results were only obtained by degrees. It was not until 1860 that the modern hospital school system was definitely inaugurated by the opening of the Nightingale Fund School at St Thomas's Hospital, founded with the money subscribed by the British public in recognition of Miss Nightingale's national services, and worked on principles laid down by her. In the meantime several nursing societies, in addition to those previously mentioned, had been founded in England and elsewhere. Among them the Baden Ladies' Society, founded in 1859 by the Grand Duchess Luise, deserves mention. In the same year the first district nurse began work in Liverpool; and in 1865 the reform of the much-neglected workhouse nursing was inaugurated by Miss Agnes Jones and twelve nurses from St Thomas's, who took up the work in Liverpool. At this time England took a decided lead, which she has never lost. Other countries gradually followed. In Germany the Albert Nursing Society was founded by Queen Carola of Saxony, and the Alice Society by the Grand Duchess Alice of Hesse, both in 1867. In France, where the nursing was comparatively well performed by the religious orders, no change was made until 1877, when a training school was opened in Paris by the municipality, and two others by the Assistance Publique, in connexion with the Salpêtrière and Bicêtre Hospitals. In the United States schools were opened in New York, New Haven, and Boston in 1873. The British colonies, Austria, and other European countries followed some years later.

It remained for the third influence to complete the work begun and to develop systematic nursing to its present dimensions. Since 1880 the increasing demands of medical knowledge have well-nigh revolutionized the craft in the home, the hospital, and the workhouse. A large part of the change may be summed up in the words "scientific cleanliness." It enters into all kinds of nursing, general and special; it is the very life of modern surgery, and it is virtually synonymous with hygiene or sanitation. And scientific cleanliness is quite incompatible with the old style of nurse. There are also other improvements in knowledge, which on the one hand emphasize the importance of good nursing and on the other raise the standard of education, intelligence, skill, and trustworthiness required for its attainment. The outcome of all this has been to raise the dignity of the calling, to induce persons of a superior class to adopt it in increasing numbers, to enlarge the demand for their services, and to multiply the means of educating them. These changes have taken effect in all countries, though in unequal degree. Information is defective with regard to the present state of things in some of them, but full details are available for Great Britain, and some indication of the systems prevailing elsewhere can be given.

Training and organization.

Nursing does not appear to be regulated by law in any country; its organization is voluntary, and even in State or municipal institutions is dependent on the direction of the administration. In Great Britain nearly all the general and special hospitals and many of the poor-law infirmaries offer systematic professional training to nurses. According to Burdett's annual hand-book (*The Nursing Profession*) for 1902, there are 137 such training schools, having over 100 beds. They are thus distributed—England 114, Scotland 13, Ireland 10. Of those in England, 37 are in London and 77 in provincial towns. In addition to these 114 major schools there are about 350 minor ones, consisting of small general hospitals and dispensaries, special hospitals of various kinds, and other institutions. The provisions differ considerably in detail, but in the larger schools the system is uniform in all important respects. Candidates must be between 23 (sometimes 21 or 22) and 35 years of age, and must produce satisfactory evidence of character, education, health, and physique; after a personal interview and one, two, or three months' trial they are admitted for three years' training. During this period they receive regular instruction in theoretical and practical knowledge, and have to pass periodical examinations. At the end of it they are granted certificates and may serve as staff nurses. They pay no premium, and generally receive a salary of £8 to £12 in the first year, rising annually to £30 or £35 as staff nurse, and subsequently to £40 or £50 as sister or head nurse. They live in a home attached to the institution, under a matron, and in the most modern establishments each nurse has a separate bedroom, with common dining and recreation rooms. In addition to these ordinary probationers, many of the large general hospitals take special pupils for short periods of instruction (three or six months), for which they pay a premium (usually 13 guineas a quarter). Their duties in the wards are the same as those of the other probationers. Private nursing staffs are attached to several of the hospitals; they are recruited from the staff nurses and probationers on completion of their course, and supply nurses to private patients. In the special hospitals the training is shorter, being for one or two years. There seems to be a constant tendency to increase the requirements. At St Bartholomew's, St George's, the London Hospital, St Thomas's, and others, probationers must enter for four years, and at St Bartholomew's they have to pass an entrance examination in elementary anatomy, physiology, and other subjects. At all the more important schools the number of applications is many times greater than the vacancies.

In Great Britain trained and certificated nurses generally belong to a society or association. Including the private staffs attached to hospitals, there are over 200 of these bodies; about thirty of them are private concerns, the rest are managed by committees. The most noteworthy of the associations is Queen Victoria's Jubilee Institute for Nurses. It was founded in 1887 with the object of providing skilled nursing for the sick poor in their own homes, and has now 479 branches thus distributed throughout the kingdom—England 236, Wales 62, Scotland 128, Ireland 53. A great many of the provincial nursing associations are affiliated to it. The number of nurses supported by each branch varies from one or two in country parishes to as many as 51 (Manchester). In London there are 20 branches and 110 nurses. The qualifications for a Queen's nurse are as follows: (1) training at an approved general hospital or infirmary for two years; (2) approved training in district nursing for not less than six months, including the nursing of mothers and infants after child-birth; (3) nurses in country districts must in addition have had at least three months' approved training in midwifery. Candidates possessing the first qualification are received on trial for one month, after which they complete their six months' training for the second qualification, at the same time entering into an agreement to serve as district nurse for one or two years at the end of the six months. The salary during training is £12, 10s., and afterwards £30 to £35 a year, with board, lodging, laundry, and uniform. With regard to the earnings of nurses in general, the salaries paid in hospitals have already been mentioned; for private work the scales in force at different institutions vary considerably, according to the other advantages and benefits provided. At some the nurses receive all their own earnings, minus a percentage deducted for the maintenance of the institute; at others they are paid a fixed salary, as a rule from £25 to £30 a year, plus a varying percentage on their earnings or a periodical bonus according to length of service. This is perhaps the commonest system, but some of the best nursing homes give a somewhat higher fixed salary without any percentage. In all these cases the nurses receive in addition board and lodging, laundry, and uniform, or an equivalent allowance. For special cases — infectious, massage, mental, and maternity—nurses on a fixed salary usually receive extra pay. The fees commonly charged by high-class institutions for the services of a trained and certificated nurse are—for ordinary cases £2, 2s. a week, for special cases £2, 12s. 6d. or £3, 3s. a week; but many provincial associations supply nurses for £1, 1s. a week and upwards. The discrepancy between the fees paid by patients and the salaries received by nurses, especially in London, has occasionally excited unfavourable comment, but it is to be remembered that the nurses are maintained when out of work or ill, and have other advantages; many institutions either provide pensions or assist the members of their staff to join the Royal National Pension Fund. This is the most important of several benefit societies now maintained by and for the profession. It offers insurance against sickness and provision for old age. Individual nurses or institutions can belong to it; in many cases a joint system is adopted, the premiums being paid partly by the persons to be benefited, and partly by the societies to which they belong.

To complete this account of the organization in Great Britain a few details with regard to special nursing are added.

Fever.—Regular training on the same plan as in general hospitals is provided in London at the fever hospitals of the Metropolitan Asylums Board (12 in number, with from 360 to 760 beds each), and at a considerable number of provincial institutions.

Insanity.—The Medico-Psychological Association of Great Britain and Ireland holds examinations and grants certificates in mental nursing; candidates must undergo two years' regular training, with instruction by lectures, &c., which may be obtained in a large number of public asylums by arrangement with the Association; one county asylum (Northampton) gives its own certificates after a three years' course.

District Nursing.—In addition to the Queen's nurses, of whom details have been given above, many local associations train their own nurses for this work. *Cottage* and *village* nursing are varieties of the same department; the former is organized on the benefit system, and aims at supplying domestic help and sick-nursing combined in rural districts for an annual subscription of from 2s. to 10s., according to the class in life of the family, and a weekly fee of the same amount during attendance.

Monthly Nursing and Midwifery.—Systematic instruction in these subjects is given at some fifty lying-in institutions in different parts of the kingdom. The usual course for nursing is not less than three months, and for midwifery not less than six months; a premium is required of 12 or 13 guineas for three months, and 25 guineas for six months.

Male Nursing.—Two or three associations in London supply male nurses (fees 2 to 4 guineas a week), but there appears to be only one institution, apart from the military and naval services, at which they are systematically trained—namely, the National Hospital for the Paralysed and Epileptic.

Massage is taught regularly at the hospital just named, and at a few other special hospitals. Competent operators are supplied by the Incorporated Society of Trained Masseuses and, to some extent, by other nursing associations; but this branch of the profession is still imperfectly organized (see MASSAGE).

Children.—A large number of children's hospitals throughout the country give regular training in the nursing of children; they take probationers at a somewhat earlier age than the general schools; the course is usually shorter (one or two years), and the salaries slightly lower.

The State offers employment to nurses in the naval and military hospitals and in the Indian Government service; the salaries are somewhat higher than in civil life, and a pension is attached.

A movement for the legal registration of trained nurses has been started in Great Britain, but the question is full of difficulties. A similar proposal to regulate the position of midwives, who may be said to stand between the medical and nursing professions, was embodied in a Bill which, after being before Parliament for several sessions, was at last carried and passed as law in 1902.

In the more important *British colonies* — Australasia, Canada, and South Africa—there are now a considerable number of hospital schools and other institutions formed and conducted on the English model. Salaries and fees are very much the same in Australia; in Canada and South Africa they are higher.

In the *United States* a similar system prevails in New York, Boston, Brooklyn, Chicago, Baltimore, Philadelphia, New Haven, and many other large towns. The period of training is either two or three years. At the Johns Hopkins School at Baltimore twelve scholarships of $100 and $120 each are awarded annually; graduate nurses are paid $360 (£72) a year. Salaries are altogether much higher in the United States. At the Boston City Hospital graduate nurses receive $420 (£84) a year, and at the Indianapolis City Hospital those on private duty are paid $72 a month, which is equivalent to £172 a year, with board, lodging, laundry, and uniform. This may be taken to indicate the possible earnings of trained nurses working independently, as they usually do in America. The system of belonging to a society and being paid a salary is much less in vogue there than in Great Britain. The fees charged for trained nurses run from $12 to $25 a week, and even more for special cases. Male nurses are trained at the New York City Hospital and at the Grace Hospital, Detroit. In the American schools more attention is paid to the preparation of nurses for private work than in the British (Burdett), and a directory or registry of them is kept in most large towns.

In *Germany*, their original home, both training schools and societies have multiplied and developed. In the year 1887 there were 14,585 trained nurses, of whom 1614 were men. Their organization was as follows:—

	Female.	Male.
Attached to religious institutions . .	10,544	584
Attached to lay institutions . . .	1,465	554
Private	962	476

Nursing by religious orders has since been largely replaced by hospital schools. The period of training appears to be considerably shorter than in Great Britain and America. At many schools it is only one year: the first three months are devoted to house-work, the second three months to theory, and the last six months to practical instruction. Members of the Albert Society of Saxony, however, spend two years in the wards at Dresden, and a third at Leipzig, attending lectures and demonstrations. They are sent out to nurse rich and poor alike, and their pay is very small. Most of the German institutes have pension funds.

In *France* a great deal of the nursing has remained in the hands of religious orders, but there too the hospital school system, inaugurated in 1877, has grown. The schools managed by the Assistance Publique in Paris give a very thorough course of instruction. Lay societies exist in several of the large towns, and provide trained nurses for private cases.

In *Russia* nursing is mainly in the hands of the Red Cross Society, whose members are, however, trained in the hospital schools.

In *Italy*, *Spain*, *Portugal*, and *Belgium* scientific nursing is in a backward state. The old religious system still prevails to a large extent, and, though some of the orders do their work with great devotion, the standard of knowledge and skill is not up to modern requirements. In Spain and Portugal monks still nurse in the male and nuns in the female wards of hospitals, as in the Middle Ages. At San Remo and Rome institutions have been established for providing English trained nurses to private cases.

Austria is also in a very backward state, in spite of the fame of the Vienna cliniques. The Red Cross Society provides a certain amount of trained nursing, and next to it the best-organized work is done by religious orders; but many of the hospitals appear to be still as neglected as were the English ones in 1850. The Brothers of Mercy have charge of most of the men's hospitals, and also carry on a remarkable system of district nursing.

In *Holland* and the *Scandinavian countries* the organization is more modern and fairly adequate.

Taken altogether, the continent of Europe is far behind Great Britain and the United States with regard to sick-nursing both in the home and the hospital. The calling, as such, has not attained the same dignity, and, with some exceptions, is pursued by an inferior class of persons, who are both less capable and less well instructed. But the pressure of modern requirements, particularly in surgery, is being felt even in the most backward quarters, and is compelling gradual improvement.

For full details on this large subject the reader is referred to the numerous text-books and other technical authorities. Only a few general observations can be made here. Many candidates approach the calling with a very imperfect appreciation of its exacting character. The work is not easy or to be taken up lightly. It demands physical strength, sound health, scrupulous cleanliness, good temper, self-control, intelligence, and a strong sense of duty. It embraces many duties—some of them menial and disagreeable—besides the purely medical and surgical functions. This is especially the case with district nursing, which is the highest and most exacting branch of the profession, because it imposes the greatest responsibility with the fewest resources and demands the most varied qualifications, while affording none of the attractions incidental to hospital work or private nursing among the rich. A district nurse should be able to do everything for the patient—which often means mother and child—and for the house: she should be able to cook, do house-work, and manage children, in addition to carrying out the technical details of nursing and applying the principles of hygiene under the most difficult conditions. This may be regarded as the ideal. It is comparatively easy to fulfil routine duties, when every means is at hand and the standing conditions are the most favourable possible; when ventilation, warmth, light, and cleanliness are all provided of the best, and when assistance can be summoned in a moment. To be thrown on your own resources and make the best of adverse conditions is an entirely different matter; it requires a thorough knowledge not of routine, but of principles. It is impossible, therefore, for nurses to be over-educated in the fullest sense of the word; but it is possible for them to be inappropriately educated, and perhaps that is sometimes the case now. Some experienced authorities believe that the third year of hospital training, however valuable or necessary it may be for the hospital career, is no advantage, but rather the contrary, for the general business of nursing; and that during it probationers carry technical knowledge to a point which tends to make them self-opinionated and unfit for the ordinary duties of the sick-room. This opinion is to a certain extent corroborated by not infrequent signs of revolt on the part of the public against the oppressive "airs" of the highly-educated modern nurse, and by the experience of general practitioners, on whom she considers herself competent to sit in judgment. Probably the meaning of it all is that nursing has been elaborated to the inevitable point of specialization, and that a somewhat different preparation is needed for different branches of the art.

Duties and qualifications.

Allusion has been made above to the subject of male nursing. It hardly finds a place in the British civil system, and has been condemned for hospitals in Germany, where it is at its best, by so eminent an authority as Professor Virchow. In the South African campaign it was even suggested that female nurses should replace orderlies at the front. The only valid reason for preferring women to attend men rather than members of their own sex is the difficulty of obtaining a supply of equally well qualified and satisfactory male nurses. But this difficulty need not be permanent, and the assumption is much to be deprecated. It is, indeed, most desirable that men should be nursed by men. The advantages are many and real. For one thing, women do not possess the physical strength which is often required. They cannot lift a heavy man, and ought not to be asked to do it. Their inability to move patients who cannot move themselves often explains the occurrence of bed-sores, which might otherwise have been avoided. Nor can they cope with delirious male patients, who sometimes escape and injure or destroy themselves. Then it is excessively irksome to a sensitive man to be attended by women for various necessary offices. In order to avoid it he will endeavour to do without assistance, and seriously prejudice his chances of recovery. There is no doubt that when men are good nurses they are quite unsurpassed; they possess every qualification for the work, and in a hospital their dress, which raises no dust and makes no sound, is greatly preferable. The writer was much struck by the efficiency of the male nurses in the cholera hospitals at Hamburg in 1892. Strong, quick, deft and clean, skirtless, and with sleeves rolled up, they moved about their work and handled the patients, many of whom were collapsed, as women could not possibly do. The restoration of male nurses on modern lines may be impossible for lack of the right material, but any movement in that direction is to be welcomed. So far as the preference for women is sentimental, it deserves nothing but condemnation. Nursing is not a sentimental, but a serious business. (See also HOSPITALS.)

AUTHORITIES.—BURDETT. *Hospitals and Asylums of the World; The Nursing Profession* (annual).—HAMPTON. *Nursing.*—LEWIS. *Nursing, its Theory and Practice.*—LÜCKES. *Hospital Sisters and their Duties.*—MORTEN. *How to become a Nurse.*—NIGHTINGALE. *Notes on Nursing.*—NIGHTINGALE BOYD. "Nursing," Quain's *Dictionary of Medicine*, 3rd edition.

Nutrition. See PHYSIOLOGY.

Nuwara Eliya, the sanatorium of Ceylon, is a town of about 5000 people, with 1000 additional visitors during the "season." It is situated 6240 feet above sea-level, with the highest mountain in the island, Pedrotallagalla, towering over the plain for 2056 feet more, offering a morning climb to the top, 8296 feet above the sea. Nuwara Eliya is reached from Colombo by rail, eight hours to Nanuoya, and thence less than one hour by coach (to be replaced by light railway). The Hakgalla Botanical Gardens are within an easy drive, and other attractions for visitors are provided. The climate is delightfully dry and cool during the "season" (1st February to 31st May). The average shade temperature for the year is 58°; the rainfall, 95 inches.

Nyasa, the third in size of the great lakes of Central Africa, occupying the southern end of the great rift valley system which traverses the eastern half of the equatorial region from north to south. Extending from 9° 29′ to 14° 25′ S., or through nearly 5° of latitude, the lake measures along its major axis, which is slightly inclined to the west of north, exactly 350 miles, while the greatest breadth, which occurs near the middle of its length, between 11° 30′ and 12° 20′ S., is 45 miles. In the northern and southern thirds of the length the breadth varies generally from 20 to 30 miles, and the total area may be estimated at 11,000 square miles. The lake lies somewhat over 1500 feet above the sea. The sides of the valley in which Nyasa lies, which are somewhat irregular towards its southern end, take a decided character of fault scarps in the northern third, and are continued as such beyond the northern extremity. Apart from the recent alluvium on the immediate shores, the lake lies almost entirely in granite and gneiss formations, broken, however, by a band of horizontally-bedded sandstones, which cuts the axis of the lake in about 10° 30′ S., the flat-topped, terraced form of the latter contrasting strangely with the jagged or rounded outlines of the former. Near the margin, overlying the sandstones, there are beds of limestone with remains of recent molluscs, pointing, like the raised beaches which occur elsewhere, to an upward movement of the coasts. The depth of the lake seems to vary in accordance with the steepness of the shores, increasing from south to north. The greater part of the northern half shows depths of over 200 fathoms, while a maximum of 430 fathoms was obtained by Mr J. E. Moore in 1899, off the high western coast in about 11° 40′ S. A more complete series of soundings, however, since made by Lieut. Rhoades, and published in the *Geographical Journal* in 1902, gives a maximum of 386 fathoms off the same coast in 11° 10′ S.

At the north-western end is a plain of great fertility, traversed by the Kivira, Songwe, and other streams, rising either among the volcanic masses to the north or on the western plateau. Just north of 10°, on the delta of the Rukuru, is the British station of Karonga, the northern port of call for the lake steamers, though with but an open roadstead. Southwards the plain narrows, and in about 10½° S. the sandstone scarp of Mount Waller rises sheer above the indentation of Florence Bay, the high western plateaux continuing to fall steeply to the water in wooded cliffs for more than 80 miles. In this stretch occur the land-locked bays of Ruarwe (11° 5′ S.) and Nkata (11° 36′ S.), and the mouth of the Rukuru (10° 43′ S.), which drains the plateau from south to north. At Cape Chirombo (11° 40′ S.) the coast bends to the west, and soon the plateau escarpments recede, and are separated from the lake along its southern half by an undulating plain of varying width. In 11° 56′ S. is the British station of Bandawe, and in 12° 55′ that of Kota Kota, on a lake-like inlet, forming a sheltered harbour. A little north of the latter the Bua river, coming from a remote source on the upper plateau, enters by a projecting delta. At Domira Bay, in 13° 35′, the coast turns suddenly east, contracting the lake to a comparatively narrow neck, beyond which it runs southwards into two bays separated by a granitoid peninsula, off which lie several small rocky islands. On this peninsula was placed the mission station of Livingstonia, the first to be established on the shores of Nyasa. From the extremity of the eastern bay the Shire makes its exit to the Zambezi. On the eastern side the plateau escarpments keep generally close to the lake, leaving few plains of any extent along its shores. The crest of the eastern watershed runs generally parallel to the coast, which it approaches in places within 20 miles. From the north point to 10° 30′ S. the coast is formed by the unbroken wall of the Livingstone or Kinga range, rising where highest (9° 40′ S.) 6000 feet above the water. On this coast, on a projecting spit of land, is the German station of Langenburg, some 10 miles from the northern extremity. In 10° 30′ the plateau is broken by the valley of the Ruhuhu, the only important stream which enters the lake from the east. The formation is here sandstone, corresponding to that of Mount Waller on the opposite shore. Just north of the Ruhuhu is the German station of Wiedhafen, on an excellent harbour, formerly Amelia Bay. South of the Ruhuhu the wall of mountains recedes somewhat, and the remainder of the eastern shore shows a variation between rocky cliffs, marshy plains of restricted area, and groups of low hills. In 11° 16′ is the deep inlet of Mbampa Bay, offering a sheltered anchorage. South of it the coast forms a wide semicircular bay, generally rock-bound, and ending south in Malo Point (12° 10′ S.), off which are the largest islands the lake possesses, Likoma and Chisamulu, the former measuring about 4 miles by 3. In the southern half the coast is highest in about 13° 10′ S., where the Mapangi hills rise to 3000 feet. Nyasa, reached in 1858 both by Dr Livingstone (from the south) and by the German traveller Roscher (from the east), was explored by the former to about 11°, and to its northern end by Young in 1876. From this date onwards it has been the scene of much civilizing work on the part of British (principally Scottish) missionaries, traders, and Government officials, and, in more recent years, of Germans also. In the political partition of Africa its shores have been divided between Great Britain, Portugal, and Germany, Great Britain holding (within the British Central Africa Protectorate) all the west coast south of the Songwe and the southern extremity of the east coast (south of 13½° S.); Portugal the rest of the east coast south of 11½° S.; and Germany the remainder. A considerable number of British steamers, including two or three gunboats, have been launched on Nyasa, which forms an important link in the water-route from the Zambezi mouth to the heart of the continent. Germany also has a gunboat on the lake. The first detailed survey of its shores was executed by Mr James Stewart (1878–83), but this has been superseded by more recent work, especially that of Lieutenants Rhoades and Phillips. (See *Proc. R.G.S.*, 1883, p. 689; *Geogr. Journal*, xii. p. 580. Also MOORE, *ibid.* x. p. 289). (E. HE.)

Nye, Edgar Wilson (1850–1896), American humorist, was born at Shirley, Me., on 25th August 1850, and after his schoolboy days went to study law in Wyoming, being there called to the bar in 1876. He soon began to contribute humorous articles to the press under the pseudonym of "Bill Nye," and obtained so much success that he devoted himself to writing and lecturing in his own humorous vein. His principal volumes were *Bill Nye and the Boomerang* (1881), *The Forty Liars* (1883), *Bill Nye's Blossom Rock* (1885), and *Remarks* (1886). He died at Asheville, N.C., on 22nd February 1896.

Nykjöbing, a seaport town of Denmark, county of Maribo, on the west shore of the island of Falster, 91 miles south-south-west of Copenhagen by rail. Its church contains a genealogical tree of the Mecklenburg ducal family, with portraits, dating from 1627 or earlier. Here is the house occupied by Peter the Great of Russia in 1716, restored in 1898. The harbour was in 1899 entered by 1184 vessels of 74,381 tons, and cleared by 1199 vessels of 74,217 tons. Exports, bacon and butter; import, coal. Population (1880), 4560; (1890), 6087; (1901), 7345. The area was slightly enlarged in 1900.

Nyköping, a seaport town of Sweden, at the head of an inlet on the east coast, 98 miles south-west of Stockholm by a branch line from the Stockholm–Malmö railway. It is a growing place, with engineering works, cotton and cloth factories, and shipbuilding. Its port and the port of Oxelösund (10 miles south-east), at the mouth of the bay, which is seldom closed in winter, together export considerable quantities of iron and zinc ore (536,250 tons in 1900), timber, oats, and wood-pulp, and import principally coal (over 200,000 tons in 1900), with iron, grain, &c. Population (1880), 4813; (1890), 5978; (1900), 7375.

Oakham, a market town of England, capital of Rutland county, in the fertile vale of Catmos, 90 miles north of London by rail. It is a clean and healthy town, with a school, endowed by Archdeacon Johnson in 1584, reconstituted in 1875 as a first-class modern school for boys, under the same charity, as Uppingham School. The parish church of All Saints has a fine reredos. There are also a Roman Catholic church and various Nonconformist chapels, an agricultural hall, the Oakham Institute (1877), and one surviving hall of the 12th-century Norman castle, now used as a county hall. The town is governed by the county magistrates and its own rural district council. Population of the two civil parishes—Oakham Deanshold with Barleythorpe and Oakham Lordshold (1891), 3542. In 1894 Barleythorpe was formed into a separate parish outside the bounds of the parish of Oakham. Population of Oakham civil parish, without Barleythorpe (1901), 3293.

Oakland, a city of California, U.S.A., capital of Alameda county, on the east side of San Francisco Bay, opposite to and 6 miles distant from the city of San Francisco, of which it is the principal residential suburb, being connected with it by ferries. It has a level site, on which it is laid out with great regularity. It is divided into seven wards, and has a good water-supply; its streets are broad, well shaded, and macadamized. It is a beautiful residential city. It is the terminus of lines of the Southern Pacific Railway, whence passengers are transferred to San Francisco by ferry. Though mainly residential, it has some manufactures. In 1900 it contained 752 manufacturing establishments, with a total capital of $6,364,651. They employed 4012 wage-earners, and the product was valued at $9,174,257. The principal items of production were lumber and foundry and flouring products. It is the seat of California College, a Baptist institution, opened in 1870, which had in 1899 eight instructors and sixty-six students. The assessed valuation of real and personal property in 1900, on a basis of about two-thirds of the full value, was $43,275,381; the net debt was only $484,030, and the rate of taxation was $25.33 per $1000. Population (1890), 48,682; (1900), 66,960, of whom 17,256 were foreign-born and 2172 coloured, including 1026 negroes.

Oaxaca de Juarez, a state of Mexico, bounded on the N. by the states of Puebla and Vera Cruz, on the E. and N.E. by those of Vera Cruz and Chiapas, on the S. by Chiapas and the Pacific, and on the W. and N.W. by Guerrero, with an area of 35,392 square miles. Its coast-line is 530 kilometres long. Its population, 744,000 in 1879, in 1895 was 884,909. It occupies a beautiful and fertile region, watered by a number of rivers; the Sierra Madre Mountains traverse the whole state. The principal agricultural products are cereals, sugar-cane, cotton, coffee, and tobacco, the total yearly yield being estimated at about $15,000,000. Stock-raising represents a capital of $4,000,000. Silver, gold, iron, lead, and coal are abundant, but as yet little exploited. The South Mexican Railway runs from Puebla to Oaxaca on its way to the Guatemalan frontier, with a branch line to Puerto Angel, and the Interoceanic Railway runs from Salina Cruz on the Pacific to Coatzocoalcos on the Gulf. It has two ports open to foreign and coastwise trade, Salina Cruz and Puerto Angel. The capital, OAXACA DE JUAREZ, near the Rio Atoyac, with 32,437 inhabitants, is one of the most beautiful and most famous cities of Mexico, has fine public buildings, an institute of sciences and arts, a model school, a general hospital, a mint, fine public gardens, and tramways. It is also an important industrial and commercial centre. It was founded in 1486 under the name of Huaxyacac. In 1872 it was given its present name. Amongst other towns in the state are Juchitan (10,820), Tehuantepec (9415), Tlaxiaco (8535), Huantla (5924), Zachila (5814), Ojitlan (5583), Tlacolula (5377), Ejutla (5254).

Oban, a seaport and parliamentary burgh—extended 1881—(Ayr group) of Argyllshire, Scotland, on the Firth of Lorn, 92 miles north-west by north of Glasgow by rail. Manufactures of aërated waters and sheep dip have been introduced; and modern erections are the parish church, United Free church, Roman Catholic pro-cathedral, cottage hospital, court house, municipal buildings, and an isolation hospital. A large quay and sea wall have been enlarged. The harbour, which will admit vessels up to 600 tons, is 20 acres in extent, and gives 12 feet of water beside the quay. At one end of the fine bay stands Dunollie Castle, beautifully situated on a rocky knoll. On the hill in the heart of the town are the picturesque ruins of a hydropathic, built on far too gigantic a scale, from which a magnificent view of the Sound of Mull and the mountains of Morven is to be had. William Black, the novelist, had a villa here for many years, and Professor Blackie was a constant visitor until he took umbrage at the railway and the class of buildings that were being erected to meet the growing popularity of the town. Oban is full of hotels, and has been called the "Charing Cross of the Highlands." Some three miles to the north-east are the hoary ruins of Dunstaffnage Castle, with relics of the Spanish Armada, but still more memorable as being the resting-place of the Stone of Destiny, prior to its removal to Scone, whence it was conveyed in 1296 by Edward I. to Westminster Abbey, where it now lies beneath the coronation chair. Population (1891), 4946; (1901), 5374.

Oberammergau, a village of Bavaria, Germany, district of Upper Bavaria, situated amongst the foot-hills of the Alps, 64 miles south-south-west of Munich (of which 57 miles by rail to Oberau), where the famous Passion Play is performed every tenth year (*e.g.*, in 1900). The people make crucifixes, rosaries, &c., and toys. Population, 1400.

Oberlahnstein, a town of Prussia, province of Hesse-Nassau, on the right bank of the Rhine, at the confluence of the Lahn, 4 miles above Coblenz. It still retains parts of its ancient walls and towers, and possesses a former castle of the electors of Mainz, the castle of Lahneck (restored in 1860), and the chapel in which King Wenceslaus was deposed in 1400. In the vicinity are iron, lead, and silver mines. It has a trade in wine, and machine factories and saw-mills. Population (1900), 7969.

Oberleutensdorf (Czech, *Litvinov horni*), a town in the government district of Brüx in Bohemia. In addition to important coal-mines, the chief industries include textiles, cutlery, and leather-making, besides manufactures of toys, furniture, hats, &c. Population (1890) 7502; (1900), 12,928, German.

Oberlin, a village in Russia township, Lorain county, Ohio, U.S.A., in the northern part of the state, and 34 miles distant (by rail) west-south-west from Cleveland. Besides being on the main line of the Lake Shore and Michigan Southern Railway, it is on the Cleveland, Elyria, and Western (electric) Railway, which furnishes connexions not only with the cities of Cleveland and Elyria, but also with the village of Wellington, thus giving access to the Cleveland, Cincinnati, Chicago and St Louis, and the Wheeling and Lake Erie railways. The village is partly paved, and has electric lighting, sewerage, and water-supply systems. Oberlin College, a co-educational institution situated here, had in 1900 (including the theological seminary, the conservatory of music, the preparatory academy, &c.), 84 instructors and 1357 students, of whom 825 were women. The college proper had 34 instructors and 428 students, of whom 231 were women. Population (1890), 4376; (1900), 4082, of whom 261 were foreign-born and 641 negroes.

Oberstein, a town of Prussia, grand-duchy of Oldenburg, in the district of Birkenfeld, and on the river Nahe, 33 miles south-west of Kreuznach. It is famous for the industry of cutting and setting agates and other precious stones, an industry which has been established here since the 16th century. The (Evangelical) parish church is partly hewn out of the solid rock. Population (1885), 5400; including Idar (1895), 14,774; (1900), 16,729.

Oberwesel, a town of Prussia, in the Rhine province, on the left bank of the Rhine, 26 miles by rail south by east of Coblenz, a former free imperial town. It is still partly surrounded with ruinous walls, having conspicuous towers. It has a couple of Gothic churches, one of the 14th century; and above the town are the ruins of the castle of Schönburg. A little lower down the river, on the opposite bank, is the romantic rock of the Lorelei, and immediately opposite the town are the rocks of the Seven Sisters. Population (1900), 2601.

Observatory.—Since 1884 the instrumental equipment of many observatories has been considerably increased, chiefly owing to the rapid rise of astronomical photography. In the following list all important additions are mentioned, and the principal new observatories founded since 1884 are shortly described. In a few cases improved values of the latitude and longitude of older institutions are also given.

[*Abbreviations:* ap., aperture; obs., observatory; o.g., object glass; phot., photographic; refl., reflector; refr., refractor; s.g., silvered glass; vis., visual. Where the names of two makers are given, the first is responsible for the optical, the second for the mechanical part of the instrument.]

Great Britain and Ireland.—*Greenwich.*—Lassell's 2 foot refl., erected 1884; 13 in. phot. refr. with 10 in. vis. o.g. by Grubb; 28 in. refr. by Grubb; 26 in. phot. refr. by Grubb, with the old 12·8 in. refr. as guiding telescope; 9 in. phot. refr. by Grubb, and 30 in. s.g. refl. by Common, the last four being on one stand; 8 in. altazimuth by Simms, erected 1896. The 26 in. and the 9 in. were presented by Sir H. Thompson.

South Kensington.—Solar Physics obs., lat. +51° 29′ 48″·0, long. 0^h 0^m 41^s·5 W. Directed by Sir N. Lockyer. 3 foot refl. by Common; 10 in. refr. by Cooke; 9 in. refr. by Henry, with attachments for phot. and spectroscopic work on the sun and fixed stars.

Oxford.—Radcliffe obs. Mr Barclay's 10 in. refr. erected; 24 in. phot. and 18 in. vis. refr. by Grubb, erected in 1902. University obs. 13 in. phot. refr. by Grubb.

Cambridge.—Mr Newall's 25 in. refr., presented and erected 1891; siderostatic telescope on Grubb's plan, with 12½ in. triple photo-vis. o.g. by Cooke, 1898.

Edinburgh.—New Royal obs. on Blackford Hill, opened 1896, lat. +55° 55′ 28″·0, long. 0^h 12^m 44^s·2 W., contains all the instruments and library of Lord Crawford's obs. and the 2 foot refl. The Calton Hill obs. has been acquired by the city, and a 21 in. refr. erected.

Glasgow.—20 in. s.g. refl. by Grubb, with spectrograph.

Armagh.—10 in. refr. by Grubb, erected 1885.

Mr Common's obs.—5 foot refl., erected 1888; the 3 foot sold.

Rev. T. E. Espin's obs., Tow Law, Darlington.—17 in. refl. by Calver.

Mr F. M'Clean's obs., Rusthall House, Tunbridge Wells.—12 in. phot. refr. by Grubb, with o.g. prism same size.

Dr Isaac Roberts's obs., Crowborough, Sussex.—Lat. +51° 3′ 7″, long. 0^h 0^m 37^s E. Erected 1890, 20 in. s.g. refl. by Grubb (with 7 in. refr.), devoted to photography of nebulæ and clusters.

Stonyhurst College.—15 in. Perry memorial refr. by Grubb.

Mr W. E. Wilson's obs., Streete, Co. Westmeath.—2 foot refl. by Grubb, and other instruments for work on solar physics.

The private observatories of Mr Barclay, Lord Crawford, Mr Knott, Mr Newall, and Colonel Tomline have been discontinued.

France.—*Paris.*—Equatoréal coudé of 10·6 in. ap., erected 1883; 13 in. phot. refr. by Henry, 1885; equat. coudé with 23·6 in. vis. and phot. o.g. by Henry and Gautier, completed 1891.

Juvissy (Seine et Oise).—M. Flammarion's obs. 9½ in. refr. by Bardou.

Meudon, lat. +48° 48′ 18″, long. 0^h 8^m 55^s·6 E. Refr. by Henry and Gautier, with 32 in. vis. and 24·4 in. phot. o.g.; refl. of 39 in. ap. by the same. M. Janssen has established a branch on Mont Blanc for solar and spectroscopic observations.

Besançon, lat. +47° 14′ 59″·0, long. 0^h 23^m 57^s·2 E. Chronometric and meteorological obs., opened 1884. 8 in. refr., 13 in. equat. coudée, 7½ in. transit circle, all by Gautier.

Lyons, lat. +45° 41′ 41″·0, long. 0^h 19^m 8^s·6. 12 in. equat. coudé.

Marseilles.—7½ in. transit circle.

Nice, lat. +43° 43′ 16″·9, long. 0^h 29^m 12^s·2 E. 15 in. refr. and 15 in. equat. coudée, both by Henry and Gautier.

Bordeaux, lat. 44° 50′ 7″·2, long. 0^h 2^m 5^s·5 W. Transit circle of 7 in. ap. by Eichens; 8 in. refr., 14 in. refr. by Merz and Gautier; 13 in. phot. refr. by Henry and Gautier.

Toulouse.—13 in. phot. refr. by Henry and Gautier; transit circle by Gautier; old 13 in. refl. by Foucault. The Brunner refr. is of 9 in. ap.

Germany.—*Bamberg.*—Remeis obs., lat. +49° 53′ 6″·0, long. 0^h 43^m 33^s·7 E. 7 in. heliometer by Repsold; 10 in. refr. by Schröder.

Berlin.—Urania Society for Diffusing Natural Knowledge, lat. +52° 31′ 30″·7, long. 0^h 53^m 27^s·5 E. Opened 1889. 12 in. refr. by Schröder.

Breslau.—Engelmann's 8 in. refr., acquired 1898.

Dresden.—Instruments given to Kasan obs., 1897.

Düsseldorf.—7 in. refr. by Merz and Bamberg.

Göttingen.—6 in. heliometer by Repsold.

Heidelberg.—University obs., lat. +49° 23′ 56″·6, long. 0^h 34^m 48^s E., 1600 feet above the Neckar. Instruments from Karlsruhe, also 6 in. transit circle by Repsold, 8 in. refr. by Merz, 12 in. refr. by Steinheil and Repsold; 16 in. phot. refr. by Brashear and Grubb.

Königsberg.—13 in. refr. by Reinfelder and Repsold.

Leipzig.—6 in. heliometer by Repsold; 12 in. refr. by Reinfelder.

Munich.—6 in. transit circle by Repsold.

Potsdam.—9 in. vis. and 13 in. phot. refr. by Steinheil and by Merz; phot. spectrograph; 31 in. phot. and 19·7 in. vis. refr. by Steinheil and Repsold, erected 1899.

Austria-Hungary.—*Vienna.*—Imp. and R. obs. 14·9 in. equat. coudé by Gautier, presented by Baron A. Rothschild.

Vienna—Ottakring.—Private observatory of M. von Kuffner, lat. +48° 12′ 46″·7, long. 1^h 5^m 11^s·1 E. 10 in. vis. and 6 in. phot. refr. by Steinheil and Repsold; 8 in. heliometer by Repsold; transit circle by same.

Lussinpiccolo (Istria).—Manora private obs., lat. +44° 32′ 11″·0, long. 0^h 57^m 52^s·4 E. 7 in. refr. by Reinfelder.

Kis Kartal.—Private obs. of Baron Podmaniezky, lat. 47° 41′ 54″·8, long. 1^h 18^m 11^s·7 E. 7 in. refr. by Merz and Cooke.

Spain.—*Cadiz.*—13 in. phot. refr. by Henry and Gautier.

Italy.—*Teramo.*—Private obs. of V. Cerulli, lat. +42° 39′ 27″ long. 0^h 54^m 56^s E. 15·5 in. refr. by Cooke.

Padua.—Dembowski's 7 in. refr., erected 1881.

Rome.—Vatican, papal obs., founded 1890, lat. +41° 54′ 4″·8, long. 0^h 49^m 49^s·5 E. 13 in. phot. refr. and 5·5 in. photoheliograph, both by Henry.

Catania, +lat. 37° 30′ 13″·3, long. 1^h 0^m 20^s E. 13 in. refr. by Merz and 13 in. phot. refr. by Henry and Gautier.

Russia.—*St Petersburg.*—University obs., lat. +59° 56′ 32″, long. 2^h 1^m 11^s.4 E., with a branch obs. at Domkino for summer use, lat. +58° 35′ 36″, long. 1^h 59^m 25^s·1 E. 9 in. refr. used for double stars.

Pulkowa.—30 in. refr. by Clark and Repsold. A branch has been established at Odessa, with a 4 in. transit by Freiberg, and 4 in. vertical circle by Repsold.

Helsingfors.—13 in. phot. refr.

Vilna.—Abolished in 1883.

Plonsk.—Discontinued after the owner's death.

Kasan.—New obs. built 1899 (see *Dresden*).

Sweden.—*Upsala.*—13 in. phot. and 14 in. vis. refr. by Steinheil.

Denmark.—*Copenhagen.*—14 in. vis. and 8 in. phot. refr. by Steinheil.

Holland.—*Leyden.*—10·5 in. refr. by Clark and Repsold.

Belgium.—*Brussels.*—New obs., lat. +50° 47′ 53″, long. 0^h 17^m 26^s·9 E.

Liége.—University obs., lat. +50° 37′ 7″, long. 0^h 22^m 15^s·2 E. 10 in. refr. by Cooke; 6 in. transit circle by same.

United States.—*Albany* (N.Y.).—New obs., lat. +42° 39′ 12″·7, long. 4^h 55^m 6^s·8 W. New 12 in. refr. by Brashear.

Cambridge (Mass.).—Harvard University obs., 12 in. horizontal telescope for photometric obs. of faint stars; 11 in. Draper phot. refr.; 8 in. Draper refr. for regular photographs of northern sky several times a year; 15 in. Draper refl. for phot. trails of stars near the pole; phot. transit photometer (see *Arequipa*, S. America).

Charlottesville (Va.).—Leander M'Cormick obs. of University of Virginia, lat. $+38° 2' 1''\cdot2$, long. 5^{h} 14^{m} $5^{s}\cdot2$ W. 26 in. refr. by Clark.

Columbus.—Ohio State University obs. 12 in. refr. by Brashear and Warner & Swasey.

Denver (Col.).—Chamberlin obs., lat. $+39° 40' 36''\cdot4$, long. 6^{h} 59^{m} $47^{s}\cdot6$ W., 5400 feet above sea-level. 20 in. refr. by Fauth.

Echo Mountain, Los Angeles (Cal.).—Lowe obs., 3500 feet above sea-level. 16 in. refr. from Rochester.

Evanston (Ill.).—Dearborn obs., lat. $+42° 3' 33''\cdot4$, long. 5^{h} 50^{m} $42^{s}\cdot3$ W. Removed from Chicago in 1889.

Flagstaff (Arizona).—Lowell obs., 7300 feet above sea-level. 18 in. refr. by Brashear.

Georgetown (D.C.).—12 in. refr. by Clacey and Saegmuller; 9 in. phot. transit instr. by Saegmuller; 6 in. phot. zenith telescope by Brashear.

Haverford (Pa.).—College obs., lat. $+40° 0' 40''\cdot1$, long. 5^{h} 1^{m} $12^{s}\cdot7$ W. 10 in. refr. by Clark.

Mount Hamilton (Cal.).—Lick obs. of University of Cal., opened 1888, lat. $+37° 20' 25''\cdot6$, long. 8^{h} 6^{m} $34^{s}\cdot9$ W. The 36 in. refr. has a 33 in. phot. lens; 6 ins. transit circle by Repsold; 3 foot refl. by Common; 5 in. horiz. photoheliograph.

New Haven (Conn.).—The new obs. is in lat. $+41° 19' 22''\cdot3$, long. 4^{h} 51^{m} $40^{s}\cdot6$ W.

New York.—Columbia University obs., lat. $+40° 45' 23''\cdot1$, long. 4^{h} 55^{m} $53^{s}\cdot6$ W. Contains Rutherfurd's instruments.

Northfield (Minn.).—16 in. refr. by Brashear and Hastings; 4·8 in. transit circle by Repsold.

Philadelphia.—University of Pa. obs., lat. $+39° 57' 7''\cdot5$, long. 5^{h} 0^{m} $38^{s}\cdot5$ W. 18 in. refr., 4 in. transit circle, and 4 in. zenith telescope, all by Brashear and Warner & Swasey.

Poughkeepsie (N.Y.).—Vassar College obs., lat. $+41° 41' 18''$, long. 4^{h} 55^{m} $33^{s}\cdot7$ W. Founded 1865. 12⅜ in. refr. by Fitz and Clark; small transit circle

Rochester (N.Y.).—Discontinued (see *Echo Mountain*).

Washington (D.C.).—New naval obs., opened 1893, lat. $+38° 55' 14''\,0$, long. 5^{h} 8^{m} $15^{s}\cdot8$ W. In addition to the old instruments, there is a 40 foot photoheliograph of 5 in. ap.; 6 in. transit circle built of steel by Warner & Swasey; 5 in. steel altazimuth by same; 12 in. refr.

Washington (D.C.).—Astrophysical obs. of the Smithsonian Institution, lat. $+38° 53' 17''\cdot3$, long. 5^{h} 8^{m} $6^{s}\cdot2$. Siderostat with 20 in. mirror; spectrobolometer, &c

Williams Bay (Wis.).—Yerkes obs. of University of Chicago, lat. $+42° 34' 15''$, long. 5^{h} 54^{m} 14^{s} W. Opened 1897. 40 in. refr. by Clark and Warner & Swasey, also a 12 in. refr., 24 in. refl., 10 in. phot. refr.

Williamstown (Mass.).—The transit circle is in the Field Memorial obs. (1882), lat. $+42° 42' 30''$, long. 4^{h} 52^{m} 50^{s} W.

Mexico.—*Taeubaya.*—National obs., lat. $+19° 24' 17''\cdot5$, long. 6^{h} 36^{m} $46^{s}\cdot5$ W., 7600 feet above sea-level. 15 in. refr. by Grubb; 13 in. phot. refr. by Henry and Gautier.

South America.—*Santiago* (Chile).—13 in. phot. refr. by Henry and Gautier; new transit circle.

Arequipa (Peru).—Branch of Harvard College obs., lat. $-16° 24'$, long. 4^{h} 45^{m} 30^{s} W., 8060 feet above sea-level. 24. in. Bruce refr. by Clark, and 13 in. Boyden telescope for phot. charts and spectra of faint stars; 4 in. transit photometer extends the Harvard photometry to the south pole.

Rio de Janeiro.—13 in. phot. refr. by Henry and Gautier.

La Plata (Argentina), lat. $-34° 54' 30''\cdot3$, long. 3^{h} 51^{m} $37^{s}\cdot0$ W. 8 in. refr., 18 in. equat. coudé, and 13 in. phot. refr. by Henry and Gautier.

Africa.—*Cape of Good Hope.*—7 in. heliometer by Repsold; 13 in. phot. and 10 in. vis. refr. by Grubb; new transit circle by Simms; 24 in. phot. and 18 in. vis. refr. by Grubb (with 24 in. objective prism), presented by Mr F. M'Clean. A phot. survey of the southern heavens has been made with a 6 in. Dallmeyer lens.

Mauritius.—Royal Alfred obs., lat. $-20° 5' 39''$, long. 3^{h} 50^{m} $12^{s}\cdot5$ E. Chiefly meteorological, but solar photos regularly taken.

Algiers.—20 in. refl., equat. coudé, and 13 in. phot. refr. by Henry and Gautier; transit circle.

India.—*Madras.*—New obs. is being built at Kodaikanal, 7700 feet above sea-level.

Poona.—Obs. of College of Science. 16½ in. s.g. refl. by Grubb, with 6 in. refr. by Cooke; spectroscopes, &c., chiefly for solar work.

Dehra Dûn.—Obs. of Indian Survey, lat. $+30° 19' 29''\cdot1$, long. 5^{h} 12^{m} $11^{s}\cdot6$ E. Regular solar phot. work.

Japan.—*Tôkyô.*—University obs., lat. $+35° 39' 17''\cdot5$, long. 9^{h} 18^{m} $58^{s}\cdot0$ E. 5 in. transit circle by Repsold.

Australia.—*Sydney.*—13 in. phot. refr. by Grubb.

Windsor (N.S.W.).—8 in. refr. by Grubb.

Melbourne.—13 in. phot. refr. by Grubb.

Perth (West Australia), lat. $-31° 57' 2''\cdot4$, long. 7^{h} 43^{m} $22^{s}\cdot6$ E. 13 in. phot. and 10 in. vis. refr. by Grubb; 6 in. transit circle by Simms.

AUTHORITIES.—In addition to their *Annals* or *Observations*, the leading national observatories (Greenwich, Paris, Washington, &c.) publish annual reports stating the nature of the work and changes in *personnel* and instruments. Short reports from nearly all British observatories are annually published in the February number of the *Monthly Notices R. Astr. Soc.*, and from most German and some other Continental observatories in the *Vierteljahrsschrift d. astr. Gesellschaft.* Since 1889 much information about American observatories is given in the *Publications of the Astr Soc. of the Pacific.* (J. L. E. D.)

Obstetrics.—Along with Medicine and Surgery, Obstetrics goes to form what has been called the Tripos of the medical profession, because every person desiring to be registered under the Medical Acts must pass a qualifying examination alike in medicine, surgery, and midwifery. Registrates who become general practitioners find that their midwifery cases make up a very large proportion of the patients they visit in their daily round, and in an ordinary practice such patients furnish the most constant contingent to the visiting list. Midwifery stands related both to medicine proper or internal medicine, as it is sometimes called, and to surgery or external medicine; and of registrates who in the larger centres of population specialize and devote themselves to one branch of the profession, whilst physicians seek the fellowship of a college of physicians and the surgeons that of a college of surgeons, obstetricians become fellows sometimes of the one college and sometimes of the other—it may even be of both. At present, in the capitals of the three kingdoms, the greater number of the obstetricians are fellows of the colleges of physicians. When two colleges combine to give a conjoint qualification the examiners in medicine are provided by the Physicians' College, and the examiners in surgery by the Surgeons' College, whilst the examiners in midwifery are provided in equal numbers by each of the two.

The Scope of Obstetrics.—It is required of the candidate for a qualifying pass in midwifery that he show acquaintance with the physiology and pathology of the female. The term Gynecology, which has come to be applied to the study of the diseases of the female generative system, in its primary sense includes all that pertains to women both in health and disease. This was its earliest application; and while the midwifery societies of the 'fifties took the name Obstetrical, younger societies discussing the same range of subjects adopt the wider name Gynecological. But as the obstetrical section of this branch of medicine preceded the gynecological in its development, so it retains its place of primary importance for those who seek to qualify themselves for practice. To become capable practitioners of midwifery they have to study woman as she plays her part in the reproduction of the race. This implies, to begin with, a study of *Emmenology*—the science which concerns itself with the cyclical changes in the female that culminate in a menstrual uterine hæmorrhage. Like other cyclical processes, menstruation is probably regulated from a nervous centre seated, it is generally believed, in this instance in the lumbar part of the spinal cord; but it is dependent for its healthy flow on the healthy condition of the circulation, and is intimately associated with ovulation —the escape of an ovum from a dehiscent ovisac. The appearance of the menstrual discharge is the first indication that the individual is susceptible of impregnation, and so long as it continues to recur the susceptibility remains.

Emmenology, therefore, has to observe the date of the first menstrual flow at from fourteen to sixteen years of age, and the modifying influences of climate, heredity, race, and social status in the development of puberty; the menstrual type, which is most frequently a twenty-eight-day cycle from the commencement of one period to the commencement of the next; the menstrual habit, which expresses the amount and duration of the flow; and at the end of reproductive life, the climacteric period or menopause, with its wide range of possibilities. Obstetricians recognize that, although the appearance of menstruation indicates the possibility of conception, puberty precedes the physiological age of nubility by as much as from seven to ten years. They know that the normal condition for reproduction is a monogamous union of two individuals, man and woman, mutually consenting and openly declaring their desire to form a family, and that a woman is not ripe, physically or psychically, for the great functions of wifehood and motherhood till she has attained the age of at least twenty-one years. There is the possibility of conception at any point in the menstrual cycle, but the period of greatest conception-probability is within a week after the cessation of the flow, so that if marriage be consummated at this date the newly-married wife may find that her next menstrual period fails to appear because the uterus has become the nest for the incubation of a fertilized ovum. The nine months, or, more precisely, the ten menstrual months of utero-gestation, during which the new being keeps growing like a parasite within the womb, test the strength of the pregnant female in every system of her body. This affords a second sphere of interest in the female economy, where obstetricians find occasion for the exercise of all their medical skill. Weaknesses of the brain and nervous system, of the heart, the blood, blood-vessels and blood-glands, of lungs, liver, stomach or kidneys, or even of the bones, that might otherwise have remained latent, come into view during the strain of pregnancy and may be a menace to the life of the mother and her child. During epidemics, as of small-pox or typhoid fever, the gravid woman runs risks from which her non-gravid sister is free; and whilst there are some common diseases that take on features of special danger, there are yet others that arise only during the course of pregnancy. The consideration of the health conditions of pregnancy has respect not only to the woman, but to her unborn infant; not only to individuals, but to the coming race; and in this regard it becomes part of the function of obstetricians to teach communities and even legislators the need of preventing poor women in the last weeks of pregnancy from toiling at their industries in ways that are detrimental to the race. Considerations of this kind would become urgent in a population thinned by war or fatal epidemics.

Tokology—the doctrine of parturition—is the most distinctive sphere of interest for obstetricians, and here their activities bring them into a closer approximation to the work of surgeons. As a science it demands a study of the phenomena of labour, which in their ordered succession are seen to present three distinct stages: one of preparation, during which the uterus dilates sufficiently to allow of the escape of the infant; a second, of progress, during which the infant is expelled; and a third, of the extrusion of the after-birth or placenta. In each of the stages analysis of the phenomena reveals the presence of three elements which are known as the factors of labour, viz., the powers or forces which are engaged in the emptying of the uterus; the passages or canals through which the ovum is driven; and the passenger or body that is being extruded. The mechanism of labour depends on the balance of these factors as they become adjusted to each other in the varying phenomena of the several stages. The diversities that are met with in different labours even of the same woman have led to their being classified into different groups. A natural labour is commonly defined as one where the child presents by the head and the labour is terminated within twenty-four hours. From this it is obvious that no case of labour can be defined at its onset. The relation of the factors may warrant a favourable expectation; but until the labour is completed, and completed within a reasonably safe period, it cannot be classed as natural. The element of time has this importance, that it is found that, apart from all accidents and interferences, the mortality both to mother and child becomes greater the longer the duration of the labour. Hence lingering or tedious labours, in which the child still presents with the head, but is not expelled within twenty-four hours after the onset of labour-pains, are properly grouped in a separate class, although they are terminated without operative interference. In the class of preternatural labours, where the head comes last instead of first, there are two subdivisions, according as the child presents by the breech and feet, or lies transversely as a cross-birth, and has usually to be delivered artificially. Operative or instrumental labours vary according as the procedures adopted are safe in principle to mother and child, such as turning and the application of the midwifery forceps; or as they involve damage to the infant in the various forms of embryotomy; or are more dangerous to the mother, as in the Cæsarean section and symphysiotomy. A final class of labours includes the cases where some complication or anomaly arises and becomes a source of danger, independently of disturbances of the mechanism or of any operative interference. These complex labours are due to complications that may be maternal, such as hæmorrhage and convulsions; or fœtal, such as twins or prolapse of the umbilical cord. To cope with these anomalies an obstetrician requires all the resource of a physician and all the dexterity of a surgeon.

The interest of obstetricians in their patients does not end with the birth of the children, even after natural labours. The puerpera is still a subject of care. The uterus, that during its nine months' evolution had been increasing enormously in all its elements, has in six weeks to undergo an involution that will restore it to its pre-gravid condition. The allied organs share in their measure in the change, all the systems of the body feel the influence, and especially the mammary glands take on their function of providing milk for the nutriment of the new-born infant. A patient with some latent flaw in her constitution may pass the test of pregnancy and labour with success, only to succumb during the puerperium. Of patients who become insane in connexion with child-bearing, a half manifest their mental disorder first during the days or weeks immediately succeeding their confinement, and numbers more whilst they are suckling their infants. A woman may have had an easy labour, and may have been thankful at the time for help from a hand that she did not know to be unclean; three days later germs left by that hand may have so multiplied within her that she is in mortal danger from septicæmia. The management of the puerperal patient requires not only the warding off of deleterious influences, but the watching of the normal processes, because slight deviations in these, undetected and uncorrected now, may become later a source of lifelong invalidism. It remains further to be noted that to obstetricians belong the earliest stages of pediatrics in their care of the new-born child. In some old works practitioners of this branch of the profession are described as ὀμφαλοτόμοι, because their first business was to cut the umbilical cord. The causes of the high death-rate among infants, whether due to ante-natal, intra-natal, or neo-natal conditions, come under their observation. They have charge of the whole wide field of the hygiene, pathology, and therapeutics of infancy.

Historical Sketch.—The origin of midwifery is lost in the mists of human origins. The learned Jean Astruc, who gave a lead to higher critics in their analysis of the Pentateuch by pointing out the presence of Elohistic and Jehovistic elements, exercised his imagination in fancying how the earliest pair comported themselves at the birth of their first child, and especially how the husband would have to learn what to do with the placenta and umbilical cord. His speculations are not in the least illuminative. The Mosaic writings let us see women of some experience and authority by the side of a Rachel dying in labour or a Tamar giving birth to twins, and superintending the easy labours of Hebrew slaves in Egypt. The Ebers Papyrus (1550 B.C.), which Moses may have studied when he grew learned in all the wisdom of the Egyptians, is the oldest known medical production. It contains prescriptions for causing abortion, for promoting labour, for curing displacements of the uterus, &c. But there is no indication as to how labours are to be managed, and with regard to the child there are only auguries given as to whether it will live or die, according, *e.g.*, as its first cry after it is born sounds like *nī* or *bā*.

The story of the rise and progress of midwifery is intimately bound up with the history of medicine in general. The obstetrician, looking for the dawn of his science, turns like his fellow-workers in other medical disciplines to the Hippocratic writings (400 B.C.). Now the father of medicine was not an obstetrician. As with Egyptians and Hebrews, the skilled attendants on women in labour among the Greeks were also women. But since nothing that concerned the ailments of humanity was foreign to Hippocrates, there are indications in the writings that are accounted genuine of his interest in the disorders of females—in their menstrual troubles, in their sterility, in their gestation symptoms, and in their puerperal diseases; his oath forswears the use of abortifacients, and he recommends the use of sternutatories to hasten the expulsion of the after-birth. In the Hippocratic writings that are supposed to be products of his followers, some of these subjects are more fully dealt with; but whilst the physician is sometimes called in to give advice in difficult labours, so that he can describe different kinds of presentation and can speak of the possibility of changing an unfavourable into a favourable lie of the infant, it is usually only with cases where the child is already dead that he has to deal, and then he tells how he has to mutilate and extract it. So these writings furnish us with the earliest account of the accoucheur's armamentarium, and let us see him possessed of a μαχαίριον—a knife or perforator for opening the head; a πίεστρον—a comminutor for breaking up the bones; and a ἐλκυστήρ—an extractor for hooking out the infant. The classical writers of Greece give the same impression as to the primitive stage of obstetrics. Women, like the mother of Socrates, have the charge of parturient women. Where divine aid is sought, goddesses are invoked to facilitate the labour. Gods or men are only called in where graver interference is required, as when Apollo rescued the infant Æsculapius by a Cæsarean section performed on the dying Semele. Some midwives are known to history, and extracts from the writings of one Aspasia are embedded in the works of later authors. In the great medical school of Alexandria, when the science of human anatomy began to take shape, Herophilus rendered a service to obstetrics in giving a truer idea of the anatomy of the female than had previously prevailed; other physicians give evidence of their interest in midwifery and the diseases of women, and some experience was gradually being acquired and transmitted through the profession until we find from Celsus (in the reign of Augustus) that when surgeons were called in to help the attendant woman they could sometimes bring about the delivery, without destroying the infant, by the operation of turning. In the 2nd century Soranus wrote a work on midwifery for the guidance of midwives, in which for the first time the uterus is differentiated from the vagina and instruction is given for the use of a speculum. A contemporary, Moschion, wrote a guide for midwives which, with that of Soranus, may be said to touch the high-water mark of archaic midwifery. It is written in the form of question and answer, was much prized at the time of the Renaissance, and was used as the basis of the first obstetric work that issued from a printing-press. Philumenos wrote a treatise of some value at the same epoch, but it is only known from the free use made of it by subsequent writers, such as Aëtius in the beginning of the 6th century. Like Oribasius, who preserved in his compilation the work of Soranus, Aëtius draws largely on preceding writers. His treatises on female diseases constitute an advance on previous knowledge, but there is no progress in midwifery, though he still makes mention of turning. This operation has disappeared from the pages of Paulus Ægineta, an 8th-century author, the last to treat at length of obstetrics and gynecology ere the night of the Dark Ages settled down on the Roman world, and it is not heard of again till a millennium had passed. During the centuries when the progress of medicine was dependent on the work of the Arabian physicians, the science of obstetrics stood still. We are curious to know what Rhazes and Avicenna in the 9th and 10th centuries have to say on this subject. But they know little but what they have learned from the Greek writers, and they show a great tendency to relapse to the rudest procedures and to have recourse to operative interferences destructive to the child. Interest attaches to the work of Albucasis in the 12th century, in that he is the first to illustrate his pages with figures of the knives, crushers, and extractors that were employed in their gruesome practices, and that he gives the first history of a case of extra-uterine pregnancy.

We come down to the 16th century before we begin to see any indication of the development of obstetrics towards a place among the sciences. Medicine and surgery profited earlier by the intellectual awakenings of the Renaissance and the Reformation. In anatomical theatres and hospital wards associated with universities great anatomists and clinicians began to discard the dogmas of Galen, and to teach their pupils to study the body and its diseases with unprejudiced minds. But the practice of midwifery was still among all people in the hands of women, and when in 1513 Eucharius Roesslin of Frankfort published a work on midwifery, it bore the title *Der Schwangeren Frawen und Hebammen Rosengarten.* Translated into English by Thomas Raynald with the altered title, *The Birth of Mankynd*, it is mainly compiled from Moschion, and the Soranus and Philumenos fragments of Oribasius and Aëtius, and is intended as a guide to pregnant women and their attendant nurses. It was illustrated with fanciful figures of the fœtus *in utero* that were reproduced in other works of later date—as in the *Rosengarten* of Walter Reiff of Strasburg in 1546 and the *Hebammenbuch* of Jacob Rueff of Zurich in 1554, the latter of which appears in English dress as *The Expert Midwife.* The greatest impulse to the progress of midwifery was given in the middle of the 16th century by the famous French surgeon Ambroise Paré, who revived the operation of podalic version, and showed how by means of it surgeons could often rescue the infant even in cases of head presentation, instead of breaking it up and extracting it piecemeal. He was ably seconded by his pupil Guillemeau, who translated his work into Latin, and at a later period himself wrote a treatise on midwifery, an English translation of which was published in 1612 with the title *Child-Birth; or, The Happy Deliverie of Women.* The close of the 16th century is rendered further memorable in the annals of midwifery by the publication of a series of works specially devoted to it. Three sets of compilations, containing extracts from the various writers on obstetrics and gynecology from the time of Hippocrates onwards, were published under the designation of *Gynæcia* or *Gynæciorum*—the first edited by Caspar Wolff of Zurich in 1566, the second by Caspar Bauhin of Basle in 1586, and the third by Israel Spach of Strasburg in 1597. Spach includes in his collection not only Paré's obstetrical chapters, but the Latin translation of the important *Traitte nouveaux de l'hysterotomotokie*, published by the French surgeon Francis Rousset in 1581, which is the first distinct treatise on an obstetric operation, and advocates the performance of Cæsarean section on living women with difficult labours. From this time onwards evidence accumulates of the growing interest of members of the medical profession, and more especially of surgeons, in the practice of midwifery, and after the middle of the 17th century they began to publish the records of their experiences in special treatises. The most important of these writers were French—as Mauriceau, Viardel, Paul Portal, Peu, and Dionis. The work of Mauriceau, which first appeared in 1668, is specially interesting from its having been translated into English in 1672 by Hugh Chamberlen, who in his preface made the then incredible statement that his father, his brothers, and himself had long attained to and practised a way to deliver women in difficult labours without hooks, where other artists used them, and without prejudice to mother or child. Many years had still to elapse before the secret of the Chamberlens leaked out. In the course of this century some women who had large experience in midwifery appeared as authors. Thus in England Jane Sharp in 1671 wrote *The Midwives' Book, or the whole art of Midwifery discovered*; in Germany, Justine Siegemund, in 1690, *Die Chur-Brandenburgische Hoff-Wehemutter*; and earlier and better than either, in France, Louise Bourgeois in 1626 published *Observations sur la Sterilité et Maladies des Femmes.* Perhaps they were beginning to feel that there was some need to assert their power, for it was during this century that parturient ladies began to call in men to attend them in natural labours. According to Astruc, Madame de la Vallière wished her confinement to be kept secret, and Louis XIV., in June 1663, sent for Jules Clement, the court surgeon, to superintend the delivery. This was accomplished successfully. The king gave him the title of accoucheur. Clement afterwards attended the dauphiness and other court ladies, and went thrice to Madrid to assist at the confinement of the queen of Philip IV. Up till this epoch physicians and surgeons had only been summoned to the lying-in room by midwives who found themselves at the end of their resources, to give help in difficult cases where the child was usually dead and the mother often moribund. Now that it began to be a fashion for women in their ordinary confinements to be under the surveillance of a physician, it became possible for men with their scientific training to study the normal phenomena of natural labour, and through the medium of the printing-press to communicate the results of their observation and experience to their professional brethren. Hence the books of the men already referred to, and of others that appeared later, such as the *Traité Complet des Accouchemens* of De la Motte, 1721, which is a storehouse of acute observations and wise discussion of obstetric measures. In other countries than France physicians and surgeons began to take up midwifery as a speciality and not as a subsidiary part of their practice, of which they were somewhat ashamed (Le Bon, one of the writers whose work is found in Bauhin's *Gynæcia*, says, "Hæc ars viros dedecet"), and it was in Holland that a work was produced that has earned for its author the designation of the Father of Modern Midwifery. Heinrich van Deventer, who practised as an obstetrician at The Hague along with his wife (a Vrœdvrow, as he was a Vrœdmeester), published in 1696 a preliminary treatise called *Dageraat* (*Aurora*) *der Vrœdvrowen*, and in 1701 he followed it up by a more complete second volume, of which the Latin edition that came out simultaneously with the Dutch has a title beginning *Operationes Chirurgicæ Novum Lumen Exhibentes Obstetricantibus*. It has the supreme value of being the first work to give a scientific description of the pelvis, and to take some steps towards the development of the mechanism of labour. The "obstetricantes" for whom Deventer wrote are both men and women. In the early part of the 18th century women had still the main and often the sole charge of their parturient sisters; but the practice of having a doctor to superintend or to supersede the midwives kept spreading among the classes who could afford to pay the doctor's fee; and by the time Deventer's treatise was doing its educational work in an English translation, as *The Art of Midwifery Improved*, in 1716, the doctors were getting into their hands the "harmless forceps" with which a living child could be extracted without detriment to the mother, in conditions where formerly her child's life was sacrificed and her own endangered. This life-saving instrument was invented in London, but by a man not of English birth. The Huguenot, William Chamberlen, fled from Paris to escape the St Bartholomew massacres, carrying with him to Southampton his wife, his two sons, and a daughter. William Chamberlen seems to have been a surgeon, and his descendants through four generations had large and lucrative practices in London. The eldest son Peter, who was old enough when he came to England to be able to attest the birth and baptism of a younger brother, is, on good grounds, credited with being the inventor of the forceps, which for a century was kept a secret among brothers, sons, and grandsons. Hugh, indeed, a great-grandson of William, and the translator of Mauriceau, had offered to sell the family secret for 10,000 crowns; but his failure to effect delivery in a test case that Mauriceau put to him led the profession to believe that he was a boastful quack. Palfyn of Ghent, when in Paris in 1723, putting a work on anatomy through the press, laid before the Academy of Science a pair of forceps, which was figured in Heister's surgery in 1724. He has thus the honour of first laying before the profession a midwifery forceps. But his implement was ill-constructed, and never came into general use. Meanwhile the knowledge that the Chamberlens were really possessed of a serviceable instrument must have stimulated other practitioners. Perhaps a colleague with a keen eye may have got sight of it on some occasion, or an intelligent midwife had been able to describe the "tongs" which she had seen one of the family apply. In 1734 Dr Edward Hody published a record of *Cases in Midwifery* that had been written by Mr William Giffard, "surgeon and man-midwife." The dates range from January 1724 to 1731. Amongst the cases are several where he effected the delivery by means of the forceps—"extractor," he calls it—of which a figure is given; and when Edmund Chapman, who practised first at Halstead and afterwards in London, published his *Treatise on the Improvement of Midwifery* in 1733, he speaks of the use of the forceps as "now well known to all the principal men of the profession both in town and country."

In the course of the 18th century the development of midwifery in the hands of medical men made greater strides than in all the preceding ages. The progress was accelerated by the establishment of chairs of midwifery in the universities of various countries, Edinburgh taking the lead in the appointment of a professor in 1726, and Strasburg coming closely after in 1728. In Strasburg the chair had the advantage of being at once associated with a clinical service. Lecturing was carried out, moreover, by men who were devoting themselves as specialists in midwifery and the diseases of women and infants, and were succeeding in developing lying-in institutions for the benefit of poor women in labour that became schools of instruction both for midwifery nurses and for medical students. Two new operations came during this epoch to enhance the powers of the obstetrician, viz., symphysiotomy, first introduced by Sigault in Paris; and the induction of premature labour, first carried out by Macauley in London in circumstances described by Denman in the preface to his *Midwifery*. William Hunter in London, Sir Fielding Ould in Dublin, Röderer in Göttingen, Camper in Amsterdam, Baudelocque in Paris, Saxtorph in Copenhagen, and many other authors contributed to progress by their atlases and their books. But there are three whose names stand out pre-eminently because of the influence they exerted on the whole obstetric world—Levret, Smellie, and Boër. Kilian, in his vidimus of the history of midwifery, calls Levret "one of the greatest masters in the department that ever lived." Of Smellie he says: "Inferior to Levret in nothing, he excels him in much." Boër he characterizes as "the most meritorious and important of German obstetricians." Levret improved the construction of the forceps, and widened the sphere of their applicability; Smellie worked in the same direction, and furnished, moreover, descriptions and illustrations of natural and morbid labours that are of classical value; and Boër first clearly placed pregnancy (which Mauriceau, *e.g.*, had spoken of as "a nine months' disease") and parturition in the category of physiological processes that might be hindered rather than helped by the pragmatical interferences of meddlesome midwives.

Throughout the 19th century midwifery continued to advance, gynecology grew into a special department with an extensive literature, the mechanism of labour developed under the clinical observations of men like Nägele and the study of such frozen sections of cadavera as were made by Braune, the indications for interference became more clear and the methods of interference more simple and safe, and a whole realm of antenatal pathology and teratology was added to the domain of science, while practitioners learned the art of saving premature and delicate infants by the use of the incubator and proper alimentation. Every advance in all the cognate sciences was appreciated and applied for the advancement of obstetrics. But there are two achievements which will make the 19th century for ever memorable in the annals of midwifery—the abolition of the pains of labour and the arrest laid on mortality from the so-called puerperal fever. In February 1847 Sir J. Y. Simpson, choosing a case where he had to deliver by turning, put the patient asleep with ether. Seeing that the uterine contractions continued, though the attendant pain was abolished, he proceeded to administer ether in cases of natural labour, and in November of the same year demonstrated the virtues of chloroform, and so furnished the most serviceable anæsthetic, not only to the obstetrician in the lying-in room, but to the surgeon on the battlefield and to the general practitioner in his everyday work. Ignaz Philipp Semmelweiss, assistant in the maternity hospital of Vienna, was struck and saddened with the appalling mortality that attended the delivery of the women under his care, as many as one (in some months three) out of every ten of the puerperæ being carried out dead. He observed that the mortality was much higher in the wards allotted to the tuition of students than in those set apart for the training of nurses. In the spring of 1847 he saw at the post-mortem examination of a young colleague who had died of a poisoned wound, that the appearances were the same as he had too often had occasion to see at the post-mortem examinations of his puerperæ. He ordered that every student who assisted a woman in her labour must first wash his hands in a disinfectant solution of chloride of lime, and in 1848 already the mortality was less in the students' than it was in the nurses' wards. Thus the first light was shed on the nature of the mischief of which multitudes of puerperal patients perished, and the first intelligent step was taken to lessen the mortality. When, some twenty years later, Lister had applied the bacteriological principles of Pasteur with beneficent results to surgery, obstetricians gladly followed his lead, and the 19th century beheld added to the comfort of anæsthetic midwifery the confidence of midwifery antiseptic and even aseptic.

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Ocaña, a town of Spain, in the province of Toledo, on the extreme north of the plateau of Ocaña, near and to the south-east of Aranjuez, with a station on the line from that place to Cuenca. This plateau produces wine, wheat, oil, fruit, mostly sent to Madrid, and in Ocaña there are manufactures of pottery, alcohol, soap, and leather. The town is surrounded by walls in ruinous condition, and there are the remains of an old castle. It has broad regular streets, several squares with arcades, a fine town hall, schools, hospitals, convents, three parish churches, in one of which is the chapel of Our Lady de los Remedios, in which Ferdinand and Isabella were married. Near the town are the ruins of the convent of La Esperanza, which this queen built. Ocaña is the Vicus Cuminarius of the Romans, and was the dower that Abden Aled of Seville gave his daughter Zaida on her marriage with Alfonso VI. In Ocaña several Cortes of the Middle Ages assembled. Near this town, on 19th November 1809, a battle was fought between the Spanish army under Lacy and the French invaders commanded by Joseph Bonaparte and Marshal Soult, who routed the Castilian forces. Population, about 6000.

Occleve (or Hoccleve), **Thomas** (1368?–1450?), ranks, like his more voluminous and better known contemporary Lydgate, among those poets who have a historical rather than intrinsic importance in English literature. Their work rarely if ever rises above mediocrity; in neither is there even any clear evidence of a poetic temperament. They are eclipsed, not only by every poet of the Scottish school, but by more than one of their nameless English successors. Yet they represented for the 15th century the literature of their time, and kept alive, however faintly, the torch handed on to them by their "maister," Chaucer. What is known of Occleve's life has to be gathered mainly from his works. At eighteen or nineteen he obtained a clerkship in the Privy Seal Office, which he retained on and off, in spite of much grumbling, for about thirty-five years. He had hoped for a benefice, but none came; and in 1399 he received instead a small annuity, which was not always paid as regularly as he would have wished. *The Letter to Cupid*, his first poem to which we can affix a date, was translated from the French in 1402, evidently as a sort of antidote to the moral of *Troilus and Cressida*, to some MSS. of which we find it attached. *La Male Regle*, one of his most readable poems, written about 1406, gives some interesting glimpses of his "misruly" youth. His contrition for the past, which has brought him, as he bewails, to poverty of body and purse, seems to have been lasting; and about 1410 he settled down to married life, and to the composition of moral and religious poems, which are interspersed with continual complaints of poverty. His longest work, *De Regimine Principum*, written for Prince Hal shortly before his accession, is a tedious homily on the virtues and vices, with appropriate instances from the usual mediæval sources; but it is relieved by a Proem, about a third of the whole, containing some further reminiscences of London tavern and club life, in the form of a dialogue between the poet and a beggar. On the accession of Henry V. Occleve turned his muse to the service of orthodoxy and the Church, and one of his poems is a remonstrance addressed to Oldcastle, calling upon him to "rise out of the slough of heresy." Then a long illness was followed for a time, as he tells us, by insanity. His *Dialog with a Friend*, written after his recovery, gives a naïve and pathetic picture of the poor poet, now fifty-three, with sight and mind impaired, but with hopes still left of writing a tale he owes his good patron, Humphrey of Gloucester, and of translating a small Latin treatise, "Scite Mori," before he dies. His hopes were fulfilled in his moralized tales of *Jereslaus' Wife* and of *Jonathas*, which with his *Learn to die* belong to his old age. After finally retiring from his Privy Seal clerkship, he was granted in 1424 sustenance for life in the priory of Southwick, Hants, on which, with his former annuity, he appears to have lived on till about the middle of the century. Besides his *De Regimine*, of which there are a number of MSS., his works are comprised in four MS. volumes, of which three have been edited by Dr Furnivall, and the fourth (Ashburnham MS.) is promised by Mr Gollancz, for the Early English Text Society.

The main interest for us in Occleve's poems is that they are characteristic of his time. His Hymns to the Virgin, Balades to patrons, Complaints to the King and the King's Treasurer, versified homilies and moral tales, with warnings to heretics like Oldcastle, are illustrative of the blight that had fallen upon poetry on the death of Chaucer. The nearest approach to the realistic touch of his master is to be found in Occleve's *Male Regle.* But these pictures of 15th-century London are clouded over by the pale cast of contrition, and are without even the occasional flash of humour that lightens up Lydgate's *London Lackpenny.* Yet Occleve has at least the negative virtue of knowing the limits of his powers. Of a modest and even timid nature, he never attempts a flight too high for him. His unassuming downrightness and sincerity of style is in some respects a relief from the colours of rhetoric and trite verbiage with which Lydgate too often wearies his readers. He says simply what he means, and does not affect what he does not feel. A Londoner, to whom the country was evidently a bore, he has not afflicted us with artificial May mornings; and it is doubtful whether a single reference to nature can be found among his poems. He has yet another distinction among his contemporaries: he wrote no allegory. Whether we ascribe it to his lack of "engine," or to the influence of Chaucer when in his later years he had discovered the limitations of this poetic form, we cannot but be grateful to the poet who has spared us. As a metrist Occleve is also modest of his powers. He confesses that

> Fader Chaucer fayn wolde han me taught,
> But I was dul and learned lite or naught;

and it is true that the scansion of his verses seems occasionally to require, in French fashion, an accent on an unstressed syllable. Yet his seven-line (or *rime royale*) and eight-line stanzas, to which he limited himself, are perhaps more frequently reminiscent of Chaucer's rhythm than are those of Lydgate. As for the heroic couplet of *The Legende of Good Women* and *The Canterbury Tales*, it may be questioned whether Chaucer ever succeeded in imparting the secret of its rhythm to any, whether poet or scribe. Lydgate alone had the temerity to attempt it in the doggerel "riding-rime" of the *Troy Book* and the *Story of Thebes.* Then it disappears from our literature, to be rediscovered from the Italian in the next century. (W. S. M.)

Oceanography.—The department of geography which deals with the phenomena of the collected waters of the globe is termed by the Italians *talassografia*, and attempts have been made but without success to introduce the name "Thalassography" in other languages. The term "Hydrography" has been introduced in Sweden; but this is a misleading expression, as at least two different subjects are already designated by that word. In general use Oceanography is the term applied to the study of the oceans and seas, the cognate science of lakes being termed Limnology, and that of rivers Potamology.

The form of the ocean basins, like that of the land, is the concern of physical geography (see GEOGRAPHY).

Seas. Practically, however, the form of the sea-bed is so intimately associated with all the phenomena of the water resting on it that both have to be considered together. The primary division of the hydrosphere into oceans and seas is arbitrary, but in each case some parts of the boundary are natural limits. A sea is a detached or partially detached portion of the hydrosphere of considerable size. Elaborate classifications of seas have been proposed, according to their relations to the open oceans and to the land; but the simplest, that of Sir John Murray, suffices for most purposes. A sea may be (1) entirely surrounded by land (*inland*), like the Caspian; (2) enclosed by land, except for a single entrance (*enclosed*), like the Mediterranean; (3) partly enclosed by land, but with two or more openings (*partially enclosed*), like the North Sea or Caribbean Sea; to which we may add (4) divided from the general mass of the ocean only beneath the surface (*barred off*) like the Norwegian Sea. In a few instances the name sea is given to a part of the ocean distinguished from the rest by physical peculiarities, but not bounded in any part by land, such as the Sargasso Sea.

The largest divisions of the hydrosphere are termed oceans, but it is just as difficult to distinguish an ocean

Oceans. from a sea as it is to distinguish a continent from an island. From the time of the first circumnavigators three great oceans running from north to south have been recognized—the Atlantic, between Europe-Africa and America; the Indian, between Africa and Malaysia-Australia; and the Pacific or South Sea, between Asia-Malaysia-Australia and America. The extent and limits of the oceans to north and south were variously given by different writers, and much confusion resulted. The question of nomenclature was considered by the Royal Geographical Society in 1845, when a committee drew up provisional rules which were never formally adopted, but nevertheless came into current use.[1] They recognized an Arctic and Antarctic Ocean lying wholly within the respective polar circles, and the water area between the north and the south polar circles was divided into the Atlantic, Pacific, and Indian Oceans by the continental coasts and arbitrary meridians. The advance in physical knowledge of the oceans has shown it to be desirable to recognize the great ring of unobstructed water girdling the southern hemisphere, south of the continents, as a natural unit, and it has accordingly become common, if not yet usual, to place the limits of the Atlantic, Indian, and Pacific Oceans at 40° S., and to call all the water south of that parallel the Southern Ocean. The Southern Ocean may be considered to stretch to the edge of the Antarctic ice, or, if preferred, the southern portion, within the Antarctic circle, may retain its old name. From several points of view it is advisable to call the Arctic Ocean a sea, and to view it as an extension of the Atlantic basin. The chief physical differences between oceans and seas are due to the freedom of the former from the influence of land, which dominates the character and the circulation of the water in the latter.

Historically, it may be noticed that the early Greek antithesis between the Mediterranean Sea surrounded by the habitable land, and the Ocean River surrounding the known world, gave place gradually to the idea of an Ocean Sea, in which the various continents formed islands or parts of islands, and the term Ocean Sea only went out of use when the three great divisions of Atlantic, Indian, and Pacific Oceans were recognized. The distribution of depth in the ocean was very vaguely known so long as the question was merely one of scientific curiosity, although ingenious apparatus for ascertaining the depth had been devised by Robert Hooke and Stephen Hales in the 17th century, and the use of the lead in shallow water early became habitual with sailors. When the question of laying submarine telegraph cables gave practical importance to a knowledge of the form and temperature of the sea-bed about 1855, the methods of deep-sea sounding and temperature-taking were rapidly improved, and scientific oceanography may be said to date from that period.

History of oceanography. The development of oceanography up to 1870 may be summarized in a few lines. The speculations of the Greeks and the crude observations of the European navigators of the 15th and 16th centuries led to no definite knowledge beyond the existence of the trade winds and a few facts as to currents and tides. Athanasius Kircher in 1664 made the first generalization as to the circulation of the waters of the ocean, illustrated by a map of the surface currents; but so little was then known of the depth or configuration of the ocean-bed that he freely introduced subterranean channels to account for local currents, and even suggested a great tunnel through the axis of the Earth as a sort of mainspring to actuate the perpetual motion of the surface water. H. B. de Saussure in 1780 made the first fully satisfactory observations of temperature at a great depth by means of slow-change thermometers, and he drew up a fairly comprehensive scheme of oceanic research.[2] Major Rennell (1742–1830) placed the slowly increasing knowledge of ocean currents on a scientific basis, and the numerous Arctic voyagers of the early part of the 19th century made isolated and sometimes important observations. Sir John Ross in 1818, by means of his "deep-sea clamms," was the first to obtain large samples of mud from great depths, and to prove the existence of organic life on the floor of the ocean.

The adaptation of Sixe's self-registering thermometer, for use in deep water by the device of surrounding the bulb by an outer glass sheath partly filled with mercury or alcohol, was first tested in 1857 on board H.M.S. *Cyclops*. This marked an era in oceanographical research. It was, however, the American naval officer M. F. Maury who did most to direct attention to the science of the sea, and his fascinating *Physical Geography of the Sea*, first published in 1856, continues to be one of the most inspiring scientific works, although the theories of oceanic and atmospheric circulation it puts forth have proved untenable. Maury organized oceanic research under the auspices of the United States Hydrographic Office, and this led to the marine services of other countries taking up similar work, which has been carried out with remarkable success by the British Meteorological Office and the German Marine Observatory.

In 1839 the British Association appointed a committee under the direction of Professor Edward Forbes charged with the investigation of the marine fauna of the British seas. The activity of this committee extended over many

[1] See *Geographical Journal*, i. (1893), p. 535.

[2] *Voyages dans les Alpes*, tome iv., Neuchâtel, 1796.

years, and aroused much interest in the bathymetrical distribution of life. Dr W. B. Carpenter took up the study of the physical conditions and the life of the oceans with great enthusiasm, and as a result of his efforts small expeditions were sent out by the British Government on the *Porcupine*, *Lightning*, and *Shearwater*, to different parts of the North Atlantic between 1868 and 1870.

In 1872 the British Government were induced by the Royal Society to send out H.M.S. *Challenger* for a three years' cruise expressly for the purpose of investigating the physical conditions of the ocean and the distribution of marine life. This was an epoch in oceanography, resulting in a vast increase of knowledge and in the progressive improvement of apparatus and methods of research. Since the return of the *Challenger* in 1876 the most important advances of oceanography, in addition to those resulting from the cruises of surveying and telegraph ships, have been due to the Norwegian North Atlantic expedition in the *Vöringen*, 1876–78, the French *Talisman* and *Travailleur* expeditions in the Bay of Biscay, 1880–83, the foundation of the Scottish Marine Station by Sir John Murray in 1884, the Russian voyage of the *Vityaz* in the Pacific in 1886–89, the explorations of the Austro-Hungarian ship *Pola* in the Mediterranean and Red Sea, 1890–98, the voyages of the Prince of Monaco in the North Atlantic since 1885, the researches of Professors Ekman and Pettersson on the Baltic since 1885, drift of the *Fram* in 1893–96, the Danish *Ingolf* expedition in 1896, the cruises of the United States Fish Commission steamers *Blake* and *Albatross* in the Atlantic, Caribbean Sea, and Pacific, 1877–1901, the voyage of the German ship *Valdivia* through the Atlantic, Southern, and Indian Oceans in 1898–99, and that of the Dutch *Siboga* in the Malay Archipelago in 1900.[1]

Methods and Apparatus.—The study of the ocean floor and of the intermediate depths of water has to be carried on under the disadvantage of inaccessibility; all information must be obtained by means of instruments attached to a single line of rope or wire, and sunk far out of sight. Attempts to employ bathometers for measuring depths without the use of a sounding line have been made for over 400 years, but they have hitherto failed in practice, and no efforts to employ two separate lines to work apparatus at a great depth have ever succeeded. The number of ingenious contrivances, and even of successful instruments, for oceanographical work is so great that it is impossible to give details of any special forms in this article; all that can be attempted is to indicate the principles on which the most satisfactory forms are constructed.

Deep-sea sounding.

The simplest operation is that of ascertaining the depths of the water at a given point. For shallow water, down to 100 fathoms, the familiar hand-lead (weighing 7 lb) or the deep-sea lead (weighing 14 lb) and hemp line may be employed without inaccuracy. In very deep water the amount of line which has to be used is sufficient to float the lead unless the latter is made very heavy, and if very heavy the line is apt to break on attempting to heave it in. Many experiments were made by Maury to overcome this difficulty, but some of them gave very wild results, and depths of 10 miles and over were reported in different parts of the ocean. Midshipman Brooke of the U.S. navy invented the principle, already foreshadowed by Cusanus in the 15th century and by Hooke in the 17th, of using a heavy weight so hung on the sounding tube that it was automatically released on striking the bottom and left behind, while the light brass tube containing a sample of the deposit was easily hauled up. This principle has been universally adopted for deep soundings, and is now applied in many forms. An essential feature is the tube for bringing up a specimen of the bottom, as without such proof of its completion no sounding can be accepted. The weights used as a sinker are usually cast-iron segments, which may be built round the sounding rod, and for great depths they weigh 100 lb or more. The next great advance consisted in the substitution of steel wire for hemp rope, thus practically eliminating friction and permitting a great length of line to be stowed in a small space. The disadvantage of wire is that the line is apt to snap when a kink forms, and hence there is a considerably increased risk of loss of instruments. A stranded wire or wire-rope in which a number of very fine wires are twisted together as in a hawser is free from this objection, and can be made very little bulkier than the single steel wire. Various bronzes have been used instead of steel, but while they have the advantage of greater toughness and flexibility, they are very costly. The depth may be measured either by a registering block, *i.e.*, a pulley fitted with a train of index wheels on the principle of a gas-meter, or by a revolution-counter on the drum on which the wire is wound. The indicator shows the depth and the rate at which the line runs out, a sudden increase in the time intervals being the usual sign that the bottom has been reached. The Lucas and other recent sounding machines automatically stop the running out of the wire as soon as the bottom is reached. The wire is usually hauled in by a steam engine, but the experience of the *Valdivia* expedition showed the great advantage of using an electro-motor, especially in polar seas where steam-pipes are apt to be frozen. The instruments usually attached to the sounding line are water-bottles for collecting samples of water, and thermometers for ascertaining its temperature.

Water-bottles ought to be constructed in such a way that they may be filled with water at any given depth and securely closed as soon as filled, so that no interchange can take place between the water inside and outside. They are usually made of brass, and are technically divided into valve, stop-cock, and slip water-bottles.[2] The first class depends on the principle of two valves opening upwards, which remain open while the bottle descends and allow a continuous current of water to pass through the instrument, but when one begins to pull up the water-bottle the valves are closed by the pressure of the water outside, and the sample then inside is brought up. The only form now in use is Sigsbee's "Water-cup," in which the valves are locked after the first few fathoms of ascent by the action of a small screw propeller which rotates freely during the descent. In Wille's water-bottle the receiver is a spiral tube open at both ends during descent, and locked on the ascent by a propeller at each end. The stop-cock water-bottle as used on board the *Challenger* has the form of a long brass tube closed by a very large stop-cock at each end. This was sent down open, and water passed freely through, but when one commenced to pull it up the resistance of the external water acting on a hinged pressure-plate actuated a lever working on both stop-cocks and closed them simultaneously, shutting in the water which it then contained. A modification of this instrument has been introduced by its inventor, Mr J. Y. Buchanan, by which the stop-cocks may be closed by a weight slid down the line, and thus secured more definitely at any particular depth. The drawback to all these forms is that they collect a mixture of the water from a considerable range of depth, and are thus quite unsuited for use where layers of different salinity are superimposed, or in shallow water. Slip water-bottles are more satisfactory in this and in other ways. The best forms consist of a metal cylinder open at both ends and of uniform diameter throughout, hung so that the water can pass freely through, and capable of being detached at any given depth so as to fall against a fixed base and be closed by a top plate, all three parts becoming automatically united. On the *Challenger* the cylinders of the slip water-bottles were very heavy, with finely ground surfaces, which rested upon correspondingly ground fixed portions of cones. In more recent forms, such as Mill's for shallow water and Pettersson's for deep water, the cylinder is locked against indiarubber discs covering the fixed metal plates. The mechanism for releasing the cylinder is usually actuated by a weight slipped along the line which depresses a lever or spring by its impact; or else by a small screw propeller which revolves freely during the descent, but on being drawn upwards engages with a bolt, and in a certain number of turns, corresponding to a definite vertical distance, sets free the cylinder. The use of a propeller can be justified in deep water alone, and there only in default of more serviceable gear. The grand difficulty in the use of all apparatus which must act at a great distance from the observer and out of his sight is to know whether the action has or has not taken place at the proper position. In shallow water the closing of the water-bottle can be distinctly felt on the line, and it would be very desirable if some method could be found for detecting the impact through a wire at the greatest depth.

Deep-sea thermometers.

The most important physical observation in the deep sea is that of temperature, the problem here being to devise a thermometer which shall bring to the surface a record of the actual temperature at a given depth. One of the most satisfactory, though by far the slowest, of the methods is the use of a slow-action thermometer, *i.e.*, an ordinary thermometer, the bulb of which is embedded in a relatively large mass of badly-conducting material—wax, as originally used by de Saussure in the Mediterranean in 1780; gutta-percha and ebonite, as employed by the German observers on the North Sea and Baltic a century later. This thermometer, to be really satisfactory in its working, should be left immersed at the depth from which a

[1] For a historical summary of oceanography see Sir John Murray, "Summary of Scientific Results," First Part, in the "*Challenger*" *Reports*, London, 1895.

[2] For early forms see H. R. Mill, "On Water-bottles," *Proc. Roy. Soc. Edinburgh*, xiii. (1885), p. 539.

reading is desired for several hours, and its bulb will retain that temperature long enough to allow it to be hauled up and read in the air. An elegant and quick-working adaptation of this principle is found in the Pettersson-Nansen insulating water-bottle as worked out in 1900. This is a slip water-bottle, the cylinder of which is made up of a number of concentric metal tubes, so that when the instrument closes it shuts in a series of entirely separated concentric layers of water, each of which must have its temperature changed in turn before any effect can be produced on the water in the central tube, in the middle of which the bulb of a sensitive thermometer is placed, the stem projecting through the lid. Experiment has shown that in cool climates the central core of water does not change one-hundredth of a degree for many minutes after the water-bottle has been exposed to the temperature of the air, and in the opinion of Professor Nansen this is by far the most accurate method of obtaining deep-sea temperature.[1]

The method hitherto most frequently used is to employ a registering maximum and minimum thermometer on the Miller-Casella modification of Sixe's pattern. When made of a large size with an arbitrary scale of millimetres engraved on the glass, as suggested by Mr J. Y. Buchanan, this thermometer may give the extreme temperatures during the period of its immersion with considerable accuracy. The bulb has to be protected from pressure by an outer bulb partially filled with liquid, and the steel indexes (which are set by means of a magnet) have to be provided with springs which will enable them to hold their position in spite of the tremor of the line in heaving in. The drawback to all maximum and minimum thermometers is that the temperature at a given depth can only be deduced from a series of other temperatures, and in some possible distributions of warmth cannot be ascertained at all.

Outflow thermometers of an elaborate form were used by Aimé as long ago as 1840, but Negretti and Zambra's deep-sea thermometer, which was perfected after the return of the *Challenger*, was the first to give satisfactory results with simple working. Its essential feature is that after the thermometer has attained the temperature of its surroundings it is turned over (see THERMOMETER), the column of mercury outside the bulb breaks off at a little constriction of the tube, and runs down into the inverted upper end, which is graduated so as to be read in that position. The inversion is secured either by means of a screw propeller, as in Magnaghi's frame, or preferably, when the depth permits, by means of a lever worked by a weight slipped down the line, as in the frames devised by Rung, Mill, the Prince of Monaco, and others. The worst drawback to the Negretti and Zambra thermometer is that in deep water the vibration of the wire line in heaving in is apt to shake little jets of mercury out of the overflow reservoir outside the bulb into the tube, and so to make the readings too high. This difficulty has been overcome by Herr Martin Knudsen, who employed on the *Ingolf* expedition a thermometer the bulb of which lies parallel with the stem, and when the instrument is inverted, rests with its orifice upwards instead of downwards; hence it is impossible for any amount of shaking to pass mercury from the bulb to the tube after inversion. The importance of protecting the whole thermometer from pressure, and not merely the bulb, is now recognized, and the Negretti and Zambra and Knudsen thermometers are entirely enclosed in a strong sealed glass tube. The pressure below the surface may be roughly estimated as one ton per square inch for every 1000 fathoms of depth.

Electrical methods of registering deep-sea temperature have frequently been tried and abandoned, but the platinum resistance thermometers of Professor Callender appear likely to lead to good results at sea, as they have been found practicable in the deep lakes of America. Resistance thermometers were experimented with by Knudsen in 1900 in conjunction with an electrical apparatus for finding the salinity by the resistance of the water *in situ*, the balancing of the resistances being effected by the use of a telephone instead of a galvanometer.[2] The resulting curves, both for temperature and salinity in shallow water, appear to show that the method is of value.

In discussing thermal (as distinct from temperature) changes in water, Mr Buchanan has pointed out the convenience of reckoning by the fathom-degree or metre-degree, both units being practically the same, if the Fahrenheit scale is used with the fathom and the centigrade scale with the metre, since a fathom exceeds a metre in the same ratio as a centigrade degree exceeds a Fahrenheit degree.

The physical or chemical examination of sea-water can only be completely carried out in a laboratory on shore when results of the highest precision or complete analyses are required; but much work may be done on board ship. The density of sea-water is usually expressed as specific gravity, or the ratio to the density of pure water, which is taken as unity. The temperature of both is taken as 0° C. in pyknometer observations, on account of the convenience of making direct measurements at that temperature. But in hydrometer work it is more convenient to take as the standard some temperature near the ordinary temperature of the air, either 60° Fahr. (15·6° C.) or 17·5° C. being usually chosen. The comparison may be made either with pure water at the same temperature, or at its temperature of maximum density, *i.e.*, 4° C. It is necessary, therefore, to state the exact meaning of specific gravity in every case. This is usually expressed in the form $S\frac{t}{T}$, where t is the standard temperature of the sea-water sample, and T that of the pure water with which it is compared. The *Challenger* specific gravities are published in the form $S\frac{15{\cdot}6^\circ\,C.}{4^\circ\,C.}$, and those of most of the later Continental expeditions as $S\frac{17{\cdot}5^\circ\,C.}{17{\cdot}5^\circ\,C.}$ Any of these forms can be converted into the others by calculation. The salinity can always be expressed without ambiguity by the amount of chlorine or of total salts, the latter being preferable, and the most convenient form of expression being in parts per mille. It is very desirable that this datum should be given in all statements of results, by whatever method they are obtained. The chemical study of sea-water at sea is practically confined to the volumetric estimation of chlorine and of alkalinity and the collection of dissolved gases, the analysis of the gases and determination of the sulphates or other constituents in the water sample being made in a laboratory on shore. The direct determination of total salts is rendered troublesome by the decomposition of the magnesium salts on evaporation, and the variations in the composition of the salts are usually so slight that extraordinary precautions must be taken in order to detect the differences. The salts of sea-water taken from enclosed seas or near the mouths of rivers do, however, show some variability in composition. The object of determining the alkalinity is that it gives a measure of the carbonic acid in actual combination with a base as normal carbonate, the alkaline reaction of sea-water being due to the carbonates it contains. When kept in glass bottles sea-water is apt to change in alkalinity on account of chemical action on the glass. The extraction of gases from sea-water on board ship, and the sealing of the samples in tubes, is a troublesome and somewhat delicate operation. If a sample of sea-water is preserved in a stoppered bottle its gaseous contents are sure to undergo change in consequence of changes of temperature, while even if the sample be sealed up in a clean glass tube the dissolved gases are altered in nature and amount by the decomposition of the minute plant and animal organisms which the water contained. By Pettersson's method two specimens of each sample of sea-water, brought up by his insulating water-bottle without change of temperature, are taken in glass tubes which have been previously coated internally with mercuric chloride (corrosive sublimate), exhausted of air, and sealed. The tip of the tube is broken off in the water-bottle, and when filled the tube is again sealed up; the corrosive sublimate kills all the organisms and prevents their decomposition, and the sample keeps unchanged. One tube is used for determining the absorbed oxygen and nitrogen, the other for the carbon dioxide. The substantial uniformity of the composition of the salts of ocean-water makes it possible to determine the salinity (*i.e.*, the proportion of total salts to the mass of water) quite accurately by determining any one of the chemical constituents. That selected is always the total halogen estimated as chlorine.

Physical and chemical study of sea-water.

The relations of salinity to density at constant temperature and of density to temperature at constant salinity have been worked out with great accuracy by Professors Thorpe and Rücker, Professor Dittmar, Herr Martin Knudsen, and others. The problem of finding both density and salinity may thus be solved by measuring directly either the density or the total halogen. If p stands for the salinity expressed in parts per thousand by weight (*i.e.*, 1 gram of total salts in 1 kilogram of sea-water), $S\frac{t}{T}$ for specific gravity at temperature t° compared with pure water at temperature T°, and χ the chlorine (total halogen) in grams per kilogram of sea-water, the relation between chlorine and salinity is usually given as—

Relation of density, salinity, and chlorine.

$$p = 1{\cdot}83\,\chi - 0{\cdot}0012\,\chi^2,$$

but Knudsen finds the simpler formula $p = 0{\cdot}03 + 1{\cdot}81\,\chi$ to give excellent results. The relation between salinity and specific gravity is—

$$\sigma\left(S\frac{t}{T} - 1\right)$$

where σ is the salinity constant. In the case of $S\frac{17{\cdot}5^\circ\,C.}{17{\cdot}5^\circ\,C.}$, $\sigma = 1300$; but for $S\frac{15{\cdot}6^\circ\,C.}{4^\circ\,C.}$ the value of σ varies with the value of S, being 1410 for $S\frac{15{\cdot}6^\circ}{4^\circ} = 1{\cdot}010$ and 1340 for $S\frac{15{\cdot}6^\circ}{4^\circ} = 1{\cdot}028$.

[1] *Geographical Journal*, xvi. 1900, p. 469.

[2] *Beretning fra Kommissionen for videnskabelig Undersogelse af Danske Farvande*, vol. ii. part 3. Copenhagen, 1900.

The determination of chlorine is simple, accurate, and direct, and can easily be carried out by titration on board ship, the standard solutions being previously prepared on shore. The measurement of density or specific gravity demands more attention. The only method admitting of the highest accuracy is weighing on a delicate balance a measured portion of distilled water at a constant temperature (usually 0° C.) in a glass tube known as a pyknometer, and again weighing the same tube filled to the same point with the sample of sea-water at the same standard temperature. This is an operation requiring skill and care, and as it must be conducted in a laboratory on shore, the samples require to be secured in such a manner as to prevent any change occurring in the salinity.

The use of hydrometers or areometers is much more simple, and they are as sensitive as the pyknometer, though not so trustworthy. They have the immense advantage of not requiring a rigid table, and thus being capable of employment at sea in moderate weather. The usual form of instrument consists of a cylindrical glass body of considerable size, terminating above in a narrow glass stem, immersed in a sample which comes within the range of salinity for which the instrument is adapted. The scale is usually graduated so as to enable specific gravity to be read directly, the temperature of the water being ascertained at the same time, and the reading reduced to a standard temperature by reference to a table of corrections. Mr J. Y. Buchanan introduced an extremely sensitive and accurate form on the voyage of the *Challenger*, and has since greatly improved it.[1] The stem contains a scale divided into millimetres, and the specific gravity is obtained by the use of tables. The instrument is absolute, inasmuch as its weight is determined beforehand, and several accurately weighed coils of wire are provided which can be used to increase the weight of the whole instrument by small increments in such a way that a series of half a dozen readings may be made at different parts of the scale in a few minutes. The volume of the body of the hydrometer and of each millimetre of the stem may be previously ascertained by experiment in distilled water, and its expansion with temperature determined in the same way. Thus each reading gives the volume of the instrument immersed, and the total weight of that volume of the water under examination. The temperature correction can be much simplified by using the hydrometer in distilled water at the temperature of the air before placing it in the sample of sea-water at the same temperature, and thus comparing directly the weight of equal volumes of sea-water and pure water. By this process the chief difficulty in the use of the hydrometer—the effect of surface tension—is eliminated if the surface of the sea-water and pure water be equally clean. Many oceanographers, however, using direct-reading hydrometers, have found the uncertainty due to the variations of surface-tension so serious as greatly to detract from the value of the instrument.

Hydrometers.

The total-immersion hydrometer is sometimes used to evade surface tension: it is a cylinder with a very short stem, which is loaded by the addition of coils of wire until it just sinks in the water, the final adjustment being made either by titration with sea-water and distilled water, as in Pisati's method of 1890, or more elegantly, as in Nansen's method of 1900, by varying the temperature of the water in the jar by a fraction of a degree, so as to fix the exact temperature at which the immersed hydrometer and the water have the same density.[2] Experiments have been made with the refractometer to measure the specific gravity of sea-water by the refractive index, which is a function of the density. The method has the advantages of being independent of the motion of the ship, and requiring only a minute quantity of water as a sample. Electrical resistance has also been utilized; in Tornøe's method, as tested on the *Fram*, the resistance of a small sample was observed, and the instrument calibrated by experiment on standard solutions; in Knudsen's method the variations in resistance due to salinity are measured *in situ*, and, if this is found practicable in deep water, it will constitute an immense advance in oceanography.

Transparency and colour.

The transparency of sea-water is usually measured by sinking a white enamelled disc, and noting the depth at which it ceases to be visible. The test is a rough one, the depth of visibility depending not only on the transparency but also on the amount of sunlight and the powers of vision of the observer. The colour of sea-water as seen on looking through the depth of a fathom or so at a white disc may be measured with a considerable degree of approximation by the use of Forel's xanthometer. Assuming that the water of lakes varies from pure blue to clear green, Professor Forel constructed a scale of which the extremes were solutions of copper sulphate in ammonia for blue, and of neutral potassium chromate for yellow, the intermediate tints being supplied by mixtures of the two in definite proportions. Dr W. Ule, with the advice of Professor von Drygalski, introduced a brownish tint (a solution of cobalt sulphate) in order to measure the gradations which actually occur in the ocean.[3]

Measurement of currents.

The measurement of ocean currents has been attempted in many ways, none of which can be looked upon as wholly satisfactory, especially in deep water and in the open sea. Rapid surface currents, exceeding say 1 mile per hour in velocity, may be easily measured by watching the drift of a buoy from an anchored ship or mark. It is difficult, however, to anchor even a small vessel in water exceeding a few hundred fathoms in depth. Under-currents are much more difficult to investigate. Their direction can usually be ascertained by the use of a current drag, exposing two large surfaces at right angles to each other and both in a vertical plane. This, when sunk to the proper depth and attached by a line to a float offering a very small surface, will show, with reference to a fixed mark, a certain approximation to the movement of the layer in which the drag is immersed.[4] A more sensitive arrangement is a light drag hung by a wire from a spar projecting over a boat which is kept by the use of the oars in such a position that the wire remains parallel with a plumb-line hung from the end of the same spar. When this is done, the boat moves on the surface in the direction towards which the water of the undercurrent flows and at the same rate.

Much attention has been devoted to the construction of current gauges intended to record the directions and velocities of currents at great depths by rotating vanes, meter-wheels, and other mechanical devices; but the results have not as yet rewarded the labour and ingenuity expended.

The slow-moving currents which carry out most of the superficial circulation of the oceans may be roughly measured in calm weather by the difference between the observed and calculated positions of a vessel, and, in certain circumstances, by the use of floats. Floats are only of great value for determining the speed of currents in the case of oceans the coasts of which are thickly peopled by an intelligent population, and at the present time the North Atlantic alone can be profitably investigated in this way.

For merely testing the direction of currents, without estimating their rate, floats are always useful, and Mr H. C. Russell has shown that much information of the drifts even in the Southern Ocean may be thus obtained. It is essential that a current float should be submerged so as to present as little surface as possible for wind to catch; it should be strong enough not to be damaged when thrown on shore, and sufficiently conspicuous to attract the attention of a passer-by. The experiment of using glass balls of specific gravity a little greater than that of sea-water, to roll along the bottom, in places like the North Sea, where they might be recovered by trawlers, and thus to trace the movements of the deepest layers of shallow seas, has not as yet been fairly tried. The interpretation of current-floats is really satisfactory only when many have been launched simultaneously, or in close succession, along definite lines. Then the first to be found sets a minimum velocity for the current, and the direction of the current may be inferred by laying down on a map the line joining the launching place and the point at which the float nearest to it was found, drawing the course of the next nearest parallel to the first so far as it goes, then straight to its destination, and so with the rest. Treated thus, the "bottle charts" of the North Atlantic give an excellent idea of the superficial circulation of the waters.[5]

Accidental floats, like derelicts or logs, and natural floats such as icebergs and volcanic ashes, often map out the main lines of a current very clearly; and the plankton, or drifting organisms, may also be looked upon as ear-marking definite bodies of water. In the same way, temperature, salinity, and gas-contents are of value in suggesting, and sometimes in demonstrating, the place of origin of the sea-water under examination.

Biological observations.

The apparatus for scientific biological research at sea has been for the most part developed from that used in fishing. The dredge and trawl differ little from those of the oyster-boat and the trawling smack. The Prince of Monaco has introduced a sort of gigantic lobster pot, with the happiest effect in very deep water. The continuous study of plankton on a voyage is usually carried out by straining the sea-water as it is pumped on board for the use of the condensers or to fill tanks. The tow-net, however, a strong silken or canvas bag drawn after the ship to capture the drifting organisms, is purely scientific in its origin. The surface tow-net has been developed into a series of ingenious devices for obtaining specimens from any depth, or even just skimming the mud of the bottom, without catching anything from an intermediate position.

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1 "A Retrospect of Oceanography" in *Report of VI. Int. Geog. Congress*, London, 1895, p. 403.

2 For a summary of discussions on the hydrometer in oceanography, with references, see F. Nansen, "Hydrometers and the Surface-tension of Liquids," in the *Scientific Results of the Norwegian North Polar Expedition*, vol. iii., London, &c., 1902.

3 *Petermanns Mitteilungen*, 38, 1892, p. 70; 40, 1894, p. 214.

4 For methods of current observation, see A. S. Thomson in *Report of VI. Int. Geog. Congress*, London, 1895, p. 443.

5 For the general question of current floats, see G. Schott, *Die Flaschenposten der Deutschen Seewarte*, Hamburg, 1897.

Results of Oceanographical Study (see also the articles on the different oceans).—On account of the small number and irregular distribution of deep-sea soundings, except in the North Atlantic, it is impossible to generalize with any confidence as to the form of the ocean hollows. It is, however, known that the relief of the ocean floor is almost always more gentle and less varied than that of the land. Being protected by the water from the rapid sub-aërial erosion which sharpens the features of the land, and subjected to the regular accumulation of deposits, the whole ocean floor has assumed some approach to uniformity. The continental slopes and the elevations from which some islands rise are, however, often as steep as land slopes. The general arrangement of depths is unsymmetrical; as a rule, the deepest depressions occur near the margins of the oceans, while the greater and more continuous elevations of the sea-bed occur near the centre, and are usually marked on the surface by islands which rise from them. The average depth of the oceans, as calculated by Karstens in 1894,[1] disregarding the shallow seas, is 2170 fathoms, but the actual average depth is probably somewhat greater. Depressions exceeding 3000 fathoms in depth occur in four places in the Atlantic, near the continental slopes; in the angle between the Sunda Islands and Australia, in the Indian Ocean; and in the centre and north-west of the Pacific. The only extensive area over 4000 fathoms in depth is a narrow trough in the north-west Pacific along the oceanic slope of Japan and the Kurile Islands. Individual soundings exceeding 5000 fathoms have been obtained in various parts of the Pacific, the deepest on record being 5269 fathoms at a point east of the Ladrones. A sounding of over 4000 fathoms reported by Sir James Ross in the Southern Ocean, south of the Atlantic, has never been verified, and a definite object of the Scottish Antarctic expedition (1902) was to test the existence of a great depression in that region. The distance of the remotest part of the ocean (as deduced by Rohrbach) from the nearest continental land exceeds 3000 miles only in the South Pacific in 20° S., 130° W.; but if islands be taken into account, De Windt shows that no part of the ocean is more than 1300 miles from land, the remotest spots occurring in the centre of the North Atlantic, at 25° N., 43° W., and at three points in the eastern Pacific, respectively 15° N., 135° W.; 8° S., 115° W; and 45° S., 106° W.[2]

Ocean basins.

The question of sea-level is involved in the comparison of depths, for in all calculations of vertical relief, either above or below the surface, the surface of the ocean is assumed to be uniform. The attraction of the elevated portions of the lithosphere, granted that the whole crust were of uniform density, should cause a rise of the level of the sea along the shores. The survey of India demonstrated that the sea-surface was 300 feet farther from the centre of the Earth at the head of the Arabian Sea than at Ceylon, presumably in consequence of the gravitational attraction of the Himalayan range. Geodetic operations of the necessary delicacy to measure such differences of absolute level have been made as yet in few parts of the Earth, and the problem of the true form of the geoid remains to the future. Minor variations in level between enclosed seas or gulfs and the open ocean may be due to the set of the tidal streams, the excess of rainfall or evaporation in particular areas, the melting or the formation of sea ice, or to the direction and force of the prevailing winds. (For the movements of the ocean due to the differential gravitational attraction of external bodies in the solar system, see TIDES.)

Sea-level.

The salinity of the water of the oceans, as mapped by Mr J. Y. Buchanan, Dr A. Buchan, and others, shows a general banded arrangement. In the far north and the far south, bordering the polar ice, the surface water is comparatively fresh. Two zones of maximum salinity occupy the trade-wind regions and are crossed by the tropics, while a belt of low salinity lies a little north of the equator. The average salinity of the whole surface of the oceans is about 35·0 per mille, the areas of high salinity in the tropics reach about 37·0 per mille as a maximum, and near the edge of the ice the salinity is only about 33·0. Enclosed seas in dry regions, like the Red Sea and Mediterranean, may have a salinity approaching 40·0, while seas in a rainy climate, or those fed by many rivers, such as the Baltic, may have an average salinity under 30·0. The high salinity of the trade-wind areas is due to the rapid evaporation from the surface; while the check to evaporation, perhaps as much as the heavier precipitation of the calms, accounts for their lower salinity. The deeper water of the ocean is usually somewhat fresher than that on the surface, although, on account of lower temperature, it is, at equal pressures, actually denser.

Salinity of the oceans.

The salts of average ocean water differ greatly from those of any "fresh" water, and the composition is practically constant so far as regards the open ocean, the following table (from Dittmar) representing a probable grouping of the salts in the proportion in which their constituents occur.

Composition of Ocean Salts.

Sodium chloride	77·8
Magnesium chloride	10·8
Magnesium sulphate	4·3
Calcium sulphate	4·1
Potassium sulphate	2·5
Magnesium carbonate	0·3
Magnesium bromide	0·2
Total	100·0

A complex solution of this nature exercises a certain amount of chemical action on the substances exposed to it, and is also acted upon in various ways by the life-processes and the decomposition of organisms. The salts of average river water contain over 50 per cent. of calcium and magnesium carbonates, and 10 per cent. of free silica, with only about 2 per cent. of sodium chloride, thus differing very greatly from those of the sea. There has been much speculation as to whether the salts of the ocean are the result of the action of the hot water which first condensed on the surface of the cooling Earth, or the product of the concentration of river water, changed by chemical and vital processes. On the latter assumption, the present salinity of the ocean has been taken by Professor Joly as a measure of the age of the Earth. In ocean water the only distinct local variation of saline composition is a very slight increase in the proportion of dissolved carbonates and calcium salts with increase of depth; but in the water which is contained in the muds, oozes, and clays of the ocean floor there is a remarkable difference. Sir John Murray and Mr Irvine have shown that the sea-water mixed with the blue muds, the typical shallow water terrigenous deposit, is not only of higher salinity than the overlying water, but contains a much smaller proportion of sulphates and thus a relatively higher proportion of chlorides. The chemical action of the iron in the mud reduces sulphates producing ultimately ferrous sulphide, to which the dark colour of the mud is due. When iron is deficient to take up the reduced sulphur, sulphuretted hydrogen is produced, as in the deep water of the Black Sea, where this gas occurs in a proportion as high as 6·55 cubic centimetres per litre of water.[3] Researches have shown that the presence of bacteria in the mud may be a necessary accompaniment, and possibly the cause of this chemical action.

The chemical action of the salts of sea-water on the organic matter of deposits produces decompositions which lead in some cases to the formation of petroleum. Chemical precipitation appears to cover the floor of the sea in some places with a deposit in the form of a stony crust, the physical action of which by the diffusion through it of the different salts is held by Dr Natterer of the Austrian *Pola* expedition to exercise a considerable influence on the chemical processes which occur in the deep sea.

[1] K. Karstens, *Eine neue Berechnung der mittleren Tiefen der Oceane*, Kiel, 1894.

[2] "Sur les distances moyennes à la côte dans les Océans," *Mém. couronnés de l'Acad. des Sciences de Belgique*, lvii. (1898).

[3] *Trans. Roy. Soc. Edinburgh*, xxxvii. (Pt. 2), No. 23 (1892); also *Proc. Roy. Soc. Edinburgh*, xxi. (1896), pp. 25 and 35.

Sea-water in contact with the air absorbs oxygen and nitrogen in an amount dependent on the temperature and salinity of the water, the solubility of the gases and the proportion in which they occur in the atmosphere. Fully aërated normal ocean water at 32° Fahr. contains 8·2 c.c. of oxygen and 15·6 c.c. of nitrogen per litre, the amount absorbed diminishing as the temperature rises: thus at 70° Fahr. only 5·2 c.c. of oxygen and 10·0 of nitrogen are absorbed. It will be observed that on account of the greater solubility of oxygen the dissolved air in sea-water contains one-third of its volume of that gas, instead of only one-fifth, which is the proportion in the atmosphere. The action of living organisms in the water alters the proportion of oxygen and carbon dioxide, while that of nitrogen remains practically unchanged, and is proportional to the temperature at which the atmospheric gases had been absorbed at the surface. Hence when the nitrogen extracted from a sample of water has been estimated it is possible to tell the temperature which the water possessed when at the surface, and the amount of oxygen it originally contained. Herr Martin Knudsen has shown in the *Ingolf* expedition that wherever vegetable plankton (diatoms, &c.) is abundant the absorbed gases contain more oxygen than should normally be associated with the nitrogen, while where animal plankton prevails there is a deficit of oxygen and a larger quantity of carbonic acid. He has even been able to detect a distinct difference between the amount of oxygen in solution in sea-water by day and by night when diatoms are present. The extreme variability of the dissolved gases in the presence of living organisms explains many of the discrepancies in the earlier observations which were formerly very puzzling. The fact that no sample of ocean water, even from the greatest depth, has ever been found entirely without absorbed oxygen proves that the whole mass of water in the ocean is subject to a general circulatory movement. In deep enclosed seas, on the other hand, of which the Black Sea is the best example, the absorbed oxygen disappears and carbonic acid and sulphuretted hydrogen take its place. In such conditions the deep water is incapable of supporting life.

Absorbed gases in sea-water.

Carbonic acid in sea-water is troublesome to estimate because it rarely exists as a free gas; unless the proportion is very large it forms a bicarbonate with the normal carbonates which give to sea-water its alkaline reaction. The amount of carbonic acid present as normal carbonate is given by the alkalinity determination, and the total carbonic acid may be determined very accurately by Pettersson's method of boiling acidified sea-water under greatly reduced pressure. The amount of carbonic acid absorbed by sea-water from the air must always be very small; but the respiration of organisms may, in places, convert almost all the absorbed oxygen into carbon dioxide.

Carbon dioxide in sea-water.

Ammonia salts occur in a small and varying proportion in sea-water, as a result of the decomposition of organic matter, and they appear to play an important part in the secretion of calcium carbonate by marine organisms. The combined carbonic acid in sea-water, even if all associated with lime, would only allow a very small proportion of the total salts to exist in the form of calcium carbonate, while the amount of calcium carbonate withdrawn from the water by living organisms is relatively large. It has been shown, however, that ammonium carbonate generated from the waste products of animal life causes a precipitation of calcium carbonate from the sulphate or other salts of calcium present in sea-water, and this is probably the source of the immense quantities of calcareous matter accumulated as oceanic deposits or coral reefs.[1]

The classification of marine deposits generally accepted was arrived at by Sir John Murray and Professor Renard as the result of studying all the specimens brought back by the deep-sea expeditions of all nations up to the completion of the volume of the "*Challenger*" *Reports* dealing with the subject in 1891. The system of classification is twofold, according to origin and according to the depth of water.

Marine deposits.

Classification of Marine Deposits.

1. Deep Sea Deposits (*beyond 100 fathoms*).	Red Clay Radiolarian Ooze Diatom Ooze Globigerina Ooze Pteropod Ooze	I. PELAGIC DEPOSITS.—*Formed in deep water remote from land.*
	Blue Mud Red Mud Green Mud Volcanic Mud Coral Mud	II. TERRIGENOUS DEPOSITS.—*Formed in deep and shallow water close to land.*
2. Shallow Water Deposits (*in less than 100 fathoms*).	Sands, Gravels, Muds, &c.	
3. Littoral Deposits (*between high and low water marks*).	Sands, Gravels, Muds, &c.	

[1] R. Irvine and G. S. Woodhead in *Proc. Roy. Soc. Edinburgh*, xv. (1888), p. 308.

Estimated Area covered by Marine Deposits, &c. (Murray, 1889).

	Deposit.	Estimated Area in Sq. Miles.	Mean Depth, Fathoms.	Mean per cent. of $CaCO_3$.
Pelagic	Red Clay	50,290,000	2730	6·70
	Radiolarian Ooze	2,790,000	2890	4·01
	Diatom Ooze	10,420,000	1480	22·96
	Globigerina Ooze	47,750,000	2000	64·53
	Pteropod Ooze	900,000	1120	79·26
Terrigenous	Coral Sands and Muds	3,200,000	710	86·41
	Other Terrigenous Deposits, blue muds, &c.	27,900,000	1020	19·20

In the tropical oceans far from land, where the depth is less than 600 fathoms the typical pteropod ooze formed by the accumulation of the dead shells of molluscs, foraminifera, and other organisms which live at the surface may contain as much as 90 per cent. of calcium carbonate. With precisely the same surface conditions and with equal abundance of the same organisms in the water the deposits at a depth of about 2000 fathoms have only about 60 per cent. of calcium carbonate; the pteropod shells have disappeared, and the deposit is a globigerina ooze composed mainly of foraminifera. If the depth is 2400 fathoms, the proportion of calcium carbonate is reduced to 30 per cent., and at 2600 fathoms to 10 per cent., while in deeper water it is rare to find anything more than a trace of calcium carbonate in the deposit. This gradual elimination of calcium carbonate with depth points to solution by the sea-water under pressure, and perhaps in presence of carbonic acid due to decomposition of the organic matter in the shells. The slight increase of dissolved calcium salts in water from great depths tends to confirm this deduction. As the foraminiferal remains diminish, the residual deposit is named Radiolarian or Diatom ooze, if the skeletons or spicules of one or other of these silicious organisms are conspicuous, or Red clay if they are practically absent.

Pelagic deposits.

Red clay is the most remarkable as well as the most widespread of all deposits. It is made up partly of the disintegrated fragments of volcanic rocks, such as pumice, partly of the non-calcareous remnants of marine organisms which had lived on the surface, and partly of the teeth of sharks, and the ear-bones of whales, very often crusted over with, or even embedded in, masses of iron and manganese oxides which have been formed by the decomposition of the volcanic rock fragments. Crystals of zeolites, evidently produced *in situ*, are frequently found in the Red clay, and particles of meteoritic iron are also found in considerable quantity. The chemical changes which take place in deep-sea deposits are still very imperfectly known, but it is certain that the Red clay increases in thickness at an excessively slow rate. It is not to be supposed that the remains of more sharks or whales, or more meteorites fall to the ocean floor in the Red clay areas than in other places, but it is evident that if these remnants have been uniformly distributed over the oceans, the more rapid accumulation of the other deposits has covered them up, and they only remain unburied in the Red clay. Sir John Murray believes that not more than a few feet of Red clay have accumulated in the deepest depressions since the close of the Tertiary period, many of the sharks' teeth belonging to fossil species. The existence of this deposit is the main argument for the theory of the permanence of the oceanic and continental areas. Since no rock similar to Red clay has been found in any geological formation, it appears improbable that any part of the present land was ever an ocean floor in the abysmal area.

Red clay.

Terrigenous deposits pass from the stones and rough pebbles of the beach to shingle and sand between tide marks, and to fine mud on the outer margin of the continental shelf. The finer deposits are classified as sands or muds according to the size of the particles composing them. The composition of the deposits depends mainly on the nature of the rocks from which they are derived; thus, oceanic islands, if of coral, are surrounded by coral sands and muds, and if volcanic, by volcanic sands and muds. Off continental shores beyond the continental shelf, blue, green, or red

Terrigenous deposits.

muds are found, the colour of green mud being due to the formation of the secondary mineral glauconite on the grains of rock. Phosphatic nodules are also formed in the same positions by secondary decomposition. The blue and red muds owe their colour to the less or greater degree of oxidation of the iron they contain.

Distribution of deposits.

The distribution of the various kinds of deposit over the ocean floor has been provisionally mapped by Sir John Murray.[1] A belt of sea-bed averaging 200 miles in width around the land is occupied by terrigenous deposits, which are the only deposits found in seas. Only in exceptional cases, *e.g.*, where a great river carries its muddy water several hundred miles out to sea, or where a current floats icebergs laden with mud and boulders far from land, or where a prevailing off-shore wind bears desert dust half across an ocean, is this limit exceeded. Diatom ooze appears to be characteristic of the Southern Ocean, where it probably forms a ring north of the belt of terrigenous deposits which encircles the Antarctic ice. It is always most abundant under relatively fresh and cold water. The moderate depths of the temperate and tropical oceans, down to say 2000 fathoms, are typically covered with globigerina ooze, which closely resembles chalk in its composition, and may be said to be the characteristic deposit of the North Atlantic. Below the depth of 2500 fathoms Red clay prevails, its occurrence being clearly a function of depth, and in places the admixture of a small proportion of radiolarian spicules gives to it the name of Radiolarian ooze. Red clay is the typical deposit in the Indian and Pacific Oceans.

Temperature of sea-water.

The water of the ocean has a somewhat lower specific heat than pure water, Professor Thoulet having determined the specific heat of sea-water of salinity 35·0 per mille as 0·935, if that of pure water is 1·000. In other words, while 100 units of heat are required to raise the temperature of 100 lb of fresh water by 1°, only 93·5 units of heat are required to raise the same weight of sea-water through the same range. The thermal conductivity of sea-water is somewhat greater than that of fresh water; hence the sea heats and cools throughout its mass by conduction more rapidly than an equal mass of fresh water would do in like conditions. It must be remembered, however, that the difference is small, and that when compared with the difference between the thermal capacity and conductivity of water and of rocks or soil it is inappreciable. The greatest difference between fresh water and sea-water with regard to the action of heat is that, whereas fresh water on cooling contracts until 39° Fahr. is reached, and then expands until it freezes at 32°, sea-water contracts steadily until it freezes at a temperature of about 26° Fahr. for normal ocean water. There is thus no temperature at which water of uniform salinity becomes less dense as it cools.

Apparently neither the light nor the heat-rays of the sun penetrate deeper than 100 fathoms, so that changes due to heating and cooling by radiation are confined to the surface layers, the great mass of ocean water changing its temperature only by the very slow and almost imperceptible process of conduction or by the direct mixture by convection or mechanical agitation of bodies of water of differing temperature.

The surface water of the ocean has a very slight diurnal range of temperature at any point, the difference between the daily maximum and minimum not probably exceeding 1° Fahr. The *Challenger* found the extreme daily range for the North Atlantic to be only 0·8° Fahr., while that of the air resting upon it was 3·2°. Dr Schott, on a long voyage on a sailing ship through the Atlantic, Indian, and West Pacific Oceans, found the daily range of surface temperature in the tropics to be about 1·6° Fahr., while in temperate latitudes it was from 0·5° to 0·7° Fahr., his results thus confirming those of the *Challenger*. He also observed that the daily range was much reduced by strong winds and a cloudy sky.[2] The coldest sea-water known is that in the Arctic and Antarctic regions, which may sink as low as 26° Fahr. when freezing; the warmest is in the Red Sea and Persian Gulf, where maxima have been recorded as high as 96° Fahr.

The ocean surface is divided into zones of temperature roughly parallel to the equator, though on account of wind and currents the arrangement in some places is very irregular. The tropical zone has a high surface temperature (for the most part over 80° Fahr.), and an extreme range between the absolute annual maximum and minimum of less than 10°. It practically coincides with the belt in which reef-building corals can live. To the north and south the mean annual temperature falls off rapidly, and the annual range increases; until in the two circumpolar zones the average surface temperature is below 40° Fahr., and the extreme annual range is again slight (under 10°), on account of the low maximum.[3] The effect of great range of temperature on water of uniform salinity is to set up convection currents at the period of annual minimum, whereby the surface water, becoming denser than the lower layers in consequence of fall of temperature, sinks and so cools and aërates the mass of the ocean. When the surface water is much fresher than that of the lower layers no degree of cold will cause it to sink, unless sea-ice forms in such quantity that the exclusion of most of the salt causes an increase of salinity, and thus of density, in the unfrozen portion, which will then sink and produce a very low temperature in the lower layers. The action of heat also, which in fresh water ensures the continuance of the upper layers at the surface, produces a concentration of sea-water by evaporation, and thus an increase of density, which may lead to a mixture with the lower layers, as in the Red Sea. It may be noted, however, that evaporation proceeds more slowly from the surface of salt than of fresh water.

While the annual range at 50 fathoms at any one spot rarely exceeds 2° Fahr., and at 100 fathoms is inappreciable, different parts of the ocean at the same depth may differ in temperature to the extent of :—

Surface	100 fathoms	500 fathoms	1000 fathoms	1500 fathoms
70°	42°	20°	11°	8°

It is evident, from the rapidity with which temperature diminishes from the surface downwards in the upper layers, and the slowness with which the diminution continues in deeper water, that the ocean is a great mass of cold water, on the surface of which, in the extra-polar regions, a thin layer of warm water floats.

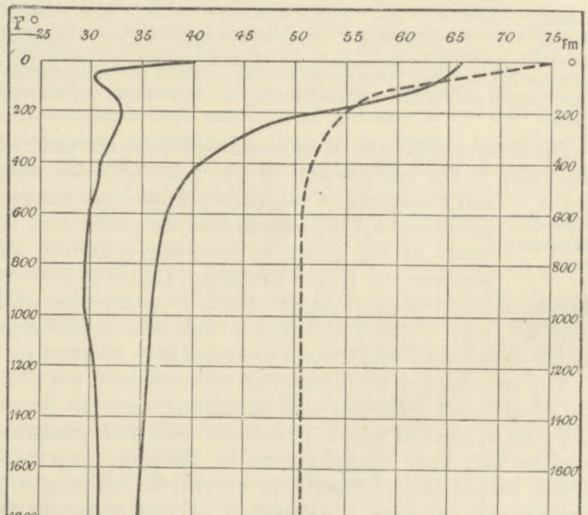

Diagram illustrating Distribution of Sea Temperature.

The normal vertical distribution of temperature is illustrated in curve A in the above diagram, which represents a sounding in the South Atlantic. Curve B shows the typical distribution of temperature in an enclosed sea (in this case the Sulu Sea), where from the level of the barrier to the bottom the temperature is

[1] "*Challenger*" *Reports—Deep-Sea Deposits.*

[2] *Petermanns Mitteilungen, Ergänzungsheft*, No. 109 (1894).

[3] Sir John Murray, "Annual Range of Temperature in the Surface Waters of the Ocean," *Geog. Journ.* xii. (1898), 113-134.

uniform. Curve C shows a typical summer polar curve where layers of water of different temperatures are superimposed. Sir John Murray calculates that no less than 80 per cent. of the mass of the ocean has a mean temperature below 40° Fahr.

The temperature of the floor of the ocean beyond the continental shelf, *i.e.*, about 90 per cent. of the whole oceanic area, is strikingly uniform. Water above 40° occupies only a narrow strip along the continental slope, and fills up the basins of the Red Sea and Mediterranean. Water at temperatures from 40° to 35° covers the whole floor of the North Atlantic south of the Wyville Thomson Ridge, and most of the Pacific, while water from 35° to 30° covers the floor of the whole Southern Ocean, the Indian Ocean, the South Atlantic and some small areas in the Pacific, the relations of which to each other have not yet been clearly made out. Water below 30° is found in the Arctic basin and in the Antarctic seas.[1]

The study of the bottom temperature shows that the main cooling agency in the hydrosphere is the melting of ice in the Antarctic area, for the oceans most open to the Antarctic are the coldest. Thus the Indian Ocean and the South Atlantic have a bottom temperature 2° lower than the North Atlantic, and about 1° lower than the Pacific. Sir John Murray points out that 92 per cent. of the ocean floor, but only 16 per cent. of the surface, have a temperature under 40° Fahr., and he shows how the deposits now being laid down contain mixed together the remains of forms of animal life which flourished in water at 90° and at 35° Fahr., a fact which has very important geological bearings.

The areas occupied by surface water at different temperatures may be given as follows :—

	Mean Annual Surface.		Bottom.	
	Square miles.	Per cent.	Square miles.	Per cent.
Area from 80°–90° F.	30,100,000	21·94	...	...
,, 70°–80° F.	38,200,000	27·84	...	...
,, 60°–70° F.	18,800,000	13·70	4,360,000	3·18
,, 50°–60° F.	13,400,000	9·77	2,710,000	1·97
,, 40°–50° F.	14,900,000	10·86	3,470,000	2·53
,, 35°–40° F. } ,, 30°–35° F. }	14,400,000	10·50	67,060,000 55,760,000	48·88 40·64
,, under 30° F.	7,400,000	5·39	3,840,000	2·80
Total .	137,200,000	100·00	137,200,000	100·00

In shallow seas, especially where there is a complex configuration and tidal currents, the form of the ground completely dominates the seasonal thermal changes in the water, which become extremely complicated and differ entirely from the conditions in the open ocean.[2]

Oceanic circulation. The facts which have been mentioned as to the practical constancy in the composition of the salts of ocean water and the nature of the absorbed gases are accepted by almost all oceanographers as proof that the water of the ocean is everywhere moving and nowhere at rest. Professor Thoulet, however, maintains that the great depths of the ocean are practically stagnant, any circulation being a molecular transference which is chemical rather than mechanical in its nature.

The movements producing the circulation of the ocean are of different velocities and directions, and are due to different causes, of which sometimes one and sometimes another has been considered to be the most important. Much weight was formerly given to the difference of temperature producing expansion of the water in the tropics as compared with the polar area, and thus initiating a difference of level which caused the surface currents to run on the whole from the equator towards the poles. Calculations have shown, however, that on account of the thinness of the heated layer the total thermal increase of level in the tropics must be very slight indeed, and quite insufficient to produce any sensible flow of water. Other theorists have pointed to the reduction of level in the heated areas in consequence of evaporation as sufficient to cause an indraught of the surrounding waters on the surface, especially from places where the level is raised by heavy rain. This undoubtedly must produce some effect even in the open ocean, and is a chief cause of the circulation of many enclosed seas. The Red Sea and the Mediterranean appear to owe their circulation almost entirely to evaporation, and the Baltic very largely to dilution. The melting of ice in the polar seas must have a considerable effect in raising the level of the surface by the liberation of fresh water, not on the surface only, but at the depth, sometimes over 100 fathoms, at which the bottoms of the icebergs float. The escape of the fresh water thus set free causes an up-welling round the bergs and a general outflow from the edge of the ice. Professor Otto Pettersson believes that this action is sufficient to set in motion the whole machinery of oceanic circulation, which thus would start from the edge of the polar ice towards the equator, the poleward-flowing currents being of secondary origin and serving to restore equilibrium.[3] It has been suggested by others that the originating cause of ocean currents is essentially tidal; but since the voyage of the *Challenger* most oceanographers have looked on the prevailing winds as the main cause of oceanic circulation, both horizontal and vertical. The suggestion of wind as the motive power of currents is old, the remarkable coincidence of direction in winds and currents having been appreciated by navigators at an early period. It is difficult to devise any crucial observation which should decide the truth of any one theory as against the others, since the currents of the ocean are all parts of a complete circulation, the impelling force for which may be applied at any part of the system with similar effect. It seems probable indeed that many causes, direct and indirect, conspire to produce the final result; wind and difference of density due to evaporation, rain, temperature, ice-formation, and ice-melting, all pushing or pulling to produce movement in the same direction.

Zöppritz has proved theoretically that the friction of moving air on the surface of the water at rest is sufficient to move forward the upper layer and to increase its velocity to nearly that of the air. The internal friction of water is sufficient to pass on the movement to deeper and deeper layers, although very slowly, the calculation being that with a uniformly acting wind it would require more than a month before water at the depth of one metre was travelling as fast as that at the surface.

It has been proved by experiment that whenever a current of water is set in motion by any cause it exercises a complex influence on the surrounding water, dragging some of it forward in the same direction and impressing on another part a movement, either on the surface or in some deeper layer, in the opposite direction. These deep reaction-currents are especially noticeable where rivers enter the sea or where strong surface currents run through narrow straits.[4]

A condition which may produce feeble currents not due directly to wind but to the cause of wind—unequal distribution of atmosphere pressure—is known as a seiche. This is most easily observed in lakes or bodies of water not affected by tide, and consists of a surge of the water too slow, gradual, and flat to be called a wave, constituting a rising at one place where the atmospheric pressure is low and a falling at another where it is high. When it is remembered that the pressure of an inch of

[1] Sir John Murray, "On the Temperature of the Floor of the Ocean, &c," *Geog. Journ.* xiv. (1899), 34–51.

[2] H. R. Mill, "The Clyde Sea Area," *Trans. Roy. Soc. Edinburgh*, xxxv. Pt. III. No. 23; xxxviii. Pt. I. No. 1 (1894). O. Pettersson, "Recent Swedish Research in the Baltic, &c.," *Scot. Geog. Mag.* x. (1894).

[3] O. Pettersson, "Ueber den Einfluss der Eisschmelzung auf die Oceanische Circulation," *Ofvers. kong. Vetensk. Acad. Förhand.*, Stockholm, lvi. (1899), 141–166.

[4] The literature of the theory of oceanic currents is too voluminous to summarize here. It will be found excellently treated in Boguslawski and Krümmel's *Ozeanographie*, vol. ii. chaps. iii. and iv., and continued in the annual volumes of Wagner's *Geographisches Jahrbuch* since 1888.

mercury is equal to that of a foot of water, and that temporary differences of barometric pressure considerably exceeding one inch of mercury between places much less than a hundred miles apart are not uncommon, the small and fugitive irregularities of the sea-surface and their associated temporary currents due to this cause can be understood.

The direct action of wind on moving water is modified by the influence of the land, the movements due to wind which may occur even in the open sea being intensified under the guiding influence of land-slopes. An off-shore wind has the effect of driving the surface water out to sea, raising the level at some place to leeward and necessitating an upwelling of the deeper layers along the land. A steady off-shore wind thus causes a constant upwelling of deep, and consequently comparatively cold, water near shore.[1] This fact and the similar effect produced by shoals which rise nearly to sea-level has been known to sailors for more than a century, and the thermometer was suggested as a guide to warn the mariner of shallow water as early as 1799.[2] An on-shore wind, on the other hand, drives in the surface-water, skimmed from a considerable extent of ocean, against the shore, raising the level of the sea near the land, and so causing a return movement. This takes place either in the deeper layers, or, if the wind acts only along a narrow path, a counter-current will escape on the surface on one or both sides of the direct current. The result is that off a lee-shore the water has a higher temperature at great depths than in the open sea. In consequence of this action, physical similarities in the configuration of the ocean basins lead to similarities in the movements of the water, which in all are closely related to the prevailing winds. Where the trade-winds blow off the land, as on the north-west and south-west coasts of Africa and of South America and the north-west of Australia, cold currents are found, welling up from below, those in the south probably reinforced by branches of the Antarctic surface drift. In the North Indian Ocean and in other places where the direction of the winds changes twice a year, the currents show a similar change and are known as monsoon currents.[3]

By whatever cause the water of the ocean is set in motion, and in whatever direction it may flow, a force arising from the Earth's rotation causes the current or drift to deviate from a straight line towards the right in the northern hemisphere and towards the left in the southern. In the northern oceans the direction of the coastlines conspires with this deviation to give to the whole of the water a general horizontal circulation in the same direction as the hands of a watch, a fact which has been very clearly proved in the North Atlantic, and is distinctly suggested in the North Pacific. In the South Atlantic, the South Indian Ocean, and the South Pacific a similar horizontal circulation, but in the direction opposite to that of the hands of a watch, as is required by Ferrell's Law of Deviation, has been partially made out.

Nature of currents. When a current-chart which is not generalized but compiled from actual observations, such as those of the British Admiralty, is attentively examined, it will be seen that the arrows indicating the directions of the observed movements are not parallel to each other, but frequently present the appearance of small eddies or divergent streams. Yet, on viewing the chart more generally, certain main directions will be noticed to recur so frequently as to make it possible to assign a definite resultant direction to considerable bands of water. It is usual to distinguish between *currents*, which are comparatively rapid, fairly definite in their boundaries, uniform and permanent in direction even during temporary changes of wind, and *drifts*, which are less defined movements of the water, less certain in direction and velocity, and liable to alter with every prolonged change of wind. But notwithstanding these differences, drifts and currents are part of one system of general oceanic movement, and they must be considered as supplementary and not contrasted. They can never be fully studied by observations of horizontal movement at the surface alone, for the movements of the surface are only the visible portion of the great system of circulation in three dimensions of the mass of the ocean. So little is known of the movements of the deeper layers that the complete system of circulation can only be divined as yet by the use of theoretical reasoning supported in part by facts of observation. The evidence points to the Southern Ocean as the great meeting- and mixing-place of the waters of the world, and it is there, between 40° S. and the Antarctic ice, that the want of systematic observations at all depths taken by exact modern methods is most seriously felt.

An ingenious system of representing the dynamical conditions determining marine circulation by means of sections has been put forward by Bjerknes and Sandström. The sections combine isotherms and isohalines into curves of equal density *in situ*, the corresponding surfaces of equal density serving to indicate the direction and strength of the movement of the water, as isobaric surfaces indicate the direction and strength of the movements of the air.

Interaction of ocean and air. The importance of the ocean in the economy of the world is perhaps greatest as a regulator of climate, and recent researches indicate that the relation between the atmosphere and hydrosphere is much more intimate and sympathetic than was formerly supposed. The general contrast of the maritime and continental climate is too well known to require emphasizing, but it is useful to remember that the influence of prevailing winds from the sea may carry a maritime climate far inland over level country, as in the North German plain, while prevailing winds from the land may carry a continental climate to islands across narrow seas, as in Japan and the Kurile group in winter. The researches of Mohn, O. Pettersson, and H. N. Dickson have shown that the distribution of sea temperature has a direct relation to the distribution of atmospheric pressure and to the resulting types of weather. The ocean surface not only affords a fair field for the development of unobstructed atmospheric circulation, but helps to fix the position of the great low and high pressure areas, on the margins of which the moving cyclones which dictate the weather of temperate latitudes are generally initiated. The subject is a promising one for future research, and it seems a hopeful direction in which to look for a guide as to the prediction of weather some considerable time in advance.

The practical importance of exact oceanographical research lies in its applications to practical meteorology, to the art of navigation, to the placing of submarine cables, and most directly to fisheries. With regard to the latter, an international council of the nations surrounding the North and Baltic Seas, which was inaugurated at Copenhagen in 1902 after preliminary conferences at Stockholm in 1899 and at Christiania in 1901, formed comprehensive plans for co-operation in the systematic study of the North-West Atlantic and its neighbouring seas at all seasons, with the object of definitely testing the assertions as to the practical value of the study.

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[1] The first recognition of this fact is claimed by E. Witte in 1870; see *Annalen der Hydrographie*, xxviii. (1900), p. 74.

[2] Jonathan Williams, *Thermometrical Navigation*, Philadelphia, 1799.

[3] J. Y. Buchanan, "Similarities in the Physical Geography of the Great Oceans," *Proc. Roy. Geog. Soc.* viii. (1886), 753.

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Important current and temperature charts of the ocean and occasional memoirs are published for the Admiralty by the Meteorological Office in London, the U.S. Hydrographic Department in Washington, the Deutsche Seewarte in Hamburg, and also at intervals by the French, Russian, Dutch, and Scandinavian Admiralties. *Pilot Charts* of the North Atlantic and North Pacific are issued monthly by the U.S. Hydrographic Office, and of the North Atlantic by the British Meteorological Office, giving a conspectus of the actual conditions of weather and sea.

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Ochakoff, a fortified town of Russia, government of Kherson, district of Odessa, 41 miles east-north-east of Odessa, on a cape of the Black Sea, at the entrance to the estuary of the Dnieper. Its population was 10,784 in 1897. The port is visited chiefly by coasting vessels (about 250, 6500 tons) for the export of grain to Odessa. It has large brickworks, a steam flour-mill, and a few small factories. Strong fortifications have been built between Ochakoff and the Kinburn promontory, to protect the entrance to the Dnieper.

Ochakoff stands on the site of the old Miletan colony Olvia and of the Greek colony Alektor. The fortress of Kara-kerman or Ozu-kaleh was built on this spot by the khan of Crimea, Mengli-ghirei, in 1492. At a later date it became the centre of a Turkish province which included Ajiber (Ovidiopol), Haji-bei (Odessa), and Dubossary, as well as about 150 villages. Moscow, Poland, and the Zaporogue Cossacks, and later the Ukrainian Hetmans, often attacked it. Russia, regarding it as the main obstacle to the possession of the Black Sea littoral, besieged it in 1737, when it was captured by Minich; but next year it was abandoned, and restored in 1739 to Turkey. The second siege was begun in 1788, and lasted six months, until the fortress was stormed and taken, after a terrible loss of life. By the peace of 1791 it became Russian.

Oconto, a city of Wisconsin, U.S.A., capital of Oconto county, on the shore of Green Bay and on the Chicago and North-Western and the Chicago, Milwaukee, and St Paul railways, in the eastern part of the state, at an altitude of 593 feet. It is in a lumber region, and contains saw and planing mills, and has a large lumber trade. Population (1880), 4171; (1890), 5219; (1900), 5646, of whom 1544 were foreign-born.

Odenkirchen, a town of Prussia, in the Rhine province, 21 miles by rail south-west of Düsseldorf. It has linen, cotton, silk, woollen, dyeing, tanning, and other industries. There is also an agricultural school. Population (1885), 10,161; (1900), 14,745.

Odense, a seaport town and bishop's see of Denmark, the principal town on the island of Fünen, near the north coast. A canal, 4 miles long and 15½ to 21 feet deep, gives access to the town from Odense Fjord. Modern buildings include the town hall (Italian Gothic, 1880–83); the museum (built 1883–85, extended in 1897), with valuable collections of antiquities of the Stone Age, coins and medals, paintings, minerals, &c.; the Renaissance provincial archives (1892–93); and the cathedral school (1892–94). In the industrial quarter, Albani, are tanneries, breweries, distilleries, tobacco factories, iron-foundries and machine-shops, and the Mechanics' Institute (1890). In 1899 the port was entered by 876 vessels of 95,999 tons, and cleared by 949 vessels of 114,820 tons, the exports being mostly agricultural produce (bacon, butter, eggs), and the imports iron, groceries, petroleum, coal, yarn, and timber. Population (1880), 20,804; (1890), 30,268; (1901), 40,138, the boundaries having been several times extended between 1882 and 1901.

Odenwald, a wooded mountainous region of Germany, almost entirely in the grand-duchy of Hesse-Darmstadt, with small portions in Bavaria and Baden. It stretches between the Neckar and the Main, and is some 50 miles long by 20 to 30 broad. Its highest elevation is the hill of Katzenbuckel, 2057 feet, overlooking Eberbach on the Neckar. The western part, which rises steeply from the Rhine valley above the Bergstrasse (which connects Darmstadt and Heidelberg), is composed principally of crystalline slates and primary rocks; the eastern portions of New Red Sandstone. The wooded heights overlooking the Bergstrasse are studded with castles and mediæval ruins; and other ruined castles and sites are associated with some of the most memorable adventures of German tradition, *e.g.*, Rodenstein, the reputed home of the Wild Huntsman, and near Grasellenbach, the spot where Siegfried of the *Nibelungenlied* is said to have been slain by Hagen.

Oder, one of the chief rivers of Germany. The navigability of this, as of the other North German rivers, has been very greatly improved since 1875; nevertheless it still shows a strong tendency to choke itself with sand in certain places. The alterations consist principally of three systems of works:—(1) The canalization of the main stream (4 miles) at Breslau, and from the confluence of the Neisse of Glatz up to the mouth of the Klodnitz canal, a distance of over 50 miles, the two costing nearly £1,100,000. These engineering works were completed in 1896. (2) In 1887–91 the Oder-Spree canal was made to connect the two rivers named. The canal leaves the Oder at Fürstenburg (132 miles above its mouth) at an altitude of 93 feet, and after 15 miles enters the Friedrich-Wilhelm canal (134 feet). After coinciding with this for

7 miles, it makes another cut of 5 miles to the Spree at Fürstenwalde (126 feet). Then it follows the Spree for 12 miles, and at Gross Tränke (121 feet) passes out and goes to Lake Seddin (106 feet), 15 miles. Depth throughout, $8\frac{1}{4}$ feet; width, 60 to 90 feet; cost, £630,000. (3) The deepening and regulation of the mouth and lower course of the stream, consisting of the Kaiserfahrt, 3 miles long, affording a waterway between the Stettin Haff and the river Swine for the largest ocean-going vessels; a new cut, $4\frac{1}{4}$ miles long, from Woitzig on the Stettin Haff to Mellin Island; the Parnitz–Dunzig and Dunzig–Oder canals, together 1 mile long, constituting the immediate approach to Stettin. Vessels drawing 24 feet are now able to go right up to Stettin. A project has been mooted for connecting Stettin *viâ* the Oder and canals (to be constructed) with Berlin. Including the older canals (Finow, &c.), there are altogether 361 miles of canal and canalized river in the Oder basin, and in addition $93\frac{1}{2}$ miles connect it with the Elbe. The stream has a total length of 560 miles, of which 480 miles are navigable for boats, though above Glogau the depth does not exceed 3 feet. The drainage basin has an area of 43,300 square miles. Between the source and Breslau the total fall amounts to 1342 feet, between Frankfort and the sea only 66 feet. Altogether a total of 3,640,400 tons of merchandise pass through Breslau (up and down together) on the Oder in the year. There is valuable fishing in the lower part of the river, near Stettin.

For minor canalizations, see the official work, *Der Oderstrom*, &c., 3 vols. (Berlin, 1896); and consult also A. PENCK, "Der Oderstrom," in *Geog. Zeitschrift* (1899), pp. 19–47 and 84–94; HEUBACH, *Die Verkehrsentwickelung auf den Wasserstrassen und Eisenbahnen des Elbe–Oder Gebietes in dem Zeitraum von 1882–1895* (Berlin, 1898); and LEONHARD, *Der Stromlauf d. mittleren Oder* (Breslau, 1893).

Odessa, the chief city and seaport of Russia on the Black Sea. Its population, which increased from 225,000 in 1884 to 405,041 in 1897, is very varied, and out of a population of 340,526 in 1892, in the Odessa township (which includes the suburbs), there were 188,082 Russians, 112,235 Jews, 13,462 Poles, 8897 Germans, 5272 Greeks, 1129 French, and 11,449 of different nationalities. The industrial development has been rather slow, there being in the township only 261 factories, employing 12,000 workers, and showing a yearly return of about £2,600,000, steam flour-mills, sugar refineries, iron and mechanical works, factories of jute sacks, colour and varnish, soap, candle, confectionery, and chemical works being the chief. Commercially the city is now the chief seaport of Russia for exports, which in favourable years are twice as high as those of St Petersburg, while as regards the value of the imports it is second only to the northern capital. The total returns amount to nearly 150,000,000 roubles a year, representing about one-eighth of the entire Russian foreign trade, and 14 per cent. if the coast trade be included as well. The total exports are valued at £10,820,700 yearly (£11,000,000 including the transit trade), and the imports at £3,825,400; *i.e.*, about 9 per cent. of all the imports to Russia. Grain, and especially wheat, is the chief article of export (1,990,000 tons, £7,000,000, in 1895; wheat alone, £3,900,000). The chief customer for the exports is Great Britain; then follow Holland, Germany, France, Belgium, Denmark, Italy, and Scandinavia. Refined sugar (£850,000) comes next, and then seed, fish, raw wool, iron and iron goods, cottons (£200,000), small arms, furniture, tobacco, spirits, wooden wares, &c. These articles are exported to east Siberia, Turkey, Great Britain, France, Rumania, and so on. The chief imports are raw cotton, ships, iron, olive oil, fruit, tea, agricultural machinery, coal, chemicals, &c. The port was visited in 1895 by 1207 steamers (1,798,000 tons) and 70 sailing vessels (18,150 tons); and in the coasting trade by 1930 steamers (1,047,000 tons) and 2167 sailing vessels (120,000 tons). A new and spacious harbour, especially for the naphtha trade, was built in 1894–1900. Regular steam navigation is maintained with the Mediterranean and Baltic ports by a fleet of 75 steamers, with the Far East by 10 steamers, and with the Black Sea ports by a number of smaller steamers. The town has been provided with a costly system of drainage, electric light in the ports, a beautiful new theatre, a monument to Pushkin, and a number of schools, technical and general.

Oels, a town of Prussia, province of Silesia, 20 miles east-north-east of Breslau by rail. The castle was restored in 1894. In 1884 the extinction of the ducal line of Brunswick caused the principality of Oels to lapse to the Prussian Crown. Population (1885), 10,276; (1900), 10,580.

Oelsnitz, a town of Germany, on the Weisse Elster, 26 miles by rail south-south-west of the town and in the circle of Zwickau, kingdom of Saxony The making of Axminster carpets (one firm employing 1000 workmen), corsets, worsteds, curtains, ticks, and table-covers, jute-weaving and printing, are carried on. Population (1890), 9426; (1900), 13,606.

Oelwein, a city of Fayette county, Iowa, U.S.A., in the north-eastern part of the state, at the intersection of the Burlington, Cedar Rapids, and Northern, and the Chicago Great Western railways, a railway junction and shipping point of some importance. Population (1890), 830; (1900), 5142, of whom 789 were foreign-born.

Offenburg, a town of Germany, grand-duchy of Baden, 27 miles by rail south by west of Baden, on the river Kinzig. It has three churches; a memorial fountain to Lorenz Oken (1779–1851), who was born at Bohlsbach close by; a statue of Francis Drake (1853), as the alleged introducer of the potato into Europe; a commercial and a technical school; and manufactures of cottons, hats, cigars, machinery, glass, &c. Population (1885), 7765; (1895), 9727; (1900), 13,669.

Offenburg was founded towards the end of the 12th century, and early in the 13th became an imperial town, and so continued down to 1351. It again occupied the same status from the middle of the 16th century to the year 1802, when it was transferred to Baden.

Ogden, a city of Weber county, Utah, U.S.A., at the junction of the Weber and Ogden rivers, near the shores of Great Salt Lake, in the northern part of the state, at an altitude of 4310 feet. Its site slopes gently from the Wasatch Mountains on the east towards the lake, and its plan is perfectly regular, with broad, well-shaded streets, and a good water supply. Four railways, the Oregon Short Line, the Rio Grande Western, the Southern Pacific, and the Union Pacific, have termini at this point, making it the most important railway centre in the state and, next to Salt Lake, the largest city. Population (1890), 14,889; (1900), 16,313, of whom 3302 were foreign-born and 133 coloured, including 43 negroes.

Ogdensburg, a city of St Lawrence county, New York, U.S.A., on the St Lawrence river, at the mouth of the Oswegatchie, in the northern part of the state, at an altitude of 248 feet. The city has a regular plan, is divided into four wards, has broad, well-shaded streets, few of which are paved, and a good water supply by the Holly pumping system. Its harbour is fair, and it has considerable commerce on the Great Lakes. It has two railways, the New York Central and Hudson River and the Rutland. Population (1890), 11,662; (1900), 12,633, of whom 3222 were foreign-born.

Ogowe, one of the largest of the African rivers of the second class, rising in 3° S. in the zone of West African highlands sometimes known as the Cristal range, and flowing north-west and west to the Atlantic Ocean a little south of the Equator. Its course, which may be estimated at 700 miles, lies wholly within the territory of French Congo. Its upper basin, between 2° and 3° S., is still imperfectly known, but from 2° to its mouth it has been fully explored by French travellers. In spite of its considerable size, the river is of comparatively little use for navigation, as rapids constantly occur as it descends the successive steps of the interior tablelands. The principal obstructions are the falls of Dume, in 13° E.; Bunji, in 12° 35′; Chengwe, in 12° 16′; Bowe, in 11° 53′; and the rapids formed in the passes by which it breaks through the outer chains of the mountainous zone, between 10¾° and 11¾° E. It has a large number of tributaries, especially in its upper course, but of these few are navigable. The most important are the Lolo, which joins on the south bank in 12° 20′ E., and the Ivindo, from the north, a few miles lower down. The latter—explored in 1899 by Fourneau, and in 1901 by Lesieur—has proved to be a large stream, though obstructed by rapids in its lower course. It is even said to contain more water than the upper Ogowe. Below the Ivindo the largest tributaries are the Ofowe, 400 yards wide at its mouth (11° 47′ E.), but unnavigable except in the rains, and the Ngunye, the largest southern tributary, navigable for 60 miles to the Samba or Eugénie Falls.

Ohio, the fourth of the states of the American Union in population, bounded on the N. by Michigan and Lake Erie, on the E. by Pennsylvania and West Virginia, on the S. by West Virginia and Kentucky, and on the W. by Indiana.

Population.—The total population rose from 3,198,062 in 1880 to 3,672,316 in 1890, and to 4,157,545 in 1900. The percentage of increase for the decade ending in 1900 was 13·2, as compared with 14·8 for the ten years before. Between 1880 and 1890 the percentage of persons of foreign birth remained unchanged. Of the foreigners, numbering 459,293 in 1890, 50,947 were born in England, 70,127 in Ireland, 23,180 in Scotland and Wales, and 235,668 in Germany; and there was also a decided increase in the number of Italians, Russians, Hungarians, and Bohemians, this tendency being accentuated after 1890. The total land surface of Ohio is approximately 40,760 square miles, and the density of the population was therefore 102·0 in 1900, as compared with 90·1 in 1890. In 1900 the native-born numbered 3,698,811 and the foreign-born 458,734, the latter showing a slight decrease for the decade. At the same date there were 96,901 negroes in the state. There were, in 1900, 143 incorporated places with a population of 2000 or over: of these 72 had a population of less than 5000; 43 had more than 5000 but less than 10,000; 19 had more than 10,000 but less than 25,000; and 9 had more than 25,000, namely, Cleveland, 381,768 (increase since 1890, 120,415); Cincinnati, 325,902 (increase, 28,994); Toledo, 131,422 (increase, 50,388); Columbus, 125,560 (increase, 37,410); Dayton, 85,333; Youngstown, 44,885; Akron, 42,728; Springfield, 38,253; Canton, 30,667. The urban population in 1900 was 38·5 of the total population, as compared with 31·6 in 1890. Prosecutions for crimes against the person have not increased since 1882, but prosecutions for crimes against property have increased slightly from 2049 to 2210, the latter including 2560 individuals. In the five years from 1882 to 1886 the divorces equalled $5\frac{9}{10}$ per cent. of the marriages, while in the five years from 1896 to 1900 they constituted 9 per cent. of the marriages. Because of its situation with water routes to all ports of the Mississippi valley and of the Great Lakes, its manufactures and commerce have outstripped its agricultural interests in development. Between 1880 and 1890 the number of farmers increased from 260,520 to 275,221, while the number of persons engaged in trade and transportation increased from 101,445 to 180,978, and those engaged in manufacturing and the mechanical arts from 204,787 to 273,650. Moreover, the percentage of the urban population to the total population increased in the same time from 23·3 to 31·6. And the rate of increase in the six principal lake towns, Cleveland, Toledo, Sandusky, Lorain, Conneaut, and Ashtabula, was 61 per cent., although the rate for the total population was only 14 per cent.

Agriculture.—During the years from 1882 to 1899 the agricultural interests grew slowly but steadily. Cultivated land increased from 9,388,018 acres to 10,239,866. Pasture land remained about the same, while woodland decreased from 4,208,247 acres to 2,817,599. The average production of wheat in the five years from 1882 to 1886 inclusive was 33,504,000 bushels, and from 1895 to 1899 inclusive, 33,700,000. Of shelled corn the yield for the same periods amounted to 88,733,000 bushels and 155,124,000. There was an increase in the corn acreage, but no substantial increase in the acreage of wheat. In 1882 the orchards covered 388,574 acres; in 1899, 359,256. The crop showed great fluctuations from year to year, but no decided tendency to increase or to diminish. The acreage of vineyards, situated principally along the lake shore, increased; and the product rose from 11,678,545 lb of grapes in 1882 to 31,127,743 lb in 1889. The number of horses and cattle fell off about one-fourth. Certain dairy products, eggs and milk, were increased, while there was a decrease in the production of butter and cheese. The wool clip fell off decidedly through the whole period, rallying slightly in 1898 and 1899, and was apparently little affected by changes in the tariff. In 1882 the amount was 23,629,424 lb; in 1890, 18,629,961; and in 1899, 13,017,052.

The following table shows the growth of manufactures in recent years:—

	1880.	890.	1900.	Percentage of Increase, 1890–1900.
Number of establishments . . .	20,699	28,673	32,398	13·0
Capital . . .	$188,939,614	$402,793,019	$605,792,266	50·4
Wage-earners, average number . . .	183,609	292,982	345,869	18·1
Value of product .	$348,298,390	$641,688,064	$832,438,113	29·7

The leading industries were iron and steel, the value of the products of which increased from $65,206,828 in 1890 to $138,935,256 in 1900; foundry and machine shops, with products valued in 1900 at $72,399,632; flouring and grist-mills, $37,390,367; liquors, $31,771,591; and lumber and timber, $20,790,854. In the value of its manufactures Ohio ranks as fifth among the states.

Minerals.—The mining of iron ore has been almost abandoned, the product falling from 276,286 tons in 1884 to 52,266 in 1900; while the product of bituminous coal has risen from 9,450,000 tons in 1882 to 11,788,859 tons in 1890, and to 12,448,822 in 1897. In 1884 natural gas was discovered at a deeper level than that at which it had been believed to exist. In January 1886 a well was drilled at Findlay to a depth of 1144 feet. For a time the daily yield was 12,080,000 cubic feet. Findlay soon had a daily product of 25,000,000 feet. These discoveries led to others in various parts of the state and of neighbouring states, but the supply was wastefully used, so that after a time it became uncertain, and its commercial value decreased.

Railways and Transportation.—The natural highways afforded by Lake Erie and the Ohio river are supplemented by systems of canals and of railways. With the development of the railways, the receipts from the canals have fallen off, so that there has long been an annual deficit; yet the General Assembly has maintained the canals, wisely seeing in them a means of keeping rates of transportation from becoming oppressive. The mileage of railways, including main line, second line, branches, and side tracks, in 1882 was 8311; in 1890, 10,504; and in 1898, 13,289. The valuation of railways for taxation increased 18 millions during the same period. The receipts for 1898 were $68,764,938, and the expenditures $49,062,218. There has been a decided tendency towards consolidation. Such through lines as the Lake Shore and Michigan Southern, the Pennsylvania, the Erie, the Baltimore and Ohio, and the Cleveland, Columbus, Cincinnati, and St Louis have acquired control by purchase or by lease of many of the minor lines. So far has this movement for consolidation gone that the Lake Shore and Michigan Southern and the Baltimore and Ohio have passed under the control of other and larger railway companies.

Banks.—The national banks increased from 189 in 1882, with a capital of $31,464,000, to 228 in 1890, with a capital of $39,592,719, and to 268 in 1900, with a capital of $45,380,670. The state banks and banking associations grew even more rapidly, from 30 in 1882 to 181 in 1900, with a capital of $14,895,532.

Finances.—From 1882 to 1900 the valuation increased from $1,634,910,734 to $1,834,053,228. The state tax remained about the same, while the local taxation increased 5 millions. The net receipts of the state treasury for 1900 were $5,222,355, and the disbursements $5,104,769. The funded debt on 15th November 1900 was $701,665. In 1882 it was $4,901,665. More than half of this debt became due in 1886, and was refunded at 3 per cent., a reduction of one-half in the rate of interest. The local debts increased from $45,766,551 in 1882 to $62,992,957 in 1890 and $96,193,514 in 1899.

Education.—The number of children of school age rose from 1,081,321 in 1882 to 1,226,366 in 1900. Of these 829,160 were enrolled, and 616,365 in daily attendance. The number of teachers employed was 26,017. The receipts amounted to $14,426,858, and the expenditures to $14,266,973. There were, in 1882, 25 colleges granting a degree; in 1890, 30; in 1900, 32. The number of instructors increased from 222 to 1031. Of the 222 instructors in 1882, 27 per cent. were in four institutions, *i.e.*, Oberlin College, Ohio State, Ohio Wesleyan, and Western Reserve universities; but of the 1031 instructors in 1900, 47 per cent. were in these institutions. In 1898 the total property reported was $14,716,782; the income, $1,242,135; and the expenditures, exclusive of permanent improvements, $902,714. In nearly all the colleges men and women are admitted, but the co-educational system was abandoned by Adelbert College, of Western Reserve University, formerly Western Reserve College at Hudson, and a separate college for women was organized as a department of the university. In 1890 the total number of students in universities and colleges was 3963, of whom 1163 were women; in 1898 it was 5530, of whom 1582 were women.

Churches.—The organized churches in 1890 numbered 9345. The Catholics were the leading denomination, with 336,114 communicants in 586 churches, and a property of $7,395,640; although the Methodists, with a smaller number of communicants (272,737), had 2798 churches and a property of $9,600,820. In number of communicants and in property the Presbyterians come third, but they have fewer churches than the Baptists. The Episcopalians, though seventh in number of communicants and ninth in number of churches, are fifth in property

Public Institutions.—There are 17 charitable institutions, maintained by the state at an expense of $3,085,880. They include 8 hospitals for the insane, 2 asylums for juvenile offenders, 1 reformatory, 5 educational and benevolent institutions, and the penitentiary.

Legislation.—Legislation regulating or taxing the liquor traffic has been difficult, owing to a section in the constitution which forbids the granting of licences for the sale of liquors. After some futile attempts at legal control, the Dow tax law was passed in 1886, and successfully defended in the courts as a tax and not a licence. The organization of the state government, with a General Assembly uncontrolled by executive veto and with an independent executive, has been unchanged, except that circuit courts have been substituted for the district courts, and that the constitutional provision for biennial sessions of the General Assembly, after remaining a dead letter since 1851, was in 1894 carried out by the passing of an appropriation bill covering the expenses of two years and by an adjournment *sine die.* The election laws were changed by introducing the Australian ballot system in 1891, and by granting in 1894 the suffrage to women for the election of school officials. The results of the last measure have been unsatisfactory, even to its advocates.

Politics.—Since 1882 the Republicans have uniformly been successful, except in the elections for governor in 1883 and 1889; in the latter year their failure was attributed to personal rather than political reasons. The Prohibitionist party gradually lost strength, and was finally disorganized by the famous struggle between the Republicans and Democrats in 1896. It polled only one-fourth of its average vote at that election, and rallied only slightly in 1897 and 1898, to fall back again in 1899. In the Presidential election of 1884, 784,610 votes were cast as follows:—Republican, 400,082; Democratic, 368,280; Prohibitionist, 11,069; Greenback, 5179. In the election of 1888, 840,361 votes were cast as follows:—Republican, 416,054; Democratic, 396,455; Prohibitionist, 24,356; Union Labour, 3496. In the election of 1892, 850,164 votes were cast as follows:—Republican, 405,187; Democratic, 404,115; People's Party, 14,850; Prohibitionist, 26,012. In 1896, 1,014,295 votes were cast as follows:—Republican, 525,991; Democratic, 474,882; People's, 2615; Prohibitionist, 5068; National Party, 2716; Social Labour, 1165; National Democrat, 1858. In 1900, 1,040,073 votes were cast as follows:—Republican, 543,918; Democratic, 474,882; Union Reform, 4284; Prohibitionist, 10,203; Social Labour, 1688; People's, 251; Social Democrat, 4847.

See Ohio Statistics (annual), published by the Secretary of State, and reports of various State Boards.—Publications of the Ohio Archæological and Historical Society, 7 vols. 1893–99.—*Historical Collections of Ohio*, 3 vols. Columbus, 1889–91.—*List of Books on Ohio.* Cincinnati, 1893.—KING. *Ohio.* (American Commonwealth Series). Boston, 1889.—HINSDALE. *The Old North-West.* New York, 1888.—KNIGHT and COMMONS. *History of Higher Education in Ohio.* Washington, 1891. (H. E. B.)

Ohio River, the largest eastern branch of the Mississippi river, U.S.A., formed by two main forks, the Allegheny river, which rises in southern New York, and the Monongahela, rising in West Virginia. These two streams join at Pittsburg. Its general course from Pittsburg to its mouth at Cairo is south-west, although in detail it flows in nearly every direction except eastwards. Its length is 963 miles. It is navigable throughout, with the exception of the falls at Louisville, which are overcome by means of a canal and lock. Its drainage basin comprises 201,720 square miles, including parts of New York and Pennsylvania, nearly all of West Virginia and part of Virginia, most of Ohio and Indiana, and a large part of Illinois, all of Kentucky, nearly all of Tennessee, and parts of North Carolina, Alabama, and Mississippi. Besides its parent streams, the Allegheny and Monongahela, the Ohio has numerous large branches. On the north it receives the waters of the Muskingum, Scioto, Miami, and Wabash rivers, and on the south those of the Kanawha, Big Sandy, Kentucky, Green, Cumberland, and Tennessee rivers. The Ohio drains the western slope of the Cumberland–Allegheny plateau from New York south to Alabama, and also most of the east side of the Mississippi valley. Several large cities are on its banks, among them Pittsburg, Cincinnati, and Louisville. For a century the Ohio has been one of the great highways of internal commerce, and even now, in spite of the competition of the railways, its waters are laden with boats which transport the heavier and bulkier articles of freight, such as coal and lumber.

Ohlau, a town of Prussia, province of Silesia, 16 miles by rail south-east of Breslau, on the left bank of the Oder. It is the centre of a tobacco-growing district and has manufactures of cigars, machinery, white lead, beer, &c. In the 17th and 18th centuries it was often the residence of the dukes of Brieg and of the Sobieskis. Population (1885), 8575; (1900), 9235.

Ohligs, a town of Prussia, in the Rhine province, 17 miles by rail north of Cologne. It is an industrial place, manufacturing cutlery, hardware, silks, and bricks, and possessing iron-foundries and flour-mills. Down to 1891 it was known as Merscheid. Population (1885), 12,646; (1900), 20,682.

Ohrdruf, a town of Germany, duchy of Saxe-Coburg-Gotha, 11 miles by rail south by east of Gotha. It has manufactures of porcelain, paper, copper goods, small wares (buttons, &c.). It has a castle, a couple of churches, and a technical school. Close by is the summer resort of Luisenthal. Population (1900), 6295.

Oil City, a city of Venango county, Pennsylvania, U.S.A., on the Allegheny river, at the mouth of Oil Creek, in the north-western part of the state, at an altitude of 1005 feet. It is in the centre of the Pennsylvania oil region, and owes its existence to the development of the petroleum industry. It contains petroleum refineries, and its manufactures are in great part related to the production and refining of oil. It is at the intersection of four railways, the Allegheny Valley, the Erie, the Lake Shore and Michigan Southern, and the Western New York and Pennsylvania. Population (1890), 10,932; (1900), 13,264—2001 foreign-born and 184 negroes.

Oil Engines. See Engines, 3.

Oise, a department of northern France, traversed by the Oise.

Area, 2272 square miles. The population, 404,555 in 1881, was 405,642 in 1901. Births in 1899, 8933, of which 861 were illegitimate; deaths, 9387; marriages, 3174. The schools in 1896 numbered 1134, with 57,000 pupils, and 4 per cent. of the population was illiterate. Out of 1,417,780 acres cultivated in 1896, 948,480 were plough-land, 32,110 gardens, and the rest grass and woodland. The wheat produce of 1899 returned the value of £1,640,000; rye, £120,000; oats, £1,005,000; mangold-wurzel, £208,000; potatoes, £260,000; beetroot, £1,280,000; apples, £52,000. Oise owned in 1899, 48,990 horses, 126,180 cattle, 354,500 sheep, and 35,280 pigs. With the exception of building-stone, the department raised (1898) only 8300 metric tons of peat; but the industry in metals yielded, in 1898, 17,000 tons of iron and 41,000 tons of steel, of a total value of nearly £400,000. Oise ranks fifth among the departments for the production of sugar—1,400,000 cwts. in 1899—while its alcoholic production in the same year amounted to 1,760,000 gallons. These, with tapestry, are the principal industries. Beauvais, the capital, had in 1901, 20,300 inhabitants.

Okehampton, a municipal borough, parish, and market town in the Tavistock parliamentary division of Devonshire, England, on the East and West Okement rivers, 22 miles west by north of Exeter by rail. Its earliest charter dates from 1623. In 1885 the electric light was adopted by the town, a complete scheme of drainage was carried out in 1886–87, and the market premises were rebuilt in 1900. The curfew bell is still tolled here. Population (1891), 1879; (1901), 2568.

Oki, a group of islands belonging to Japan, lying due north of the province of Izumo, at the intersection of 36° N. and 133° E. The group consists of one large island called Dôgo, and three smaller isles—Chiburi-shima, Nishi-no-shima, and Naka-shima—which are collectively known as Dôzen. These four islands have a coast-line of 182 miles, an area of 130 square miles, and a population of 62,759. The island of Dôgo has two high peaks, Daimanji-mine (2185 feet) and Omine-yama (2128 feet). The chief town is Saigo in Dôgo, distant about 40 miles from the port of Sakai in Izumo. The name Oki-no-shima signifies "islands in the offing," and the place is celebrated in Japanese history not only because the possession of the islands was much disputed in feudal days, but also because an ex-emperor and an emperor were banished thither by the Hôjô regents in the 13th century. Great quantities of cuttle-fish are taken at the archipelago.

Oklahoma, a territory lying in the south central part of the United States, organized under an Act of Congress, passed 2nd May 1890. It was formed from the western part of Indian Territory, and included all that part of it not occupied by the Five Civilized Tribes, and the Indian tribes within the Quapaw Agency, except the Cherokee outlet lands. The Cherokee outlet and "No Man's Land" were added by proclamation of the President in September 1893. Lying between 34° and 37° N. and 96° and 103° W., it is bounded on the N. by Colorado and Kansas, on the E. by Indian Territory, on the S. by Texas, and on the W. by Texas and New Mexico. There are contained within its boundaries 39,030 square miles, of which 4600 square miles are reserved. Geologically it is divided into regions of mountains, prairie plains, and great plains. The group or range, in the southern part, known as the Wichita Mountains, is of granitic formation, and rises through Silurian limestones and red beds to an altitude of about 2700 feet above the sea-level. The prairie plains in the north-east are a continuation of the residual soils of the Carboniferous prairies to the east, extending westwards to about 97° 30′ W., marked by red sandy clays, or red beds, and further characterized by great deposits of gypsum and salt. Here and there over the prairies are areas of Cretaceous formation, the sandy beds of which are covered with oak timber ("Cross timbers"). The great plains in Oklahoma are eastern breaks of the Great Plains plateau to the west, making a ragged line through the western part, with sandy tongue-like divides between the streams. Soils and rocks are sandstone, gravel, and marl, and there are great salt deposits in the north-western corner along Beaver Creek.

Geography.—There is very little relief to the surface, which is generally flat or rolling prairie, with the single exception of the isolated Wichita Mountains, situated in the middle southern portion. The principal rivers, which are the characteristic broad shallow streams of the semi-arid west, flowing through wide valleys, are the Arkansas, Cimarron, North Fork of Canadian, Washita, North Fork of Red, and Red rivers. The extreme western portion is a semi-arid, treeless plain, while the extreme eastern part is wooded by the belt of forest known as the "Cross timbers"; between lie fertile prairies and valleys partly wooded and principally along streams. The forest is composed largely of varieties of oak on the higher ground, with ash, elm, and cottonwood by the rivers in the valleys. The climate is about the same as Arkansas and Tennessee, except that it is less humid, the mean annual rainfall being about 32 inches in the eastern part of the Territory and about 20 inches in the western. Among the wild animals and birds are deer, antelope, wolf, coyote, fox, prairie dog, rabbit, squirrel, turkey, prairie chicken, quail, hawk, and buzzard.

History.—For a number of years before the opening of this country, public lands in adjoining territory had been so over-populated that many illegal attempts were made by covetous squatters to obtain possession. When finally the lands had been purchased of the Indians by the Government, and thrown open to settlement, the rush to secure homesteads and town lots was unprecedented, there being five or six persons for every available claim, and innumerable contests arose in consequence. Probably no agricultural country was ever settled with such rapidity. Towns were started without a single inhabitant in the morning and by night contained a population of five thousand, housed in tents or without shelter. Railways already built facilitated this rapid growth by landing building material and supplies without delay. "No Man's Land," the extreme western strip of land, was for many years unattached to any state or territory, and designated on the maps as "Public Land." Greer county, in the south-western corner, was disputed territory for many years, the state of Texas claiming that the North Fork of the Red river was the main stream, and therefore the boundary line. A decision of the United States Supreme Court was against this claim and it remains attached to Oklahoma.

Products.—The eastern and middle parts are agricultural lands, the richest soil being in the bottom lands of the broad river valleys, devoted to the cultivation of various farm products, the most important of which are wheat, oats, cotton, and corn. Indian corn, castor beans, melons, pea-nuts, alfalfa, and many fruits and vegetables are raised. The rainfall is occasionally much below the average, when failures result, but with normal conditions the soil produces luxuriantly. The western part is a grazing land, affording pasturage for cattle in large numbers. Horses, sheep, and swine are also raised. No trustworthy statistics have been gathered since the settlement of the country in regard to farm products or domestic animals, but from the best obtainable data it is estimated that during 1901 25,000,000 bushels of wheat, 60,000,000 bushels of corn, and 140,000 bales of cotton were raised, and that 36,235 horses, 52,580 mules, 617,750 cattle, 42,000 sheep, and 277,289 hogs were owned in the Territory.

Population.—The population in 1900 was 398,331, as compared with 61,834 in 1890; 214,359 were males and 183,972 were females; 382,651 were native and 15,680 were foreign-born; 367,524 were whites, 18,831 were negro, 11,945 were Indians, and 31 were Chinese. The population materially increased in 1901 by the opening to settlement of the Kiowa and Comanche Indian Reservation. The average number of persons to the square mile was 10·3, as compared with 1·6 in 1890. There were fifty incorporated cities and towns in 1900, but of these only two had a population of over 4000, namely, Oklahoma city with 10,037, and Guthrie (the capital) with 10,006 inhabitants. There are 700 churches and 2000 public schools, several normal schools, and an agricultural college, the school attendance being 110,000. One thousand and seventy-five miles of railway had been built at the beginning of 1901, four trunk lines extending across the Territory. There are about 12,000 Indians upon the several reservations and allotted lands set apart for their use, representing members of the following tribes: Kiowa, Comanche, Apache, Wichita, Cheyenne, Arapaho, Sac and Fox, Ponca, Pawnee, Caddo, Delaware, Kansas, Osage, and Shawnee. Some of the tribes are dependent upon the Government for support, while others are self-sustaining. Several Government schools are maintained, attended by 2000 Indian children. Many acres of their land are leased for grazing purposes, but some of it is used by the Indians themselves for agriculture and grazing. There is a military post at Fort Sill and also at Fort Reno. About 400 Apache Indians, prisoners of war, are held on a small reservation near Fort Sill, where they are slowly becoming civilized, and are taught farming and cattle-raising.

There has been a remarkable increase in the manufactures and mechanical industries since 1890, an increase even more striking than the increase in population (544·2 per cent.), and exceeding that of any other state or territory. Compared with older localities, the amount of manufacturing is still insignificant. A notable product is the manufacture of cotton-seed oil, which has grown with the rapid development of the cotton crop. The accompanying table is a comparative summary of the manufacturing and mechanical industries of the Territory for 1890 and 1900. (C. H. F.)

	1890.	1900.	Per cent. of Increase.
Number of establishments	72	870	1,108·3
Capital	$95,519	$3,352,064	3,409·3
Wage - earners, average number . . .	147	2,054	1,297·3
Total wages . . .	$52,326	$807,826	1,443·8
Miscellaneous expenses .	$21,970	$246,081	1,020·1
Cost of materials used .	$56,518	$4,449,944	7,773·5
Value of products, including custom work and repairing . . .	$180,445	$7,083,938	3,825·8

Oklahoma, a city of Oklahoma Territory, U.S.A., capital of Oklahoma county, on the north fork of the Canadian river and on the Atchison, Topeka, and Santa Fé, the Choctaw, Oklahoma, and Gulf, and the St Louis and San Francisco railways, in the south-eastern portion of the territory, at an altitude of 1195 feet. The city is regularly laid out on a level site, has considerable trade in cotton, and contains cotton gins and flour and other mills or factories. It was settled in 1889. Population (1890), 4151; (1900), 10,037, of whom 571 were foreign-born and 1219 negroes.

Okuma (Shigenobu), Count (1837——), Japanese statesman, was born in the province of Hizen in the year 1837. His father was an officer in the artillery, and during his early years his education consisted mainly of the study of Chinese literature. Happily for him, however, he was able to acquire in his youth a knowledge of English and Dutch, and by the help of some missionaries he succeeded in obtaining books in those languages on both scientific and political subjects. These works effected a complete revolution in his mind. He had been designed by his parents for the military profession, but the new light which now broke in upon him determined him to devote his entire energies to the abolition of the existing feudal system and to the establishment of a constitutional government. With impetuous zeal he urged his views on his countrymen, and though he took no active part in the revolution of 1868, the effect of his opinions exercised no slight weight in the struggle. Already he was a marked man, and no sooner was the Government reorganized, with the Mikado as the sole wielder of power, than he was appointed chief assistant in the department of Foreign Affairs. In the following year he succeeded to the post of secretary of the joint departments of the Interior and of Finance, and for the next fourteen years he devoted himself wholly to politics. In 1870 he was made a councillor of state, and a few months later he accepted the office of president of the commission which represented the Japanese Government at the Vienna Exhibition. In 1872 he was again appointed minister of finance, and when the expedition under General Saigô was sent to Formosa (1874) to chastise the natives of that island for the murder of some shipwrecked fishermen, he was nominated president of the commission appointed to supervise the campaign. Throughout his political career Count Okuma was a leader of the progressive party, and with indefatigable energy he in 1887 advocated the revision of the treaties. By one of those waves of popular feeling to which the Japanese people are peculiarly liable, the nation which had supported him up to a certain point suddenly veered round and opposed him with heated violence. So strong was the feeling against him that on one occasion a would-be assassin threw at him a dynamite shell, which blew off one of his legs. During the whole of his public life he recognized the necessity of promoting education. When he resigned office in the early 'eighties he established the Semmon Gako, or school for special studies, at the cost of the 30,000 yen which had been voted him when he received the title of count, and subsequently he was instrumental in founding other schools and colleges. He was a consistent advocate for the higher education of women, and did much to elevate the position of his countrywomen in the social scale. In 1896 he joined the Matsukata cabinet, and resigned in the following year in consequence of intrigues which produced an estrangement between him and the prime minister. On the retirement of Marquis Ito in 1898 he again took office, combining the duties of premier with those of minister of foreign affairs. But dissensions having arisen in the cabinet, he resigned a few months later, and retired into private life, cultivating his beautiful garden at Waseda near Tôkyô.

Öland, an island of Sweden, lying off the east coast, from which it is separated by Calmar Sound. The principal products are cattle, game, fish, cement, lime, and building stone. The town of Borgholm (population, 926 in 1900) has now a certain repute as a seaside resort. Population of island (1900), 30,408, scarcely more than in the middle of the 19th century.

Old-Age Pensions.—The organization of annuities for the poor by the State was proposed in the 18th century—*e.g.*, by Francis Maseres, cursitor baron of the Exchequer, in 1772, and by Mr Mark Rolle, M.P., in 1787. Suggestions for subsidizing friendly societies have also been frequent—*e.g.*, by T. Paine in 1795, tentatively in Sturges Bourne's Report on the Poor Laws, 1817, and by Lord Lansdowne in 1837. The subject has been revived in the present day. Many persons unfortunately become destitute in old age, and it has been tacitly assumed by advocates of State pensions that destitution in old age is entitled to greater public sympathy, and that it can advantageously be dealt with in a manner more liberal, than the destitution of widows, orphans, and persons prematurely stricken with permanent illness. No such plea, however, was originally put forward by Canon Blackley, the reviver of the controversy towards the close of the 19th century. His plan assumed the ability of the great mass of the population to provide for themselves. He proposed, therefore, to compel every one to insure with a State department against sickness and old age, and essentially his scheme was one for the relief of the ratepayers and a more equitable readjustment of the poor-rate. The terms provisionally put forward by him required that every one in youth should pay £10, in return for which the State was to grant 8s. a week sick allowance and 4s. pension after seventy. These proposals were submitted to the Select Committee on National Provident Insurance, 1885–1887. This body reported unfavourably, more especially on the sick insurance part of the scheme, but the idea of old-age pension survived, and was taken up by the National Provident League, of which Mr (afterwards Sir) J. Rankin, M.P., was chairman. The subject was discussed in the constituencies and expectation was aroused. An unofficial parliamentary committee was formed, with Mr Chamberlain as chairman. This committee published proposals in March 1892, which show a very interesting change of attitude on the part of the promoters. Compulsion, which at the earlier period had found favour with Canon Blackley, Sir J. Rankin, and even Mr Chamberlain, was no longer urged. The annuitant was no longer required to pay a premium adequate to the benefits promised, as in Canon Blackley's proposal. The benefit was no longer a pure annuity, but premiums were, in certain cases, returnable, and allowances were provided for widows, children (if any), and for the next of kin. Canon Blackley's professed object was to supersede the friendly societies, which, he alleged, were more or less insolvent; a proposal was now introduced to double every half-crown of pension derived by members from their friendly societies. Several alternative schemes were put forward, but the figures were only provisional, and it is enough to say that the principle suggested was to double, by subsidy from public funds, the value of the contribution made by the annuitant himself. Adverse criticism has been directed against these voluntary and contributory schemes, not only by those who are entirely opposed to State intervention, but by an influential section of those who favour that principle. Of these, Mr Charles Booth has been the most prominent spokesman. There is only one point of agreement between these two schools. They both assume, not only what all admit, that the destitution of old age is entitled to sympathy, but that it is entitled to a special treatment not accorded to other forms of destitution. Mr Chamberlain's scheme proposes State assistance, on condition that the annuitant voluntarily contributes one-half the requisite amount. Mr Booth points out that this condition will not be fulfilled by the class from which pauperism is drawn. Unless the pension is gratuitous, this class either would not or could not profit by it. Accordingly Mr Booth has proposed that there shall be a general endowment of old age, *i.e.*, as originally proposed, 5s. a week to every one at the age of sixty-five. The details have been varied, but the principle is the same. This proposal involves an expenditure of £18,000,000 for England and Wales and £24,000,000 for the United Kingdom, exclusive of the cost of administration. So large an expenditure has been felt to be a difficulty, and proposals have been made to limit the gratuity either to a special class, *e.g.*, persons with an income of less than 10s. weekly or to members of a friendly society, or to those who require it and are of good character. Mr Booth, however, considers universality to be of the essence of his scheme. The difficulty of drawing a line between those who are, and those who are not, entitled to such assistance seems to him insuperable; and to limit the endowment to those who plead destitution is to reduce the system to a form of poor-law relief, which *ex hypothesi* is supposed to be unsatisfactory. Mr Booth throughout has been anxious to append to his scheme the further condition, that, on its adoption, out-door poor-law relief shall be discontinued. How far this is accepted by those who act with him is not clear. While Mr Booth has severely criticized the weak points of the contributory and voluntary schemes, their most influential advocate, Mr Chamberlain, has not spared Mr Booth's proposals. Speaking at Highbury, for instance, on 24th May 1899, he described Mr Booth's universal scheme as "a gigantic system of out-door relief for every one, good and bad, thrifty and unthrifty, the waster, drunkard, and idler, as well as the industrious," and very forcibly stated his inability to support it.

Notwithstanding these differences of opinion, the advocacy of these gentlemen has raised considerable expectation, and the subject has been referred to a succession of commissions and committees, but without any practical result. In 1893 Mr Gladstone's Government was pressed to declare a policy, and sought refuge in a royal commission (Lord Aberdare, chairman). A majority report, adverse to the principle of State pensions, was issued in 1895. A minority report, signed by Mr Chamberlain and others, dissented, mainly on the ground that public expectation would be disappointed, if nothing was done. In 1896 Lord Salisbury appointed a committee "of experts" (Lord Rothschild, chairman) to report on schemes submitted, and, if necessary, to devise a scheme. The committee were unable to recommend any of the schemes submitted, and added that, "we ourselves are unable, after repeated attempts, to devise any proposal free from grave inherent disadvantages." This second condemnation was not considered conclusive, and a select committee of the House of Commons (Mr Chaplin, chairman) was appointed to consider the condition of "the aged deserving poor." After an ineffectual attempt by Mr Chaplin to induce the committee to drop the pension idea, and to consider the provision made for the aged by the poor law, the committee somewhat hastily promulgated a scheme of gratuitous pensions for persons possessing certain qualifications. Of these the following were the most important:—age of sixty-five; no conviction for crime; no poor-law relief, "unless under exceptional circumstances," within twenty years; non-possession of income of 10s. a week; proved industry, or proved exercise of reasonable providence by some definite mode of thrift. The committee refrained from explaining the machinery and from estimating the cost, and suggested that this last problem should be submitted to yet another committee.

Accordingly a departmental committee (chairman, Sir E. Hamilton) was appointed, which reported in January 1900. The estimated cost of the above plan was, by this committee, calculated at £10,300,000 in 1901, rising to £15,650,000 in 1921. Mr Chaplin had publicly suggested that £2,000,000, the proceeds of a 1s. duty on corn, would go a long way to meet the needs of the case—a conjecture which was obviously far too sanguine. These unfavourable reports appear to have discouraged the more responsible advocates of State pensions. Mr Chamberlain appealed to the friendly societies to formulate a plan, an invitation which they showed no disposition to accept. Efforts continued to be made to press forward Mr Booth's universal endowment scheme or some modification of it. To this Mr Chamberlain declared his hostility. And here up to 1902 the matter rested.

The scheme throughout has been strongly opposed by the school of poor-law reformers generally identified with the London Charity Organization Society. Mr Booth's universal proposal they consider impracticable, and unnecessary to a large extent; and, where necessary, not to be distinguished in its moral and economic effects from poor-law relief. They object also to State-assisted pensions, on the ground that they attempt to popularize a form of investment which probably is not the best use of a poor man's savings. The leaders of the great friendly society movement have also, with few exceptions, opposed or stood aloof from the proposal. Their aim is the absolute independence of their members. The offer of gratuity to their own associations, though very tempting, has been rejected partly on grounds of principle, and also from the belief that State aid would mean more State supervision and ultimately State management.

The movement in favour of State aid to provision for old age has been largely due to the example of Germany. The German system (which for old age dates from 1891) is compulsory and contributory. The element of compulsion was very early deemed unsuitable for the United Kingdom, and the precedent of Germany, therefore, no longer applies. One half of the premium payable is there paid by the labourer, the other half by the employer. The State adds a subvention to the allowances paid to the annuitant. (See *The German Law of Insurance against Invalidity and Old Age*, by T. E. Young, actuary of the Commercial Union Assurance Company, 1891.) A well-informed article by Mr H. W. Wolff in the *Charity Organization Review*, December 1899, describes another phase of the question. He points out that the law is unpopular both with the workmen and the employer, and that the financial difficulty of employing the insurance fund is considerable and progressive. Continuous pressure seems to be exerted in favour of raising the amount of pension and of relaxing the conditions of contributory thrift. The Government, much against its will, is being pushed away from the endowment of thrift, which has been its ideal, towards the mere endowment of old age, which it has always condemned.

The Danish system of old-age pensions differs entirely from the above. It has been disavowed and condemned by Dr Bödeker, the late President of the German State Insurance Department, as a mere extension of out-door relief, as an endowment, and therefore an encouragement not of thrift but of need. The Danish system has been described by Mr A. W. Flux in a pamphlet reprinted from the *Yale Review*, February 1899, and by Mr J. S. Davy of the Local Government Board in evidence given to the Select Committee on the Aged Deserving Poor, 1899. By the law of 1891, the burden of maintaining the aged is in part transferred from the local to the national taxes, and relief from this latter source is called a pension. The committee remark on the Danish plan, "It is difficult to see what substantial difference there is in practice between the pensions in Denmark and the out-relief given in this country [Great Britain] to the deserving poor, except that in Denmark such relief can be claimed as a matter of right, and conveys no civil disqualification." The grant of a pension, though it can be claimed as a right, can be refused, if the applicant is of bad character, has been in receipt of poor-law relief within ten years, or if from other sources he has enough to maintain him. The allowance given, it is stated, like the British system of out-door relief, tends to be inadequate, for it is assumed that applicants as a rule do not fully disclose their resources. As might be expected, the change of incidence of the burden, though it has decreased the demand on the local rates, has increased expenditure by a more than commensurate addition to the central taxes. The idea that, while to be a recipient of poor-law relief is derogatory from the part of a good citizen, the dependency of a pensioner is an honourable status, has gained some sort of currency. Accordingly, promises to extend the scope and amenity of pension-endowment, a form of dependency that is not injurious, are put forward in the rivalry of party politics.

New Zealand.—In 1898 a Bill, introduced by the Rt. Hon. R. J. Seddon, premier, became law which provided for the payment of an old-age pension out of the consolidated fund (revenue of the general government) to persons duly qualified, without contribution by the beneficiaries. The claimants must be 65 years of age, resident in the colony, and have so resided for 25 years. They must be free from conviction for lesser legal offences for 12 years, and for more serious breaches of the law for 25 years, previous to the application. They must be of good moral character and have a record of sobriety and respectability for five years. Their yearly income must not exceed £52, and they must not be owners of property exceeding in value £270. Aliens, aborigines, Chinese, and Asiatics are excluded. The pensions are for £18 per annum, but for each £1 of yearly income over and above £34, and also for each £15 of capital over and above £50, £1 is deducted from the amount of the pension. Applications have to be made to the deputy registrars of one of 72 districts into which the colony is for this purpose divided. The claim is then recorded and submitted to a stipendiary magistrate, before whom the claimant has to prove his qualifications and submit to cross-examination. If the claim is admitted, a certificate is issued to the deputy registrar and in due course handed to the claimant. Payment is made through the local post-office as desired by the pensioner. The Act came into force 1st November 1898. Up to March 1899, 7487 pensions had been granted, amounting to a liability of £128,082 per annum. The average pension was £17, 2s. See *New Zealand Official Year Book* for 1899. In March 1900 the number of pensions was 11,285, and the cost £193,718. The Act was avowedly experimental, and only provided for payments out of revenue until the close of the second session of the next parliament. The cost considerably exceeded the estimate of £100,000 per annum which was originally put forward. The authors of the measure maintain that it is a great success, while others point to the invidious character of the cross-examination required in proving the necessary degree of poverty, and allege that the arrangement penalizes the thrifty members of the poorer class, and is a direct incentive to transfer of property, of a more or less fraudulent character, between members of a family. It is too early as yet to pronounce an authoritative verdict on the facts.

Victoria.—By the Old Age Pensions Act, 1900, £75,000 was appropriated for the purpose or paying a pension of not more than 10s. per week to any person who fulfilled the necessary conditions, of which the following were the principal:—The pensioner must be 65 years of age or permanently disabled, must fill up a declaration that he has lived twenty years in the state; has not been convicted of drunkenness, wife-desertion, &c.; that his weekly income and his property do not exceed a given sum (the regulation of this and other details is intrusted to the Governor in Council). Further sums have since been appropriated to the purposes of the Act, but it is not yet possible to say how far the Act is regarded as a success.

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Oldbury, a township and parish in the northern parliamentary division of Worcestershire, England, 5 miles west of Birmingham by rail. It is controlled, together with Langley and Warley, by an urban district council. Public buildings erected in 1891 contain its various offices. Population (1891), 22,697; (1901), 25,191.

Old Calabar. See NIGERIA.

Old Catholics.—Since 1878 there is little to record about Old Catholicism. Its position has disappointed the expectation of its friends and of its enemies. It has neither advanced rapidly, as the former had hoped, nor retrograded, as the latter have frequently predicted it would do. In Germany there are 90 congregations, served by 60 priests, and the number of adherents is estimated at about 60,000. In Switzerland there are 40 parishes (of which only one, that at Lucerne, is in the Roman Catholic cantons), 58 clergy, and about 50,000 adherents. In Austria, where very considerable accessions have been received since the *Los von Rom* movement commenced in 1899, there are 8 priests, 12 churches (besides three more in course of erection), and about 15,000 adherents. In Holland, where the Old Catholic Church has existed independently of the Papacy for nearly two centuries, an addition has taken place in the number of adherents which is very gratifying to the authorities of that Church. There are 3 bishops, 27 congregations, and 8030 adherents. France possesses but one congregation, in Paris, where it has built for itself a church. It is now under the supervision of the Old Catholic archbishops of Utrecht. In Italy a branch of the Old Catholic communion was established in 1881 by Count Enrico di Campello, a former canon of St Peter's at Rome. A church was opened in Rome by Monsignor Savarese and Count Campello, under the supervision of the bishop of Long Island in the United States, who undertook the superintendence of the congregation in accordance with the regulations laid down by the Lambeth conference. But dissensions arose between the two men. The church in Rome was closed; Savarese returned to the Roman Church; and Campello commenced a reform work in the rural districts of Umbria, under the episcopal guidance of the bishop of Salisbury. This was in 1885. In 1900 Campello returned to Rome, and once more opened a church there. In 1902 Count Campello retired from active participation in the work, on account of age and bodily infirmity; and his place at the head of it was taken by the Rev. Professor Cicchitti of Milan. In 1902 there were six priests, who are either in Roman or Old Catholic orders. No statistics have been issued, but there are thirteen congregations. Old Catholicism has spread to America. The Polish Romanists there, in 1899, complained of the rule of Irish bishops; elected a bishop of their own, Herr Anton Kozlowski; presented him to the Old Catholic bishops in Europe for consecration; and he presides over seven congregations in Chicago and the neighbourhood. The Austrian and Italian churches possess no bishops, and the Austrian Government refuses to allow the Old Catholic bishops of other countries to perform their functions in Austria. In 1878 a question arose which threatened the existence of Old Catholicism. The Swiss and German laity insisted that their clergy should be free to marry. The Dutch church protested, and threatened excommunication. Döllinger strongly disapproved of the step. But though it checked adhesions from Romanism, the difference has been accommodated. Every Old Catholic congregation has its choral union, its poor relief, and its mutual improvement society. Theological faculties exist at Bonn and Bern, and at the former a residential college for theological students was established by Bishop Reinkens. Old Catholicism has eight organs in the public press—two in Italy, two in Switzerland, and one each in Holland, Germany, Austria, and France. It has built several churches, of which that at Karlsruhe is the most imposing. It has held reunion conferences at Lucerne in 1892, at Rotterdam in 1894, and at Vienna in 1897. At these, members of the various episcopal bodies have been welcomed. It has also established a quarterly publication, the *Revue Internationale de Théologie*, which has admitted articles in French, German, and English, contributed not merely by Old Catholics, but by members of the Anglican, Russian, Greek, and Slavonic churches. Old Catholic theologians have been very active since 1878, and the work of Döllinger and Reusch on the Jesuits and the history of the Roman Church by Professor Langen have attained a European reputation.

The only history of Old Catholicism is that published at Giessen in 1887 by the celebrated canonist Von Schulte. (J. J. L*.)

Oldenburg, a grand-duchy of Germany, with an area of 2479 square miles, and population (1885), 341,525; (1900), 398,499, thus distributed—duchy of Oldenburg, 317,842; principality of Lübeck, 37,337; principality of Birkenfeld, 43,320. Of the total in 1900, 197,954 were males and 200,545 females. The density is 160 inhabitants to the square mile. In 1895, 26·6 per cent. of the population were classified as urban, and 73·4 per cent. as rural. The number of emigrants decreased from 1296 in 1892 to 255 in 1900. Classified according to religion in 1895, 289,620 of the people (77·5 per cent.) were Protestants, 81,492 (21·8 per cent.) Roman Catholics, and there were 1430 Jews. In 1897 there were 157 secondary schools for boys, 21 for girls, 13 theological seminaries, a school of navigation, &c. About one-half of the population are engaged in agriculture and pastoral pursuits, the crops principally grown being hay, potatoes, oats, wheat, and barley. The farms are mostly under 25 acres. In 1900 the live stock numbered 264,885 cattle, 210,808 pigs, 112,064 sheep, and 41,849 horses. The breweries in 1899 produced 4,796,000 gallons of beer. There were 334 miles of railway in 1899, all, except 25 miles, under State control. The mercantile fleet, which belongs to the ports of Oldenburg, Elsfleth, and Brake, consisted in 1900 of 150 sea-going vessels of 77,467 tons. The public revenue for the entire grand-duchy in 1900 amounted to £390,650, and the expenditure to £478,700. In 1900 the public debt was £2,793,200; and in 1901 the contribution to the imperial treasury, £202,030.

Oldenburg, a town of Germany, capital of the grand-duchy of Oldenburg, on the Hunte, 27 miles by rail west of Bremen. The more important modern buildings are the town hall (1885–87); a west wing (1894–99) to the castle, with frescoes by Fitger; the antiquarian museum

(1876–79); the palace of the heir-apparent (1896); the theatre (1891), rebuilt after a fire; the provincial bank (1896); and the Peace church (1893–94). The grand-ducal palace has been adorned with pictures by modern German artists (Gode, Mackart, Böcklin, Siemiradzki, &c.). Additional pictures by these and other modern painters (*e.g.*, Tischbein) have been collected in the castle. The church of St Lambert was restored in 1874–86. The town possesses, further, an industrial museum, a memorial of the war of 1870–71, a military school, and a teachers' seminary. There is an important horse fair. Population (1885), 19,937; (1900), 26,635.

Old Forge, a borough of Lackawanna county, Pennsylvania, U.S.A. It is in the anthracite coal region, in the north-eastern part of the state, and its industries are mainly devoted to handling and shipping coal. Population (1900), 5630, of whom 2494 were foreign-born.

Oldham, a municipal, county (1888), and parliamentary borough and market town of Lancashire, England, on the Medlock, 200 miles by rail from London. The municipal technical school has been taken over by the corporation. Modern buildings include an Established church, Hulme Grammar School (1895), a free library, art gallery and museum, and the county court. The infirmary was enlarged in 1889. There are 2 daily newspapers. The factories number about 230, and the spindles over 13,000,000. The consumption of cotton is about one-fifth of the total importation into the United Kingdom. In 1891 there were 14,691 males and 20,170 females employed in the manufacture of cotton goods; 1735 males as fitters and turners (engine and machine); 544 persons in the iron and steel manufacture. Area of municipal borough, 4730 acres. Population (1881), 111,343; (1891), 131,463; (1901), 137,238.

Old Town, a city of Penobscot county, Maine, U.S.A., on the west bank of the Penobscot river, and on the Maine Central and the Bangor and Aroostook railways, at an altitude of 95 feet. It is known as the home of a remnant of the Penobscot tribe of Indians, and as one of the termini of the second railway constructed in the country, running thence to Bangor, and built in 1836. Population (1880), 3395; (1890), 5312; (1900), 5763, of whom 1247 were foreign-born.

Olean, a city of Cattaraugus county, New York, U.S.A., on the north bank of the Allegheny river, in the south-western part of the state, at an altitude of 1437 feet. Its site is in the level valley and its plan is regular. It is on three railways, the Erie, the Pittsburg, Shawmut, and Northern, and the Western New York and Pennsylvania. It is in the midst of the oil and natural gas region, and the surrounding country is diversified with oil tanks and derricks. It contains large refineries and storage tanks, and is the eastern terminus of the Ohio pipe line and the western terminus of a pipe line to the seaboard. Population (1880), 3036; (1890), 7358; (1900), 9462, of whom 1514 were foreign-born and 122 negroes.

Olhão, a town of Portugal, district Faro, 5 miles east of Faro, on the coast. Its people are good seamen, and employ themselves in fishing. Population (1900), 9993.

Oliphant, Laurence (1829–1888), English author, son of Anthony Oliphant, a member of a family of ancient descent but moderate fortune, long settled in central Scotland, was born at Cape Town in 1829. His father was then Attorney-General in Cape Colony, but was soon transferred as Chief Justice to Ceylon. The boy's education was of the most desultory kind. Far the least useless portion of it belonged to the years 1848 and 1849, when he accompanied his parents on a tour on the continent of Europe. In 1851 he accompanied Jung Bahadur from Colombo to Nepaul. He passed an agreeable time there, and saw enough that was new to enable him to write his first book, *A Journey to Khatmandu* (1852). From Nepaul he returned to Ceylon and thence to England, dallied a little with the English bar, so far at least as to eat dinners at Lincoln's Inn, and then with the Scottish bar, so far at least as to pass an examination in Roman law. He was more happily inspired when he threw over his legal studies and went to travel in Russia. The outcome of that tour was his book on *The Russian Shores of the Black Sea* (1853). Between 1853 and 1861 he was successively secretary to Lord Elgin during the negotiation of the Canada Reciprocity Treaty at Washington, the companion of the duke of Newcastle on a visit to the Circassian coast during the Crimean war, and Lord Elgin's private secretary on his expedition to China. Each of these experiences produced a pleasant book of travel. In 1861 he was appointed First Secretary in Japan, and might have made a successful diplomatic career if it had not been interrupted, almost at the outset, by a night attack on the Legation, in which he nearly lost his life. It seems probable that he never properly recovered from this affair. He returned to England and resigned the service, and was elected to Parliament in 1865 for the Stirling Burghs. Oliphant did not show any conspicuous parliamentary ability, but made a great success by his vivacious and witty novel, *Piccadilly* (1870). He fell, however, under the influence of the spiritualist prophet Thomas Lake Harris, who was at the head of a small community at Brocton on Lake Erie. This man obtained so strange an ascendancy over Oliphant that the latter left Parliament in 1868, followed him to Brocton, and lived there the life of a farm labourer, in obedience to the imperious will of his spiritual guide. The cause of this painful and grotesque aberration has never been made quite clear. It was part of the Brocton régime that members of the Community should be allowed to return into the world from time to time, to make money for its advantage. After three years this was permitted to Oliphant, who, when once more in Europe, acted as correspondent of *The Times* during the Franco-German war, and spent afterwards several years at Paris in the service of that journal. There he met Miss Alice le Strange, whom he married. In 1873 he went back to Brocton, taking with him his wife and mother. During the years which followed he continued to be employed in the service of the Community and its head, but on work very different from that with which he had been occupied on his first sojourn. His new work was chiefly financial, and took him much to New York and a good deal to England. As late as December 1878 he continued to believe that Harris was an incarnation of the Deity. By that time, however, his mind was occupied with a large project of colonization in Palestine, and he made in 1879 an extensive journey in that country, going also to Constantinople, in the vain hope of obtaining a lease of the northern half of the Holy Land with a view to settle large numbers of Jews there. This he conceived would be an easy task from a financial point of view, as there were so many persons in England and America "anxious to fulfil the prophecies, and bring about the end of the world." He landed once more in England without having accomplished anything definite; but his wife, who had been banished from him for years and had been living in California, was allowed to rejoin him, and they went to Egypt together. In 1881 he crossed again to America. It was on this visit that he became utterly disgusted with Harris, and escaped finally from the long and squalid tyranny under which he and his had suffered. He was at first a little afraid that his wife would not follow him in his renunciation of "the prophet," but this was not the case, and they settled themselves very agreeably, with one house in the midst of the German community at Haïfa, and another about twelve miles off at Dalieh on Mount Carmel. It was at Haïfa in 1884 that they wrote together the strange book called *Sympneumata*, and in the next year Oliphant produced there his novel *Masollam*, which may be taken to contain its author's latest views with regard to the personage whom he long considered as "a new Avatar." One of his cleverest works, *Altiora Peto*, had been published in 1883. In 1886 an attack of fever, caught on the shores of the Lake of Tiberias, resulted in the death of his wife, whose constitution had been undermined by the hardships of her American life. He was persuaded that after death he was in much closer relation with her than when she was still alive, and conceived that it was under her influence that he wrote the book to which he gave the name of *Scientific Religion*. In November 1887 he went to England to publish that book. By the Whitsuntide of 1888 he had completed it and started for America. There he determined to marry again, his second wife being a granddaughter of Robert Owen the Socialist. They were married at Malvern, and meant to have gone to Haïfa, but Oliphant was taken very ill at Twickenham, and died on 23rd December 1888. Although a very clever man and a delightful companion, full of high aspiration and noble feeling, Oliphant was only partially sane. In any case, his education was ludicrously inappropriate for a man who aspired to be an authority on religion and philosophy. He had gone through no philosophical discipline in his early life, and knew next to nothing of the subjects with regard to which he imagined it was in his power to pour a flood of new light upon the world. His shortcomings and eccentricities, however, did not prevent his being a brilliant writer and talker, and a notable figure in the world in which he happened to move.

See also *Memoir of the Life of Laurence Oliphant and of Alice Oliphant his Wife*, by MARGARET OLIPHANT. (M. G. D.)

Oliphant, Margaret Oliphant Wilson (1828–1897), novelist and historical writer, was born at Wallyford, near Musselburgh, Midlothian, in 1828. Her childhood was spent at Lasswade (near Dalkeith), Glasgow, and Liverpool. As a girl she constantly occupied herself with literary experiments, and in 1849 published her first novel, *Passages in the Life of Mrs Margaret Maitland*, which had some success. This she followed up in 1851 with *Caleb Field*, and in the same year met Major Blackwood in Edinburgh, and was invited by him to contribute to the famous *Blackwood's Magazine*. The connexion thus early commenced lasted during her whole lifetime, and she contributed considerably more than 100 articles to its pages. In May 1852 she married her cousin, Frank Oliphant, at Birkenhead, and settled at Harrington Square, in London. Her husband was an artist, of very delicate health, and two of their children died in infancy, while the father himself developed alarming symptoms of consumption. For the sake of his health they moved in January 1859 to Florence, and thence to Rome, where Frank Oliphant died. His wife, left almost entirely without resources, returned to England and took up the burden of supporting her three children by her own literary activity. She had now become a popular writer, and worked with amazing industry to sustain her position. Unfortunately, her home life was full of sorrow and disappointment. In January 1864 her only daughter died in Rome, and was buried in her father's grave. Her brother was shortly afterwards involved in financial ruin, and Mrs Oliphant offered a home to him and his children, and added their support to her already heavy responsibilities. In November 1865 she settled at Windsor, which remained her home for the rest of her life, and for more than thirty years she pursued a varied literary career with courage scarcely broken by a series of the gravest troubles. Her son Cyril died in 1890, and Frank, the youngest, in 1894. With the last of her children lost to her, she had but little further interest in life. Her health steadily declined, and she died at Wimbledon, 25th June 1897. Her life had been one long sacrifice to others, and she had enjoyed a very small share of happiness or peace.

In the course of her long struggle with circumstances, Mrs Oliphant produced more than 120 separate works, including novels, books of travel and description, histories, and volumes of literary criticism. Among the best known of her works of fiction are *Adam Graeme* (1852), *Magdalen Hepburn* (1854), *Lilliesleaf* (1855), *The Laird of Norlaw* (1858), *The Chronicles of Carlingford*, which, originally appearing in *Blackwood's Magazine*, did much to widen her reputation (1861–64), *Salem Chapel* (1863), *Madonna Mary* (1867), *Squire Arden* (1871), *He that will not when he may* (1880), *Hester* (1883), *Kirsteen* (1890), and *The Marriage of Elinor* (1892). Her friends often regretted that she did not work more slowly, and so give full play to her faculties; but it is probable that she was one of those who do best what they do quickly, and who must work at high pressure to succeed at all. Her inventive faculty was fertile and vigorous; she had humour and sympathy, but no depth of insight; she saw superficial details with great accuracy and complexity, but she was no philosopher. Her fiction was of the class that entertains the imagination and touches the emotion without appeal to the more strenuous activities of the brain. In other fields of literary work she was industrious, but unequal. Her biographies of *Edward Irving* (1862) and *Laurence Oliphant* (1891), together with her life of Sheridan in the "English Men of Letters" (1883), have vivacity and a sympathetic touch, but are not important contributions to the biographical library. She also wrote historical and critical works of considerable variety, including *Historical Sketches of the Reign of George II.* (1869), *The Makers of Florence* (1876), *A Literary History of England from 1790 to 1825* (1882), *The Makers of Venice* (1887), *Royal Edinburgh* (1890), *Jerusalem* (1891), and *The Makers of Modern Rome* (1895), while at the time of her death she was still occupied upon *Annals of a Publishing House*, a record of the progress and achievement of the firm of Blackwood, with which she had been so long and honourably connected. Many of these works show to great advantage her singular power of assimilation and arrangement; they are compilations of much charm and effect. But they rarely add anything to what is already known of the subject, and are rather exercises in agreeable presentation than storehouses of research and discovery. She wrote easily, and with a free, unaffected style, but she had little care for niceties of expression, and was herself in the habit of declaring that she had never consciously sought for literary form or finish. It was this natural facility and nonchalance that deprived her work of the highest qualities of distinction, and will probably prevent it from surviving the work of some of her less popular contemporaries. (A. WA.)

Oliva, a town of Spain, in the province of Valencia, near the sea, on the railway from Carcagente to Alicante. The population was 8779 in 1887, and 7949 in 1897. It is a port for small coasting vessels. There are no important local industries, and only some trade in agricultural products, especially wine, rice, raisins, oils. There are two parish churches, and a palace of the dukes of Gandia.

Olivenza, a town of Spain, in the province of and south of the town of Badajoz, near the left bank of the river Olivenza. The local industries include the making of porcelain, leather, and hats, besides flour-mills. It was a fortified town down to 1857, when walls and bastions were razed and the stone given to the people. There are two parish churches, Santa Maria del Castillo of the 13th century and restored in the 16th, and Santa Maria Magdalena of the 16th century, with three naves and a high altar of pluteresque style. Olivenza has good promenades, a theatre, a bull-ring, hospitals, barracks. This town, so near the frontier, has played an important part in the wars between Spain and Portugal, remaining from 1688 to 1801 in the hands of the latter. Population, about 8200.

Ollivier, Olivier Émile (1825——), French statesman, was born at Marseilles on 2nd July 1825. From his father, Démosthène Ollivier, a prominent member of the Assembly of 1848, he inherited pronounced republican opinions. He had just been called to the bar at Paris when the revolution broke out, and though only twenty-three years old, was appointed, through his father's influence with Ledru-Rollin, commissary-general of the Republic in his native department of the Bouches-du-Rhône. His vigour in repressing a Socialist outbreak at Marseilles caused him to be confirmed in his functions by Cavagnari with the title of prefect; but his administration roused much adverse criticism, and he was removed to the prefecture of the Haute-Marne, which he resigned in January 1849. When he resumed his practice at the bar, his great abilities, and especially his fervid and remarkably lucid oratory, rapidly brought him into the front rank. At the general election of 1857 he was returned for the 3rd *circonscription* of the Seine as a representative of the constitutional Opposition. He did not refuse, like some other Republicans who were returned at the same election, to take the oath of allegiance to the emperor; he felt that, setting aside an appeal to arms, which he abhorred, the Opposition could win liberty for the nation only by making use of such powers as the constitution permitted. Together with Darimon, Jules Favre, Hénon, and Picard, he formed the group known as *les Cinq*. Their unanswerable attacks forced the Government to make concessions to public opinion. The decree of 24th November 1860 was a first step towards an effective parliamentary government. Most of the Opposition regarded it as ludicrously inadequate. Ollivier, so recently as 30th December 1859, had appeared as counsel for M. Vacherot, on his trial for the publication of *La Démocratie*, and had attacked the Government in terms which caused him to be debarred from pleading for three months. But he now electrified the House by an eloquent speech in which he thanked the emperor for this first instalment of reform, and promised his support to further steps in the same direction. The divergence between him and the Irreconcilables, led by Jules Favre, widened in ensuing sessions till he stood alone. But one of the traits of his character was a self-reliance amounting to obstinacy. He brought Morny round to his views, and through him worked upon the emperor. The session of 1866 saw the formation of a "third party," to which M. Ollivier attached himself. Napoleon, seeing himself forced to yield, tried to enlist the honesty and ability of M. Ollivier in his service. An outward mark of M. Ollivier's adherence to the emperor was given by his acceptance of the post of arbitrator on the Suez Canal question. He had in July 1865 been appointed by the Egyptian Government as their representative in Paris in this matter—a post that necessitated his retirement from the bar. The negotiations begun by Morny were continued by his successor in the presidency of the Chamber, Walewski, a convinced supporter of Liberal measures. On 31st December 1866 he offered M. Ollivier, in the emperor's name, the ministry of Public Instruction, with the function of representing the general policy of the Government in the Chamber. M. Ollivier laid down a number of conditions, of which the most important were a policy of peace, involving the abandonment of the military law; the presence of the ministers in the Chamber; a law granting liberty of the press; and the abandonment of official candidatures. To these reforms he considered himself pledged. In an audience granted him on 10th January, he believed himself to have converted the emperor to his views; but the reactionary counsels of Rouher prevailed. The emperor's letter of 19th January 1867, announcing the new reforms, did not satisfy M. Ollivier's demands, and such reforms as were granted were executed in a grudging spirit. He therefore broke off negotiations with the emperor. His views were explained in his *Démocratie et Liberté* (1867) and, above all, in his *19 Janvier*, a defence of his political career, addressed to his constituents on the eve of the general election of 1869. In this he declared that the models he endeavoured to copy were Mirabeau and Benjamin Constant. At length, on 27th December 1869, the emperor entrusted him with the formation of a constitutional cabinet, in which were included several members of the Moderate Left, and in which M. Ollivier himself took the ministry of Justice. The cabinet was completed on 2nd January 1870. Though the constitution did not recognize the office of premier, M. Ollivier was the guiding spirit of the ministry in council and its chief spokesman in debate. But he fell upon troubled times. On 10th January Victor Noir was shot by Prince Pierre Bonaparte. M. Ollivier tried with great skill to satisfy the public indignation without compromising the position of the dynasty, but the passions aroused by this unfortunate event showed how the difficulties of his task had increased in the three years since he had first refused to accept office. That refusal he never ceased to regret. Nevertheless, he laid numerous reforms before the Chamber. He ordered the prefects to refrain from applying official influence at the elections, and the magistrates to administer justice without regard to politics. By Rouher's advice, the nation was asked to declare by a plebiscite whether it approved the new "Liberal Empire." The three most distinguished members of the left, Buffet, Daru, and Talhouët, resigned office rather than consent to this measure. Among their successors was Gramont, who was soon to prove M. Ollivier's evil genius. The people were told that a vote in the affirmative would be a vote for peace, and the prefects, in spite of M. Ollivier's instructions, exhausted the resources of official pressure. He himself, though at first reluctant to accede to the plebiscite, hailed its result as a "French Sadowa." The lapse of years had turned the once violent Republican into a very cautious Liberal, animated by a strong regard for the emperor, to whom he had promised "a happy old age." All his plans were suddenly disconcerted by the candidature of Leopold of Hohenzollern for the throne of Spain. The Ollivier government, not content with securing the withdrawal of the candidature, required the king of Prussia to guarantee that it should never be repeated. M. Ollivier, hitherto the strenuous advocate of peace, allowed himself to be won over by the war party. On 15th July he declared to the Chamber that the Prussian Government had addressed a despatch to the foreign Powers, announcing that the king had affronted the French ambassador. Thiers and his followers in vain pointed out that no such despatch existed, and that the ambassador had not considered himself insulted. M. Ollivier obtained a war vote of 500 million francs, and used the fatal words that he accepted the responsibility for the war "with a light heart." He went on to explain that this war was forced upon France by the requirements of honour, and was not sought by the ministry. But the phrase remained when its explanation was forgotten. The country turned savagely upon the authors of its disasters. M. Ollivier convoked the Chamber for the 9th August, when a large majority declared the Government incapable of providing for the safety of the country. In apportioning the blame for the disasters of 1870, it must be remembered that M. Ollivier was deceived, both by the Foreign Minister, Gramont, who misled him as to the attitude of Austria and the South German states, and whose rash and ignorant diplomacy hastened the crisis, and by the Minister of War, Lebœuf, who declared that the army was ready "down to the last button on its gaiters." But had M. Ollivier been as clear-sighted as Thiers, had he adhered at this crisis to that policy of peace with which he entered office, he could have averted war by the threat of resignation. He committed the fault against which he had in 1867 warned the emperor, of "entering, in company with an exhausted Austria, upon a new Seven Years' War, in which this time we should find Russia on the side of Prussia, without being sure of carrying Italy with us." After his fall he quitted France, and did not return till 1873. His subsequent attempts to enter parliament were unsuccessful, but he carried on an active political campaign in the *Estafette.* In 1885 he declared himself not anti-Republican but anti-Radical. Debarred from public life at forty-five by his one fatal mistake, he expressed his views in a series of books, the most important of which are *Principes et conduite* (1875), *Solutions politiques et sociales* (1893), and *L'Empire Libéral* (1895, &c.). His support of the decrees of 1880 against the religious Congregations involved him in a bitter controversy with the section of the Bonapartists represented by M. Paul de Cassagnac. Besides his political writings on this subject he published in 1885 a *Nouveau Manuel de Droit Ecclésiastique Français.* He was elected a member of the French Academy in April 1870. His formal reception was to have taken place in 1873, but owing to his refusal to omit certain political references from his inaugural speech, was indefinitely postponed.

Olmsted, Frederick Law (1822–——), American author and landscape architect, was born at Hartford, Conn., 26th April 1822. In 1840 he shipped as seaman for the East Indies and China. In 1845–46 he studied agricultural science and engineering at Yale College, after which he became a practical farmer for several years. In 1850 he made a pedestrian tour in Great Britain and the continent of Europe, and in 1852–1853 made a horseback trip through the southern and south-western United States. His observations on these travels were published in his books: *Walks and Talks of an American Farmer in England*, *Journey in the Seaboard Slave States*, *Journey through Texas*, and *Journey in the Back Country.* The last three volumes, printed also in England in two volumes with the title *The Cotton Kingdom*, had great influence in the discussion on American slavery preceding the Civil War. Some years after these journeys, Mr Olmsted again visited Italy, France, and Germany, making a special study of parks and rural arts. In 1856 he, with Calvert Vaux, prepared the accepted plans for the improvement of Central Park in New York City. In 1864–65, as chairman of a California State Commission, he directed the survey and preservation of the big-tree reservations of the Yosemite Valley. In 1866 he was again engaged with Mr Vaux in planning and superintending the improvements of Prospect Park in Brooklyn, N.Y. After this he was engaged in most of the important works of park improvement in the United States. Special mention may be made of the Buffalo, N.Y., parks, the Mount Royal Park at Montreal, the Capitol Grounds at Washington, the grounds of Leland Stanford Jr. University in California, the Vanderbilt estate at Biltmore, N.C., the system of parks and parkways in Boston, and the landscape improvements for the World's Fair at Chicago. In 1893 he received honorary degrees from Harvard and Yale Universities.

Olmütz, the second city and the ecclesiastical metropolis of Moravia, Austria. Population (1890), 19,761; (1900), 21,933, including garrison of 3632 men (estimated at 67 per cent. German, 33 per cent. Czech; 92·5 per cent. Catholic, 6·5 per cent. Jewish, and 1 per cent. Protestant). The fortifications were removed in 1886 and their place is occupied by a town park, gardens, and promenades. The modern public buildings include an industrial museum, a German upper *real*-school, and a Czech gymnasium. The industries include brewing and distilling and the manufactures of malt, sugar, starch, &c.

Olney, a city of Illinois, U.S.A., capital of Richland county, situated at the intersection of the Baltimore and Ohio South-Western, the Illinois Central, and the Indiana, Decatur, and Western railways, in the south-eastern part of the state, at an altitude of 481 feet. It has a level site and regular plan, and derives its chief importance from the fact that it is the point of intersection of railway lines. Population (1880), 3512; (1890), 3831; (1900), 4260, of whom 235 were foreign-born.

Olney, Richard (1835–——), American statesman, was born at Oxford, Mass., 15th September 1835. Educated at Brown University and the Harvard Law School, he attained a high position at the Massachusetts bar, but was not known in public life till, in 1893, President Cleveland induced him to enter his cabinet as Attorney-General. Upon the death of Secretary Gresham, Mr Olney succeeded him as Secretary of State, 10th June 1895. He conducted the correspondence with the British Government concerning the boundary dispute with Venezuela, and excited general comment by the vigour with which he sustained the right of the United States to intervene, and by the wide interpretation which he put upon the Monroe Doctrine. At the expiration of President Cleveland's term he resumed his law practice.

Olonets, a government of northern Russia, having Finland on the W., and the governments of Archangel on the N.E., Vologda on the E., and Novgorod and St Petersburg on the S. Its area covers 57,439 square miles. Its population was 321,250 in 1881, and 366,715 in 1897, of whom 193,001 were women (111 women to 100 men), and 24,412 lived in towns. Agriculture is still insufficient for the population, the crops in 1894–99 being: rye, 888,700 cwt.; oats, 847,000; and all cereals, 2,029,000 cwt. There were in 1895, 63,520 horses, 133,300 horned cattle, and 102,300 swine. Industries are still in their infancy (aggregate returns, £2,840,000, chiefly saw-mills). Olonets is divided into seven districts, of which the chief towns and their populations in 1897 were: Petrozavodsk, capital of the government (12,521 inhabitants), Kargopol (2952), Lodeinoye Pole (4500), Olonets (1303), Povyenets (1409), Pudozh (1469), and Vytegra (4501).

Oltenitza, a small town in Rumania, in the district of Ilfov (Bucharest), on the left bank of the Danube.

It is the ancient Constantiola, which was the seat of the first bishopric established in Dacia. In the Crimean war the Turks forced the river at this point and inflicted heavy losses on the Russians. Population, about 5500.

Olympia, a city of Washington, U.S.A., capital of Thurston county and of the state, at the head of Hood canal, an arm of Puget Sound, in the western part of the state. It has a level site and a regular plan, with broad streets. It has good water-supply and sewerage systems, and is the terminus of two branches of the Northern Pacific Railway and of two other short railways. It is in the great forest region of western Washington, and its principal industry is in lumber. It has several large mills and considerable trade by steamer on the Sound, and by rail, in lumber, fish, and oysters. Population (1880), 1232; (1890), 4698; (1900), 4082, of whom 591 were foreign-born.

Omaha, the largest city in Nebraska, U.S.A., on the west bank of the Missouri river, about 20 miles above the mouth of the Platte, occupying an elongated plateau skirted on three sides by undulating hills on which the residential districts are distributed, 962 feet above sea-level. Within the corporate boundaries are included 24 square miles. Its rectilinear street plan gives numbered streets north and south, and named streets east and west. Three bridges (two railway bridges and one waggon bridge —the last traversed by electric cars) span the Missouri, connecting Omaha and Council Bluffs, Ia. Its electric street railway system has 65 miles of trackage. The city was laid out in 1854. Population (1880), 30,518; (1890), 140,452; (1900), 102,555, exclusive of South Omaha. The smaller figures for the last decade are almost wholly due to a padding of the previous census, although growth was affected somewhat by the drought and crop failures of 1893 and 1894 in the agricultural territory, upon which the city is largely dependent. The death-rate in 1900 was 13·5. In 1901 there were 38 schools with 419 teachers, and an average daily attendance of 14,845. The annual expense of maintenance was $544,058, of which $202,624 is from direct taxes. The school district debt (1900, $835,000) and municipal debt (1900, $4,776,800) represent investment in school-houses, public buildings, pavements, drainage, and parks. The electric lighting plant, gas, and water-works are owned by private corporations. As a trade and distribution centre Omaha ranks high. Originally the eastern terminus of the first trans-continental railway (Union Pacific) it now has fourteen different railways radiating in all directions, five of which constitute trunk lines between the Missouri and the Great Lakes. There are 100 wholesale establishments and 175 manufacturing institutions; notable among these are the silver and lead smelting and refining works, employing 600 men, extensive car and locomotive construction and repair works, white-lead works, linseed-oil mill, six breweries, distillery, and bag factories. As a live-stock market South Omaha (founded in 1887, but still a distinct municipal corporation, although immediately adjoining) ranks next to Chicago and Kansas City. Receipts for 1901: cattle, 818,003; hogs, 2,414,052; sheep, 1,314,841. The seven national banks at Omaha held (March 1902) $25,837,653 in deposits, with $3,050,000 aggregate capital. The bank clearings for 1901 aggregated $329,043,688. Omaha is the headquarters of the military department of the Missouri, with military posts at Fort Omaha (immediately north) and at Fort Crook (10 miles south). An interesting example of local enterprise was the Trans-Mississippi Exposition, 1898, illustrating the progress and resources of the states west of the Mississippi. It represented an investment of $2,000,000. Although begun in time of discouraging financial depression, and held during the war with Spain, over 2,600,000 people attended it, and 90 per cent. of their subscriptions were returned in dividends to stockholders. (V. R.)

Oman, a kingdom occupying the south-eastern coast districts of Arabia, its southern limits being a little to the west of the meridian of 55° E. long., and the boundary on the north the southern borders of El Hasa. Oman and Hasa between them occupy the eastern coast districts of Arabia to the head of the Persian Gulf. The Oman–Hasa boundary has been usually drawn north of the promontory of Katar. This is, however, incorrect. In 1870 Katar was under Wahabi rule, but in the year 1871 Turkish assistance was requested to aid the settlement of a family quarrel between certain Wahabi chiefs, and the Turks thus obtained a footing in Katar, which they have retained ever since. Turkish occupation (now firmly established throughout El Hasa) includes Katif (the ancient Gerrha) and El Bidia on the coast of Katar. But the pearl fisheries of Katar are still under the protection of the chiefs of Bahrein, who are themselves under British suzerainty. In 1895 the chief of Katar (Sheikh Jasim ben Thani), instigated by the Turks, attacked Sheikh Isa of Bahrein, but his fleet of dhows was destroyed by a British gunboat, and Bahrein (like Zanzibar) has since been detached from Oman and placed directly under British protection.

Physiography.—Oman is a mountainous district dominated by a range called Jebel Akhdar (or the Green Mountain), which is 6000 feet in altitude, and is flanked by minor ranges running approximately parallel to the coast, and shutting off the harbours from the interior. They enclose long lateral valleys, some of which are fertile and highly cultivated, and traversed by narrow precipitous gorges at intervals, which form the only means of access to the interior from the sea. Beyond the mountains which flank the cultivated valleys of Semail and Tyin, to the west, there stretches the great Rhoba el Khali, or Dehna, the central desert of southern Arabia, which reaches across the continent to the borders of Yemen, isolating the province on the landward side just as the rugged mountain barriers shut it off from the sea. The wadis (or valleys) of Oman (like the wadis of Arabia generally) are merely torrential channels, dry for the greater part of the year. Water is obtained from wells and springs in sufficient quantity to supply an extensive system of irrigation.

Harbours and Roads.—The only good harbour on the coast is that of Muskat, the capital of the kingdom, which, however, is not directly connected with the interior by any mountain route. The little port of Matrah, immediately contiguous to Muskat, offers the only opportunity for penetrating into the interior by the wadi Kahza, a rough pass which is held for the Sultan or Imam of Muskat by the Rehbiyin chief. In 1883, owing to the treachery of this chief, Muskat was besieged by a rebel army, and disaster was only averted by the guns of H.M.S. *Philomel.* About 50 miles south of Muskat the port of Kuryat is again connected with the inland valleys by the wadi Hail, leading to the gorges of the wadi Thaika or "Devil's Gap." Both routes give access to the wadi Tyin, which, enclosed between the mountain of El Beideh and Hallowi (from 2000 to 3000 feet high), is the garden of Oman. Fifty miles to the north-west of Muskat this interior region may again be reached by the transverse valley of Semail, leading into the wadi Munsab, and from thence to Tyin. This is generally reckoned the easiest line for travellers. But all routes are difficult, winding between granite and limestone rocks, and abounding in narrow defiles and rugged torrent beds. Vegetation is, however, tolerably abundant—tamarisks, oleanders, kafas, euphorbias, the milk bush, rhamnus, and acacias being the most common and most characteristic forms of vegetable life, and pools of water are frequent. The rich oasis of Tyin contains many villages embosomed in palm groves and surrounded with orchards and fields.

Cultivation.—In addition to cereals and vegetables, the cultivation of fruit is abundant throughout the valley. After the date, vines, peaches, apricots, oranges, mangoes, melons, and mulberries find special favour with the Rehbiyin, who exhibit all the skill and perseverance of the Arab agriculturist of Yemen, and cultivate everything that the soil is capable of producing.

The present Sultan, a descendant of those Yemenite Imams who consolidated Arab power in Zanzibar and on the East African coast, and raised Oman to its position as the most powerful state in Arabia during the first half of the 19th century, resides at Muskat, where his palace directly faces the harbour, not far from the British residency. The little port of Gwadur, on the Makran coast of the Arabian Sea, a station of the Persian Gulf telegraph system, is still a dependency of Oman.

See Colonel MILES. *Geographical Journal*, vol. vii., 1896.—Commander I. N. STEPPE. *Geographical Journal*, 1899.

(T. H. H*.)

Omdurman. See SUDAN, ANGLO-EGYPTIAN.

Omsk, a town of Russia, capital of the province of Akmolinsk, formerly capital of western Siberia, now capital of the General-Governorship of the Steppes. It is the seat of administration of Siberian Cossacks, and see of the bishop of Omsk. It is situated on the right bank of the Irtysh, at its junction with the Om, in an altitude of 260 feet, on the main Siberian trunk railway, 1013 miles by rail from Samara (the Volga), and 1624 miles from Moscow. It is also the meeting-place of the highways to middle Russia, Orenburg, East Siberia, and Turkestan. Steamers ply down the Irtysh and the Ob, and up the former to the Altai towns and Lake Zaisan. The climate is dry and relatively temperate, but marked by violent snow- and sand-storms. The average temperatures are, for the year, 31° F.; for January, 5°; for July, 68°; the annual rainfall is 12·4 inches. It is poorly built. Its population, from 31,000 in 1881, has grown to 37,470 in 1897; this figure seems, however, to be incomplete, as in 1895 it was 43,226, of whom 8468 were military. Its industries remain unimportant (steam saw-mill, tanneries) and show a yearly return of only £50,000; but the trade, especially since the construction of the railway, is growing, Omsk becoming a depot for goods imported from Europe for the neighbouring provinces. The two yearly fairs show an aggregate return of about £100,000. It has a society for education, which organizes schools, kindergartens, libraries, and lectures for the people. There are a corps of cadets, two gymnasia for boys and for girls, and various lower schools, besides medical, dramatic, and musical societies, and also the West Siberian section of the Russian Geographical Society.

Onega, a lake of northern Russia, with an area of 3765 square miles. Its altitude, which was formerly supposed to be 236 feet, is only 125 feet. It appears from the works of the hydrographical expedition, completed in 1895 (*Izvestia* of the Russ. Geogr. Soc. 1895), that the depth of the lake had been greatly exaggerated. The greatest depths, of from 53 to 68 fathoms, are at the entrance to the double bay, Lizhemsk and Unitsk, which projects westwards in the west of the Zaonezhie peninsula. On the continuation of this line, several spots are found where the depth exceeds 40 fathoms. In the middle of the lake the depth is from 20 to 47 fathoms, and less than 20 fathoms in the south. The lake is 145 miles long, with an average breadth of 50 miles.

Oneida, a village of Madison county, New York, U.S.A., on Oneida Creek, 6 miles from Oneida Lake, at an altitude of 440 feet. The site is level, but the plan of the city irregular. It has two railways, the New York Central and Hudson River, and the New York, Ontario, and Western. Population (1880), 1649; (1890), 6083; (1900), 6364, of whom 784 were foreign-born and 82 negroes.

Oneonta, a village of Otsego county, New York, U.S.A., on Susquehanna river and on the Delaware and Hudson and the Ulster and Delaware railways, at an altitude of 1083 feet. It contains the car works of the railway, saw and planing mills, and other manufactories, together with grain elevators. One of the state normal schools is located here. Population (1880), 3002; (1890), 6272; (1900), 7147, of whom 456 were foreign-born.

Ongole, a town of British India, in the Nellore district of Madras, situated on the East Coast Railway, 181 miles north of Madras. Population (1891), 10,832; municipal income (1897–98), Rs.13,310. There are a college managed by the American Baptist mission, a high school with 330 pupils, a Government training school, a printing-press, and a reading-room.

Onitsha. See NIGERIA.

Ontario, a province of Canada, bounded on the E. and N.E. by Quebec and the Ottawa river, on the S. and S.E. by the St Lawrence and the Great Lakes, on the W. by Manitoba, and on the N. by James Bay and the Albany and English rivers. The south-eastern and south-western portions of the province are occupied by the great plain of Canada, and are underlain by rocks of Cambro-Silurian, Silurian, and Devonian age. The south-eastern tract lies in the angle between the Ottawa and St Lawrence, includes an area of 4500 square miles, and has an elevation of 100 to 400 feet above the sea. The south-western is divided into two tracts, the first lying to the north and east of the Niagara escarpment, with an area of 9000 square miles, and an altitude of 400 to 1000 feet; and the second, the tract to the south and west of the Niagara escarpment, has an area of 15,700 square miles, and an elevation of 600 to 1500 feet. In the last of these petroleum, natural gas, salt, and gypsum are important products, but in the others no minerals, with the exception of building materials, are found. The country to the north of the great plain is occupied by rocks of Archæan age, which form, in a general way, a great plateau or table-land. Its average elevation increases from about 1000 feet in the vicinity of the Ottawa river to about 1500 feet to the north of Lake Superior. It is everywhere studded with lakes, with intervening hills wooded to their summits. Minerals of economic value are almost entirely confined to the bands of Huronian rocks, and include mica, apatite, marble, graphite, and iron.

Rivers and lakes.

Both the St Lawrence and its principal tributary the Ottawa receive many affluents from the province. The Trent and Moira fall into Lake Ontario, the Grand into Lake Erie, the Thames into Lake St Clair, the Severn, Muskoka, Maganatawan, French, Wahnapitai, and Mississauga into Lake Huron, and the Michipicoten, Pic, Nipigon, Kaministikwia, and Pigeon into Lake Superior. Beyond the Height-of-Land the Winnipeg and English rivers flow westward to Lake Winnipeg, and the Albany, Kenogami, and the Moose with its affluents, the Mattagami and Abitibi, empty into James Bay. The principal lakes are: Lake Simcoe, with an area of 300 square miles, and an elevation of 720 feet above the sea; Nipissing, at an elevation of 642 feet; Nipigon, 852; Mille Lacs, 1496; Shebandowan, 1473; Rainy, 1109; St Joseph, 1172; Seul, 1150; and Lake of the Woods, 1060. The principal islands are Wolfe, Howe, and Amherst, at the foot of Lake Ontario; Manitoulin, Cockburn, and St Joseph in Lake Huron, and Michipicoten and St Ignace in Lake Superior.

Climate.

The climate is very diversified; in the south-western portion the winters are not severe, and the summers, owing to the tempering influence of the Great Lakes, are not oppressively hot; in the Ottawa and St Lawrence valleys the winters are moderately cold, but bracing and exhilarating; to the north and north-west of Lake Superior the winters are long and cold, and at times extremely low temperatures are registered. The normal temperatures for three points in the south-western, eastern, and north-western portions are given below:—

	Toronto.	Ottawa.	Port Arthur.
December, January, and February	23·7	13·3	7·3
March, April, and May	40·6	38·5	31·1
June, July, and August	65·4	67·4	58·9
September, October, and November	47·0	44·8	38·5
	in.	in.	
Average annual precipitation	33·944	32·650	23·580

The area included within the limits of the province is 222,000 square miles. The northern and western boundaries, as defined by arbitrators in 1878, were the Albany and English rivers, and a meridian line from the north-west angle of the Lake of the Woods, respectively. This decision, on appeal to the Imperial Privy Council, was upheld, and was finally confirmed by an Act of the Imperial Parliament in 1889. The following table shows the population classified by townships, towns and villages, and cities :—

Area and population.

	1881.	1891.	1901.
Townships . .	1,346,623	1,283,281	1,247,190
Towns and villages	323,188	432,912	935,752
Cities . . .	257,111	398,128	
	1,926,922	2,114,321	2,182,942

The principal cities and towns, with their respective populations in 1901, were:—Toronto, the provincial capital, 208,040 ; Ottawa, the capital of Canada, 59,928 ; Hamilton, 52,634 ; London, 37,981 ; Kingston, 17,961 ; Brantford, 16,619 ; Windsor, 12,153 ; Guelph, 11,496; St Thomas, 11,485 ; Peterborough, 11,239; Stratford, 9959 ; St Catharine's, 9946 ; Berlin, 9747 ; Belleville, 9117 ; Chatham, 9068 ; Brockville, 8940 ; Woodstock, 8833 ; Owen Sound, 8776 ; Sarnia, 8176 ; Galt, 7866 ; Sault Ste Marie, 7169 ; Lindsay, 7003 ; Cornwall, 6704 ; Barrie, 5949 ; Collingwood, 5755 ; Rat Portage, 5202 ; Pembroke, 5156 ; Smith's Falls, 5155. In 1901 the urban population was 935,752, and the rural 1,247,190. Density, 9·8 inhabitants to the square mile. In 1901 there were 1,096,641 males and 1,086,306 females. Indians, 19,597 ; and half-breeds, 5100. Classified according to place of birth, the principal nationalities in 1901 were as follows :—Canada, 1,858,788 ; England and Wales, 121,506 ; Ireland, 68,093 ; Scotland, 49,881 ; other British possessions, 2913 ; United States, 44,175 ; Germany, 18,699 ; Scandinavia, 2005 ; Italy, 3283 ; France, 1254 ; other countries, 12,350. In 1891 there were 341,714 persons engaged in agricultural pursuits ; fishermen, 1421 ; mining, 1666 ; domestic and personal service, 109,328 ; manufactures and mechanical industries, 158,831 ; professional, 30,101 ; trade and transportation, 87,174 ; and non-productive, 20,053. The following table gives vital statistics for the period 1878–1900 :—

	1878.	1888.	1900.
Births . . .	40,236	46,953	46,127
Marriages . .	12,729	14,551	17,104
Deaths . .	17,808	23,734	29,494
Still-born . .	334	(not	578
,, ,, . .	0·8 %	classified)	1·3 %
Illegitimate births	575	618	800
,, ,,	1·4 %	1·3 %	1·7 %

The executive power consists of a lieutenant-governor, appointed for five years, assisted by an executive council of eight ministers with portfolios, who have seats in the local legislature or House of Assembly. The latter consists of ninety-eight members.

Administration.

Classified according to religion, the principal denominations in 1901 were as follows :— Methodists, 666,360 ; Presbyterians, 477,383 ; Episcopalians, 367,940 ; Roman Catholics, 390,355 ; Baptists, 116,180 ; Lutherans, 48,016 ; Congregationalists, 15,285 ; Salvation Army, 6479 ; Disciples of Christ, 10,123 ; Quakers, 3648 ; Brethren, 6416 ; Jews, 5336.

Religion.

In 1900 there were 5655 public elementary schools, taught by 9440 teachers, of whom 2630 were men and 6810 women ; Roman Catholic separate schools, 355 ; Protestant separate schools, 7 ; secondary public schools, 131 (including 38 collegiate institutes), taught by 573 teachers ; and 120 kindergartens, taught by 250 teachers. The pupils enrolled in the public elementary schools of all kinds numbered 420,097, with an average attendance of 237,306 ; pupils in Roman Catholic separate schools, 42,397, with an average attendance of 25,875 ; Protestant separate schools, 416 pupils, and average attendance 238. Total amount expended on public schools during the year, $4,228,532, and on high schools, $718,601. For the professional training of teachers there are (1) county model schools, fifty-five in number ; (2) three normal schools, and (3) one normal college ; their non-professional training is obtained in the secondary schools and universities. There is an agricultural college at Guelph, and at Belleville and Brantford there are institutes for the education of the dumb and the blind. Of the six universities in the province only one, the University of Toronto, is a State institution. The others are Victoria (now "federated" with Toronto), Queens of Kingston, Trinity and McMaster of Toronto, Western of London, and the University of Ottawa.

Education.

There is no direct taxation, except a special tax on insurance, loan, and railway companies doing business in the province, the revenue being derived from the sale of Crown lands, timber, and minerals, liquor licences, and other fees, supplemented by a subsidy from the Dominion Government. The principal items of revenue and expenditure for the year 1901 are tabulated below :—

Finance.

Revenue.		Expenditure.	
Dominion subsidy	$1,116,873	Civil government	$281,136
Specific grant from Dominion Government . . .	80,000	Legislation . .	134,139
Interest . .	189,175	Justice, administration of . .	416,043
Crown lands . .	1,634,724	Education . .	782,193
Licences . .	376,373	Agriculture . .	209,859
Succession duties .	366,582	Hospitals and charities . .	192,280
Provincial tax .	237,507	Public institutions	833,164
Miscellaneous .	464,810	Miscellaneous .	1,190,020
	$4,466,044		$4,038,834

In December 1901 the province had—cash on hand, $1,468,493 ; funds in hands of Dominion Government, $6,212,497 ; and direct investments, $220,898—in all, $7,901,888 : liabilities, $5,330,596, leaving a cash surplus of $2,571,292. In 1898 the total receipts of all the municipalities were $30,921,578 ; disbursements, $29,071,839 ; assets, $61,926,795 ; liabilities, $61,390,107 ; and bonded debt, $54,506,372. In 1899 the total assessment of the townships was $450,952,948 ; towns and villages, $125,982,155 ; cities, $239,825,370 ; and grand total, $816,760,473. The taxes for the same year were: townships, $4,621,803 ; towns and villages, $2,691,534 ; cities, $5,221,947 ; and total, $12,535,284.

The mineral resources, though important, are largely undeveloped, owing to the concentration of the greater part of the population in the fertile Palæozoic tract of the province, where, with the exception of building materials, salt, petroleum, and natural gas, no minerals of economic value are found. Gold has been found along the whole length of the northern Archæan border of the province, but the richest and most numerous discoveries have been made in the country between Thunder Bay, on the north shore of Lake Superior, and the western boundary. Mining on a small scale is also carried on in Hastings county. The most important silver mine is that of Silver Islet, the total production of which between 1870 and 1884 amounted to $3,250,000. A number of silver mines yielding rich ores have been worked in the Thunder Bay district. The nickel deposits of the Sudbury region are, with the possible exception of New Caledonia, the richest in the world. Practically the whole of the copper produced in the province is obtained as a by-product of the nickel, the Bruce mines on the north shore of Lake Superior having ceased producing in 1876. There are also extensive deposits at Parry Sound, now under development, on Michipicoten island and the north shore of Lake Superior. The production of iron was till recently confined to a few mines in Hastings and Frontenac counties, and near Michipicoten. There are also immense deposits of magnetite and hematite in the country between Port Arthur and Rainy Lake, but lack of railways and cheap fuel has prevented their development. Natural gas is produced in the Welland and Essex gas-fields, the greater portion of which is exported to Buffalo and Detroit.

Minerals.

The mineral production for 1901 was as follows :—

	Quantity.	Value.
Copper	8,695,831 lb	$1,401,507
Gold	...	244,837
Iron ore	272,538 tons	174,428
Pig iron	116,371 ,,	1,599,413
Nickel	9,189,047 lb	4,594,523
Silver	151,400 oz.	84,830
Total metallic . . .		$8,099,538
Non-metallic :—		
Natural gas	...	336,183
Petroleum	612,000 barrels	979,200
Cement	408,394 ,,	592,030
Other minerals and structural materials	...	4,160,996
		$14,167,947

Ontario is pre-eminently an agricultural country, as (1) about 67 per cent. of its inhabitants are engaged in agricultural pursuits, and (2) the amount invested in lands, buildings, implements, and stock—$974,814,931—is two and a half times that invested in the manufactures of the whole Dominion. The statistics of farm lands, as taken by the municipal assessors, are given in the following table :—

Agriculture.

	1883.	1893.	1900.
	Acres.	Acres.	Acres.
Land under crop	7,542,623	8,054,612	8,794,953
Pasture . . .	...	2,682,180	2,694,600
Orchards and gardens	2,996,934	1,394,772	350,098
Fallow land, &c. .	...	...	1,457,555
Total cleared land .	10,539,557	12,131,564	13,297,206
Swamp and waste land . . .	2,093,173	2,694,487	3,143,535
Woodland . .	8,825,337	8,133,229	7,127,363
Total assessed .	21,458,067	22,959,280	23,568,104

The following table gives statistics of the principal field crops :—

	1889.		1900.	
	Product.	Value.	Product.	Value.
	Bush.	$	Bush.	$
Wheat .	20,261,162	17,556,065	30,310,070	20,202,230
Barley .	16,235,295	7,992,105	16,909,751	6,577,893
Oats . .	64,346,301	19,625,622	89,693,327	23,768,732
Rye and buckwheat	3,361,576	1,474,880	4,231,896	1,962,505
Pease and beans .	13,881,130	7,995,833	14,878,571	8,845,143
Potatoes .	14,355,529	6,531,766	21,476,439	5,605,351
Other roots	48,071,545	6,533,265	87,528,043	8,344,962
Corn, husking . .	...	...	27,093,561	8,588,659
Corn, fodder	...	...	...	4,295,064

All field crops :—

	Acres in Crop.	Market Value of Crop.	Market Value per Acre.
1889	7,758,583	$106,500,799	$14·37
1894	8,227,153	94,055,392	11·45
1900	8,794,953	114,758,761	13·05

In 1900 there were in the province 617,309 horses, valued at $46,916,999; cattle, 2,429,330, value $56,320,810; sheep, 1,797,213, value $7,711,496; hogs, 1,771,641, value $9,598,153; poultry, 9,541,241, value $2,727,363. Total value of live stock sold or slaughtered during the year, $41,642,617; wool clip, 5,805,921 ℔, value $894,112. There were, in 1883, 635 cheese factories producing 53,513,032 ℔ of cheese, valued at $5,589,339, and in 1900, 1173 factories producing 127,789,543 ℔, value $13,023,025. In 1893 74 creameries produced 2,707,570 ℔ butter, value $574,156, and in 1900, 308 creameries produced 9,041,468 ℔, value $1,819,290. Value of farm land in 1900, $574,727,610; buildings, $219,488,370; implements, $57,324,130; and live stock, $123,274,821; total, $974,814,931.

Fisheries. The principal fishes, in the order of their relative commercial importance, are trout, whitefish, herring, pickerel, sturgeon, &c. —all fresh-water fish. In 1900 the value of the catch was $1,333,294; vessels, boats and outfit, $789,042; and exports, $381,045.

Timber. The northern portion of the province possesses immense timber resources, and beyond the Height-of-Land a great spruce forest extends to the shores of Hudson Bay. White pine is still the most important as regards value and commercial importance, but the great and increasing demand for spruce for paper-making makes it one of the most valuable assets of the province. Other valuable timber trees are oak, elm, walnut, hemlock, basswood, cherry, and butternut. The cut of logs in 1899 aggregated 875,000,000 feet.

Manufactures. The following table gives statistics of the principal manufactures in 1891 :—

	Number of Establishments.	Number of Employés.	Value of Product.
Flour and grist mills .	1078	3453	$36,558,320
Saw-mills . . .	1895	23,851	26,987,259
Foundries . . .	337	6198	7,803,152
Leather manufactures	3234	6262	7,446,540
Agricultural implements . . .	130	4029	6,927,887
Carriage works . .	1561	5096	5,906,679
Woollen mills . .	303	5191	5,873,685
Distilleries and breweries . . .	89	1435	5,673,474

In 1891 there were 32,151 industrial establishments with a total fixed capital of $81,551,232; working capital, $94,420,789; employing 164,326 persons; paying in wages $49,733,359 per annum; using raw material valued at $128,142,371, and with a product of value $239,781,926.

Commerce. The following table gives statistics of exports, imports, and duty collected for the period 1874–1900 at the custom-houses within the province, but a large amount of the merchandise entered inwards and outwards at the port of Montreal should properly be credited to Ontario :—

	Exports.	Imports.	Duty.
1874	$25,157,087	$49,443,977	$4,371,625
1884	26,891,017	41,967,215	6,979,026
1894	32,726,074	42,025,638	7,475,142
1900	56,116,756	71,258,544	10,763,214

Shipping. In 1901 there were 1647 vessels with a tonnage of 145,981 on the registry books of the province. In the year ending 30th June 1898, 31,983 vessels with an aggregate tonnage of 11,257,361 were entered and cleared at the ports of the province.

Railways. Ontario had, in 1901, 6605 miles of steam railway, and 36·1 per cent. of the railway mileage of the Dominion. The principal systems are the Grand Trunk, Canadian Pacific, Canada Atlantic, and Michigan Central. There are 24 electric railways with nearly 400 miles of track, 480 motor cars, an aggregate of over 30,000 horse-power, and a capital investment of upwards of $10,000,000. The principal suburban roads are the Hamilton, Grimsby, and Beamsville, Hamilton Radial, Niagara Falls Park and River, Galt, Preston and Hespeler, and Metropolitan.

Canals. The St Lawrence canal system overcomes the difference of elevation—222 feet—between the river at Montreal and Lake Ontario, and consists of six canals: Lachine, $8\frac{1}{2}$ miles; Soulanges, 14; Cornwall, $11\frac{1}{2}$; Farrens Point, $\frac{3}{4}$; Morrisburg, $3\frac{7}{10}$; and Galops, $7\frac{6}{10}$ miles. The Welland canal is $26\frac{3}{4}$ miles long; has 25 lift-locks to overcome the difference of elevation—327 feet—between Lakes Ontario and Erie. The locks of the Welland and St Lawrence systems are 270 feet long, 45 feet wide, and have a depth at low water of 14 feet on the sills. The Sault Ste Marie canal, $1\frac{1}{10}$ mile long, with 1 lock 900 feet long, 60 wide, and with a depth of $20\frac{1}{4}$ feet on the sill, overcomes the fall of $18\frac{1}{10}$ feet at the foot of Lake Superior. The Ste Anne canal, $\frac{1}{8}$ mile, Corillon, $\frac{3}{8}$ mile, and Grenville, $5\frac{3}{4}$ miles, render the Ottawa river between its confluence with the St Lawrence and Ottawa city navigable for vessels of 9 feet draught. The Rideau canal system connects the Ottawa river, at the city of the same name, with Lake Ontario at Kingston, and has a navigation depth of $4\frac{1}{2}$ feet. The Trent Valley canal, when completed, will give a direct route from the Bay of Quinte, Lake Ontario, to the south end of Georgian Bay for vessels of $7\frac{1}{2}$ feet draught. The total amount expended on the works and maintenance (chargeable to capital) of the above canals to 30th June 1901 was $79,997,403. In addition, nearly $17,000,000 has been expended from income, making a total expenditure of $97,000,000. (J. WH*.)

Ontario, Lake. See ST LAWRENCE.

Onteniente, a town of Spain, in the province of Valencia, to the west of Albaida, on a hill on the right bank of the river Clariano. The population was 11,165 in 1887, and 11,078 in 1897. The town is well built, with broad streets and a parish church that is remarkable for a lofty square tower. There is a large new suburb outside the old town, which was a walled city in days gone by; some vestiges of the ramparts still remain. The local industries are manufactures of woollen and linen stuffs, alcohol, paper, and furniture, and there is an active trade in the agricultural products of the surrounding districts.

Oporto, the second city of Portugal, an episcopal see and seaport, and capital of the district of Oporto, on the right bank of the Douro, 3 miles above its mouth. With the view of avoiding the bar at the mouth of the river, on which the depth of water varies between 16 and 19 feet, an artificial port has been made at Leixões, on the coast, $2\frac{1}{2}$ miles north of the Douro. In 1900 the port was entered and cleared by 1797 vessels of 777,557 tons (Oporto), and 968 vessels of 1,044,223 tons (Leixões), or in all 2765 vessels of 1,821,780 tons, but a portion of the shipping is counted twice over, that is, in both ports. The total trade is valued at about five millions sterling, of which about three and a half millions represent imports. The principal exports are timber, stone, onions, cork, salt, wool, and port wine. The last-named goes principally to Great Britain, Brazil, and Hamburg, and Norway and Sweden. The combined port possesses a fishing fleet of some 360 vessels, manned by about 1600 men and boys, who catch fish to the annual aggregate value of £50,000 to £100,000. A third of the population are engaged in manufacturing industry, the chief objects of which are leather, tobacco, spirits, woollens, cottons, silk, hats, preserved foods, beer, aërated waters, soap, pottery, corks, and gold and silver filigree work. The Douro is crossed by a fine bridge, built in 1877, and measuring 1158 feet in length; the central arch has a span of 525 feet. Amongst the public buildings should be mentioned the exchange (which cost £133,500), the royal palace of Torre da Marca, and the crystal palace (350 feet long by 48 feet wide), used for exhibitions. The educational institutions embrace a medical college, polytechnic academy, industrial institute, academy of the fine arts, seminary, lyceum of secondary education, two normal schools, trade schools, and a naval training school. There are also a meteorological observatory and the commercial athenæum. Population (1890), 138,860; (1900), 172,421. Area, $13\frac{1}{2}$ square miles.

The district of Oporto has an area of 885 square miles, and population (1900), 601,688, giving 680 inhabitants to the square mile, and consequently the most densely peopled district in the kingdom. The soil is very fertile, and intensely cultivated, except on certain of the higher parts and along the low-lying sandy coast. A large proportion of the surface is covered with wood. The vine is the chief object of cultivation; in 1892 it covered 39,400 acres, the yield being 7,656,000 gallons of wine, valued at £240,000. During the four years 1896–99 inclusive an average of 4,208,200 gallons of port wine produced in this district was exported to the United Kingdom. The districts formerly ravaged by the phylloxera and other diseases are being gradually replanted with vines, though the port wine industry as a whole cannot be said to be in a flourishing condition. In respect of the value of its live stock, especially cattle and pigs, this district ranks as the first in the kingdom. Coal, antimony, and gold are mined, with a little iron and lead, the average yield annually being 7500 tons, valued at £26,900. Slates are quarried, and granite is plentiful. It is estimated that 82,000 persons are employed in industrial pursuits; in addition to the branches mentioned under the city of Oporto (above) and Villa Nova de Gaia, cottons and woollens are manufactured at Vallongo and Santo Thyrso, and at Amarante.

Oppeln, a town of Prussia, province of Silesia, 51 miles by rail south-east of Breslau, on the Oder. The sole surviving fragment, a tower, of the former ducal palace was incorporated in a new gymnasium (school) in 1898. A new Jewish synagogue was built in 1897. There is also a statue to the Emperor William I. (1891). Oppeln is the seat of the provincial administration of Upper Silesia. Population (1885), 15,975; (1895), 23,017; (1900), 30,115.

Oppert, Julius (1825–——), Assyriologist, was born at Hamburg of Jewish parents on the 9th of July 1825. After studying at Heidelberg, Bonn, and Berlin, he graduated at Kiel in 1847, and in the following year went to France, where he became professor of German at Laval. His leisure was given to Oriental studies, in which he had made great progress in Germany, and in 1854 he joined M. Fresnel's archæological expedition to Mesopotamia. On his return he occupied himself in digesting the results of the expedition in so far as they concerned cuneiform inscriptions, and published an important work upon them in 1864. In 1857 he was appointed professor of Sanscrit in the school of languages connected with the National Library, and in this capacity produced a Sanscrit grammar; but his attention has been chiefly given to Assyrian and cognate subjects, and he has been especially prominent in establishing the Turanian character of the language originally spoken in Assyria. In 1865 he published a history of Assyria and Chaldæa in the light of the results of the different exploring expeditions. At a later period he devoted much attention to the language and antiquities of ancient Media, writing *Le Peuple et la Langue des Mèdes* (1879). He has published a very considerable number of separate memoirs upon Assyrian mythology, jurisprudence, and other subjects connected with the ancient civilizations of the East.

Oran, the second port of Algeria, capital of the department, on the Gulf of Oran, between Cape Aiguille on the east and Cape Falcon on the west, 260 miles by rail west-south-west of Algiers, 220 miles east of Gibraltar. Owing to the fact that it is the Mediterranean port in the most direct line with Timbuktu and the Niger, it has experienced a large development. Among fine new edifices are the hôtel de ville, the prefecture, the bank, and the hôtel des postes. Since 1878 there has been an archæological and geological society, which holds the foremost rank in Algeria. Oran has a considerable trade in wines, cereals, oils, and wools. The harbour has been so much improved that ships which formerly stopped at the harbour formed by the promontory of Mers el Kebir, about 3 miles to the west, now enter the port. A pier, three lighthouses, and a breakwater all greatly assist commerce and navigation. Oran owes its importance as a seaport to its proximity to Spain, being only eight hours' distance (about 140 miles) from Carthagena and Almeria. The tonnage, 650,000 in 1875, mounted to 1,231,000 in 1884, 2,064,000 in 1895, and 2,310,000 in 1898. The population in 1886 was 67,681, of whom 13,853 were French; in 1896 it was 80,211, of whom 24,038 were French; and in 1900 it was 85,081, of whom 25,088 were French. The foreign element, chiefly Spaniards, exceeds 34,000.

Orange, chief town of arrondissement, department of Vaucluse, France, 17 miles north of Avignon, on the railway from Paris to Marseilles. The ancient Roman theatre has been restored (1897) and now serves as a National Theatre; the hôtel de ville, erected in the 17th century, was restored in 1888. Amongst modern erections are a colossal statue of the Virgin on the hill above the theatre, and a monument to the soldiers who fell in the war of 1870–71. Population (1881), 6118; (1891), 6099; (1901), 9705.

Orange, a town of Australia, New South Wales, in the counties of Wellington and Bathurst, 192 miles by rail west of Sydney. It lies in a fruit and wheat producing district, in which gold, copper, and silver also abound. Its suburb, East Orange, in the county of Bathurst, is a separate municipality. The mean rainfall (16 years) is 35·84 inches. Population (1901), including East Orange, 6331.

Orange, a city of Essex county, New Jersey, U.S.A., situated at the undulating base of the Watchung Mountain, in the north-eastern part of the state, at an altitude of 187 feet. Two railways—the Delaware, Lackawanna and Western, and the Erie—connect it with New York, 16 miles distant, of which it is a residential suburb. It is also connected with neighbouring cities by trolley lines. It is irregularly laid out, even in the closely-built portions. It has an excellent water-supply and sewer system, and is divided into five wards. Population (1890), 18,844; (1900), 24,141, of whom 6598 were foreign-born and 1903 negroes.

Orange River Colony, a division of South Africa, known as the Orange Free State from 1854 to 1900, situated between 27° and 31° S. and 24° 20′ and

29° 40′ E. It reverted to the position of a British colony as the result of the Boer war, the capital, Bloemfontein, being occupied by the British on 28th February 1900. Under the Boer rule the country had made considerable material progress and reached a fair standard of general comfort, although the population showed but a relatively small increase of from 133,000 in 1880 to 208,000 (78,000 whites and 130,000 natives) in 1890. But this is no doubt partly to be explained by the considerable loss of territory under the Keate award in 1871, when the Kimberley diamond fields, with Griqualand West, were assigned to Great Britain. The economic prosperity of the land is indicated by the rapid development of its agricultural resources, of railway and mining enterprise, of its exports and its sound financial condition before the outbreak of hostilities. The revenue rose from £310,000 in 1892 to £800,000 in 1898, including £408,000 from the railways, which have now a total length of nearly 400 miles, and afford direct communication southwards across the Orange with Cape Town, Port Elizabeth, and East London, and northwards across the Vaal with Pretoria. The total imports (general merchandise of all kinds) advanced from £900,000 in 1895 to £1,192,000 in 1898, while in the latter year the exports (wool, hides, corn, diamonds) exceeded £2,000,000. Much coal continues to be gained from the extensive Kroonstad deposits, while the yield of diamonds in the Fauresmith district, near the Kimberley fields, rose from 99,225 carats, valued at £224,000, in 1890, to 307,000 carats, valued at £1,508,000, in 1898. The area of cultivated lands is encroaching on the pastures, especially in the fertile tracts along the banks of the Caledon river, and in the sheltered and well-watered upland valleys to the north-east of Thaba N'chu. At present the agricultural holdings considerably exceed 10,000, with a total of about 30,000,000 acres, of which 256,600 were under tillage in 1890. In the same year the live stock comprised 890,000 horned cattle, 250,000 horses, and 6,620,000 merino and fat-tailed sheep. Former reports of the dry and salubrious nature of the climate have been fully confirmed, and there can be no doubt that, with the development of irrigation works, vast tracts might be rendered suitable for European settlers. Besides the capital, there are several townships, villages, and other centres of population, which present some interest as markets for farm produce, or for their strategic position and historic associations. Subjoined are the most important arranged in alphabetical order :—

Albertina, a railway station on the line (60 miles long) running from Ladysmith in Natal to Harrismith, not far from Van Reenens Pass.

Bethanie, a railway station on the main line from Bloemfontein to Springfontein junction, founded by the French missionaries amongst the Basutos, who formerly occupied this district.

Bethlehem, a market on the Zand river, 56 miles west of Harrismith, and 83 miles east of Smaldeel railway station.

Bethulie, a station at the head of the railway bridge which here crosses the Orange river just below the Caledon confluence ; occupied by the British, 28th February 1900.

Boshof, a township near the west frontier, a few miles north-east of Kimberley ; here fell the leader of the "European Legion," Colonel de Villebois-Marcuil, 5th April 1900.

Brandford, an important railway station on the main line from Bloemfontein to Pretoria ; occupied by the British, 5th May 1900.

Edenburg, railway station on the main line between Bloemfontein and Springfontein, south of the Riet river.

Fauresmith, a township in the south-western district, at the junction of several roads, and close to the Jagersfontein diamond mines, the most productive in the colony. Here was found the largest African stone, weighing 500 carats uncut, but of imperfect quality.

Harrismith, a town near the eastern frontier, present terminus of the railway which runs from Ladysmith, on the Durban–Pretoria line, through Van Reenens Pass, and is to be continued to Kroonstad on the Bloemfontein–Pretoria line. Harrismith, which is distant 20 miles from Van Reenens Pass, lies in the valley of the Wilge tributary of the Vaal, and is the most important place in the eastern part of the colony.

Jacobsdal, a market in the south-western district, close to the "Griqualand frontier," on the right bank of the Riet river ; occupied by the British, 16th February 1900.

Kroonstad, a town and railway station on the Bloemfontein–Pretoria line, 127 miles from the former place, and 86 miles from the Vaal river ; was chosen by President Steyn as his capital after the fall of Bloemfontein, but was occupied by the British on 12th May 1900 ; is the centre of the chief coal-mining industry in the colony.

Ladybrand, a thriving agricultural town on the right bank of the Caledon, near Maseru in Basutoland.

Lindley, a market on the Valsch tributary of the Vaal, east of Kroonstad.

Paardeberg, a post on the right bank of the Modder, 30 miles south-east of Kimberley ; here the Boer leader, Cronje, surrendered with over 4000 men, 27th February 1900.

Philippolis, a town near the Orange river, south of Fauresmith ; occupied by the British, 23rd March 1900.

Rouxville, a flourishing agricultural station near the Orange river at Aliwal North, above the Caledon confluence ; occupied by the British, 19th March 1900.

Senekal, a market on the Bloemspruit, south-east of Kroonstad ; occupied by the British, 25th May 1900.

Smaldeel, a railway station on the main line, 63 miles north of Bloemfontein ; headquarters of General Roberts, 6th May 1900.

Smithfield, a large market on the Lower Caledon, 50 miles above its confluence with the Orange.

Springfontein, a railway station at the junction of the two main lines from Cape Town and Port Elizabeth.

Thaba N'chu, a station in the hilly eastern district near Ladybrand, former capital of the petty Barolong State, which was deprived of its autonomy by the Orange Free State in 1884.

Wepener, a station on the Lower Caledon, occupied, 29th March 1900, by the British, who successfully held the place against a greatly superior Boer force, 9th–24th April 1900.

Winburg, a large market connected by a short branch with the Smaldeel station on the Bloemfontein–Pretoria main line.

(A. H. K.)

History.—In 1853 a convention was entered into between representatives of the Free State and the British Government for transferring the government of the Orange River sovereignty to representatives delegated by the inhabitants to receive it. By means of this transfer the Imperial Government established the future independence of the country, and further stated that the British Government had no alliance whatever with any native chiefs or tribes to the north of the Orange river, with the exception of the Griqua chief, Adam Kok. It was also stipulated that the Orange River government should, as hitherto, permit no slavery or trade in slaves in their territory north of the Orange river. At the time of this transfer some Boers, leading residents of the Free State, protested against the abandonment, but the duke of Newcastle, who was then British colonial secretary, stated that, in his opinion, Imperial authority had already been extended too far in South Africa. He therefore could not entertain the request made to him to retain the administration of the country.

The new state of things had only been one year in existence when the Free State government found themselves victims to an intrigue of Messrs Pretorius and Kruger, within the Transvaal, to bring about, by force if necessary, a confederation between the two countries. In the first instance, peaceful overtures were made, but the Free Staters declined to accept the proposal. Thereupon Pretorius, aided by Paul Kruger, organized and conducted a raid into the Free State territory, in the hope of overawing the Free State government, and compelling it to fall in with the views of the minority of the Free Staters, who were co-operating with Pretorius. On learning of the invasion, Boshof, President of the Free State, proclaimed martial law throughout the country, and called out his burghers. The majority of the burghers rallied to his support, and in a very short time a formidable force was got together to oppose the invaders. On the 25th of May

1854 the two opposing forces faced one another on the banks of the Rhenoster. President Boshof not only managed to get together a considerable force within the Free State, but he received an offer of support from General Schoeman, the Transvaal leader in the Zoutpansberg district. Pretorius and Kruger, when they learnt what had occurred, realized that they would have to sustain attack from both north and south, and abandoned their enterprise (see TRANSVAAL). Before leaving, a treaty was signed, which amounted to an apology on the part of Pretorius. Several of the malcontents in the Free State, who had joined the Transvaal party, returned with them over the Vaal river, and permanently settled in the Transvaal. Other Free Staters who had been guilty of high treason were arrested and punished.

In 1858 the Volksraad of the Free State were so tired of the responsibilities of independence, that they passed a resolution in favour of a confederation in some shape or form with the Cape Colony. This proposition received the strong support of Sir George Grey, at that time governor of Cape Colony, but his view did not commend itself to the home authorities, and was not adopted.

From the date of their first settlement in the Orange River territories, the Boers were continually at feud with their Basuto neighbours on the eastern border (see BASUTOLAND). In 1866 they organized a powerful expedition, and attacked Moshesh. The expedition was successful, Moshesh was defeated, and a treaty was arrived at, by which he gave up possession of a portion of Basutoland, and acknowledged himself the subject of the Free State. This treaty did not, however, by any means terminate the strife; a period of feud continued, in the course of which Moshesh and his followers were reduced to very dire straits. They appealed to Great Britain for assistance, and in 1869 a treaty was agreed to between the High Commissioner and the Orange Free State, defining the borders between the Orange Free State and Basutoland. All the fertile tract of country lying to the north of the Orange river and west of the Caledon, originally a part of Basutoland, was ceded to the Free State. This tract of country, some hundred miles long and nearly thirty wide, is a fertile stretch of agricultural land on the lower slopes of the Maluti Mountains. It lies at an altitude of nearly 6000 feet, and is well watered by the Caledon and its tributaries. It has ever since been known as the Conquered Territory, and it forms to-day one of the richest corn-growing districts in South Africa.

The Basutoland difficulties were no sooner arranged than the Free Staters found themselves confronted with a serious difficulty on their western border. In the years 1870–71 a large number of diggers had settled on the diamond fields, which were situated on the boundary between the Griqua chief Waterboer and the Free State. At the time both the Free State and Waterboer claimed the district, and the Free State established a temporary government over the diamond fields, but the administration of this body was satisfactory neither to the Free State nor to the diggers. At this juncture Waterboer offered to place the territory under the administration of Queen Victoria. The offer was accepted, and on 27th October 1870 the district was proclaimed, under the name of Griqualand West, British territory. To criticize the grounds on which Waterboer's claims were based is difficult. But whatever the justice of the decision to annex may have been, it is certain that President Brand contended at the time that Waterboer's title was a bad one. The matter involved much correspondence and no little irritation between the British Government and the Free State until 1876. It was then finally disposed of by Lord Carnarvon, who granted to the Free State £90,000 in compensation for any possible harm or wrong which the Free State might have sustained from the annexation. In making this concession, it is right to state that Lord Carnarvon, having gone into the question, declined to acknowledge any validity in the Free State claim to the territory in question. One thing at least is certain with regard to the diamond fields—they were the means of restoring the credit and prosperity of the Free State. In the opinion, moreover, of Dr Theal, who has written the history of the Boer Republics and has been a consistent supporter of the Boers, the annexation of Griqualand West was probably in the best interests of the Free State. Fortunately at the time the Free State had an enlightened and liberal-minded ruler in President Brand, who avoided collisions and encouraged amicable relations with the British authorities.

In spite of the troubles on her borders, the Free State, under Brand's beneficent and tactful guidance, made progress in various directions. Villages sprang up, roads were constructed, and a postal service was established. Tea-planting was encouraged by the government. At the same time the Free State Boers, like their Transvaal neighbours, had drifted into financial straits. A paper currency had been instituted, and the notes—currently known as "bluebacks"—soon dropped to less than half their nominal value. Commerce was largely carried on by barter, and many cases of bankruptcy occurred in the State. But as British annexation in 1877 saved the Transvaal from bankruptcy, so did the influx of British and other immigrants to the diamond fields, in the early 'seventies, restore public credit and individual prosperity to the Boers of the Free State. The diamond fields offered a ready market for stock and other agricultural produce. Money flowed into the pockets of the farmers. Public credit was restored. "Bluebacks" recovered par value, and were duly called in and redeemed by the government. At a later date valuable diamond mines were discovered within the Free State, of which the one at Jagersfontein is the richest. Capital from Kimberley and London was soon provided with which to work them. The relations between the diggers and the Free State Boers, after the question of the boundary was once settled, remained perfectly amicable down to the outbreak of the Boer war in 1899. In 1880, when a rising of the Boers in the Transvaal against Sir Owen Lanyon was threatening, President Brand showed every desire to avert the conflict. He suggested to the authorities at Cape Town that Sir Henry De Villiers, Chief Justice of Cape Colony, should be sent into the Transvaal to endeavour to gauge the true state of affairs in that country. This suggestion was not acted upon, but when, in 1881, the Boers in the Transvaal broke out into open rebellion and war followed, Brand declined to take any part in the struggle. At a later date he urged that peace should be brought about, and expressed his friendly sentiments towards the British Government. In spite of the neutral attitude taken by Brand during this period, there can be no question that a certain number of the Free State Boers, living in the northern part of the Free State, went to the Transvaal and joined their brethren then in arms against the British Government. In 1888 Sir John Brand died. He had been President of the country since 1863, and in him the Boers, not only in the Free State but in the whole of South Africa, lost one of the most enlightened and most upright rulers and leaders they have ever had. Brand had always realized the liberal character of the British Government in South Africa, and while differences from time to time did occur between him and the representatives of Queen Victoria, he nevertheless in the main accepted the broad lines of British policy, and supported them. Throughout his long official career he remained on cordial terms of friendship with Great Britain.

In 1889 an agreement was come to between the Free State and the Cape Colony government, whereby the latter were empowered to extend, at their own cost, their railway system to Bloemfontein. The Free State retained the right to purchase this extension at cost, a right which they exercised within the course of a few years. In the same year Mr Reitz was elected President of the Free State. His accession to the Presidency marked the commencement of a new and disastrous line of policy in the public affairs of the country. Mr Reitz had no sooner got into office than a meeting was arranged with President Kruger, at which various terms of the agreement dealing with the railways, terms of a treaty of amity and commerce, and what was called a political treaty, were discussed and decided upon. The political treaty referred in general terms to a federal union between the two states, and bound each of them to help the other, whenever the independence of either should be assailed or threatened from without, unless the state so called upon for assistance should be able to show the injustice of the cause of quarrel in which the other state had engaged. In 1889 the Free State, having accepted the assistance of the Cape government in constructing its railway, entered into a Customs Union Convention with them. The convention was the outcome of a conference held at Cape Town in the previous year, at which delegates from Natal, the Free State, and the Colony attended. Natal at this time had not seen its way to entering the Customs Union, but did so at a later date. In 1895 the Free State Volksraad passed a resolution, in which they declared their readiness to entertain a proposition from the Transvaal in favour of some form of federal union. In the same year President Reitz retired from the presidency of the Free State on the ground of ill-health, and was succeeded by Judge Steyn. In 1896 President Steyn visited Pretoria, where he received quite an ovation as the future probable President of the two Republics. A further offensive and defensive alliance between the two Republics was then entered into, under which the Free State took up arms on the outbreak of hostilities with the Transvaal in 1899.

In 1897 President Kruger, being bent on still further cementing the union with the Free State, himself visited Bloemfontein. It was on this occasion that President Kruger, referring to the London Convention, spoke of Queen Victoria as a "kwaaje Frau," an expression which caused a good deal of offence in England at the time, but which, to any one familiar with the homely phraseology of the Boers, obviously was not meant by President Kruger as insulting. In order to understand the attitude which the Free State took at this time in relation to the Transvaal, it is necessary to review the history of Mr Reitz from an earlier date. Previous to his becoming President of the Free State he had acted as its Chief Justice, and still earlier in life had practised as an advocate in Cape Colony. In 1881 Mr Reitz had, in conjunction with his successor President Steyn, come under the influence of a clever German named Borckenhagen, the editor of the *Bloemfontein Express*. These three men were principally responsible for the formation of the Afrikander Bond (see CAPE COLONY). From 1881 onwards there is no doubt that they cherished the one idea of an independent South Africa, in which a monopoly of independence was to be held by the Boers. Brand during his lifetime had been far too sagacious to be led away by this pseudo-nationalist dream. He did his utmost to discountenance the Bond when it was started by Mr Reitz and Mr Borckenhagen, inasmuch as he saw full well that it was calculated to cause mischief in the future. At the same time his policy was guided by a sincere patriotism, which looked to the true prosperity of the Free State as well as to that of the whole of South Africa. It was only after his death that the fatal development of an exclusively Dutch policy arose in the Free State. From his death may be dated the disastrous line of policy which led to the extinction of the state as a republic. The one prominent member of the Volksraad who inherited the traditions and enlightened views of President Brand with regard to the future of the Free State was Mr G. J. Fraser. Mr Fraser was the son of a Presbyterian minister, who had acted as a minister in the Dutch Reformed Church since the middle of the century. He grew up in the country of his father's adoption, and he consistently warned the Free State of the inevitable result which must follow their mischievous policy in being led by the Transvaal. His protests, however, were vain, and the mass of Boers in the Free State, deluded by a belief in Great Britain's weakness, paid no heed to his remonstrances. Mr Fraser lived to see the fulfilment of these prophecies. After the British occupation of Bloemfontein he cast in his lot with the Imperial Government, realizing that it had fought for those very principles which President Brand and he had laboured for in bygone years.

The economic progress of the Free State, which began with the discovery of the diamond fields, has been redoubled since the construction of the railway through its territory to Johannesburg, thus fully justifying the forward commercial policy adopted in the teeth of Transvaal opposition. In illustration of this we have only to cite the fact that, in 1898–99, out of a total revenue of about £650,000, £325,000, or more than half, represented the earnings of the railway.

On entering Bloemfontein in 1900 the British obtained possession of certain state papers which contained records of negotiations between the Transvaal and the Orange Free State. The evidence contained in these state records so clearly marks the difference between the policy of Mr Kruger and the pacific, commercial policy of President Brand and his followers, that the documents call for careful consideration. From these papers it was found that, in 1887, two secret conferences had taken place between the Republics, dealing with various political and economical questions. At the first of these conferences, held in Pretoria, there were present President Kruger, with his state secretary and state attorney, Messrs Bok and Leyds, and a commission of the Transvaal Volksraad, consisting of Messrs Wolmarans, Klopper, Taljaard, Lombard, and Spies. On the other side the deputation from the Free State Volksraad was composed of Messrs Fraser, Klynveld, and Myburgh.

An interesting account of this interview was given by a correspondent of *The Times* on 24th May 1900. The account was evidently compiled after a careful study of the papers, and the correspondent states that pre-eminent at that conference, and practically leading it, stood President Kruger, knowing exactly what he wanted, "indifferent to argument, returning again and again to the same point, however often it was refuted; incapable of conviction, though ready as a last resort to lower his demands step by step, and claim that he had made a great concession"—in fact, the same Kruger, as twelve years later at Bloemfontein, only here not on the defensive against a superior intellect and a will as strong as his own (both of which he met in Sir Alfred Milner), but active, persuasive, impassioned, appealing to men more capable of being brought under his influence. On the Free State side was Mr Fraser, resolutely endeavouring to carry out the traditions of Brand's policy.

The objects of the Free State deputies at this conference were apparently straightforward. They were to arrange a general treaty of amity and commerce which would knit the states more closely together, and to come to some agreement with reference to the scheme for building a railway across the Free State from the Cape, to connect with a further extension in the Transvaal to Pretoria. Another proposition of the deputation, which they urged upon the Transvaal, was that of joining the South African Customs Union. Both of these suggestions were strongly disapproved of by Mr Kruger, inasmuch as they obviously meant knitting South Africa together with the British possessions, instead of merely bringing the Free State into completer dependence on the Transvaal. From the minutes of this conference it is clear that the two deputations were practically at cross purposes. In the minds of President Kruger and his immediate followers one idea was dominant, that of ousting and keeping out at all costs British influence and interests in every shape or form. On the part of the Free State, on the other hand, there was obviously a genuine desire to further the best interests of the state, together with the general prosperity of the whole of South Africa. In President Kruger's eyes British trade meant ruin; he desired to keep it out of the Republic at all costs, and he begged the Free State to delay the construction of their railway until the Delagoa Bay line was completed. He said, "Delagoa is a life or death question for us. Help us: if you hook on to the Colony you cut our throat. . . . How can our state exist without the Delagoa railway? Keep free." With regard to the Customs Union President Kruger was equally emphatic; he begged the Free State to steer clear of it. "Customs Unions," he said, "are made between equal states with equal access to harbours. We are striving to settle the question of our own harbour peacefully. The English will only use their position to swindle the Transvaal of its proper receipts." In response, Mr Fraser remarked that a harbour requires forts, soldiers, ships, and sailors to man them, or else it would be at the mercy of the first gunboat that happened to assail it. President Kruger replied that once the Transvaal had a harbour foreign Powers would intervene. Mr Wolmarans was as emphatic as President Kruger. "Wait a few years. . . . You know our secret policy. We cannot treat the Colony as we would treat you. The Colony would destroy us. It is not the Dutch there we are fighting against. Time shall show what we mean to do with them; for the present we must keep them off." This last sentence probably refers to an intrigue with certain Dutchmen in the Cape Colony. If it did not refer to an actual intrigue, the least it could have meant was the intention to intrigue when occasion arose.

The result of this conference was a secret session of the Transvaal Volksraad and the proposition of a secret treaty with the Free State, by which each state should bind itself not to build railways to its frontier without the consent of the other, the eastern and northern frontiers of the Transvaal being excepted. The railway from Pretoria to Bloemfontein was to be proceeded with; neither party was to enter the Customs Union without the consent of the other. The Transvaal was to pay £20,000 annually to the Free State for loss incurred for not having the railway to Cape Colony. Such a treaty as the one proposed would simply have enslaved the Free State to the Transvaal. It was rejected by the Free State Volksraad in due course, but President Kruger, not content with this resolution, determined on a still more active measure, and proceeded with Dr Leyds to interview President Brand at Bloemfontein. A series of meetings took place in October of the same year (1887). President Kruger had come to Bloemfontein nominally with the intention of discussing railway and commercial matters, and also of promoting closer union between the two Republics. President Brand, therefore, opened the proceedings by proposing a treaty of friendship and free trade between the two Republics, in which a number of useful and thoroughly practical provisions occurred. President Kruger, however, soon brushed these propositions aside, and responded by stating that, in consideration of the common enemy and the dangers which threatened the Republic, an offensive and defensive alliance must be preliminary to any closer union. To this Brand rejoined that, as far as the offensive was concerned, he did not desire to be a party to attacking any one, and as for the defensive, where was the pressing danger of the enemy which Kruger feared? The Free State was on terms of friendship with its neighbours, nor (added Brand) would the Transvaal have need for such an alliance as the one proposed if its policy would only remain peaceful and conciliatory. At a later date in the conference (see TRANSVAAL) President Brand apparently changed his policy, and himself drafted a constitution resembling that of the United States. This constitution appears to have been modelled on terms a great deal too liberal and enlightened to please Mr Kruger, whose one idea was to have at his command the armed forces of the Free State when he should require them, and who pressed for an offensive and defensive alliance. Brand refused to allow the Free State to be committed to a suicidal treaty, or dragged into any wild policy which the Transvaal might deem it expedient to adopt. The result of the whole conference was that Kruger returned to Pretoria completely baffled, and for a time the Free State was saved from being a party to the fatal policy into which others subsequently drew it. Independent power of action was retained by Brand for the Free State in both the railway and Customs Union questions.

After Sir John Brand's death, as already stated, Mr Reitz became President, and consistently followed out that policy which, as one of the founders of the Bond, he had endeavoured to inaugurate throughout Dutch South Africa. A series of agreements and measures in the Volksraad gradually subordinated those true Free State interests which Brand had always protected to the mistaken ambition and narrow views of the Transvaal. Mr Fraser in vain tried to stem the tide of Krugerism within the Free State, but the extent to which it had travelled after Brand's death was evidenced by the election for President in February 1896, when Mr Steyn was elected against Mr Fraser by forty-one votes to nineteen. That this election should have taken place immediately after the Jameson Raid probably increased President Steyn's majority. At the same time the history of the state after Brand's death renders it probable that Mr Fraser's defeat was only a question of degree. Mr Fraser continued, down to the outbreak of the war of 1899, consistently to denounce the policy on which the Free State had embarked, warning his countrymen continually that this policy could have but one end—the loss of their independence. Underlying the state policy there was undoubtedly the belief, if not with President Steyn himself, at least with his followers, that the two Republics combined would be more than a match for the power of Great Britain should hostilities eventually occur.

In December 1897 the Free State revised its constitution in reference to the franchise law, and the process of naturalization was reduced from five to three years. The oath of allegiance to the state was alone required, and no renunciation of nationality was insisted upon. In 1898 the Free State also acquiesced in the fresh convention arranged with regard to the Customs Union between the Cape Colony, Basutoland, and the Bechuanaland Protectorate. These measures suggest that already a slight reaction against the extreme policy of President Kruger had set in. But events were moving rapidly in the Transvaal, and matters had proceeded too far for the

Free State to turn back. In 1899 President Steyn suggested the conference at Bloemfontein between President Kruger and Sir Alfred Milner, but this act, if it expressed at all a genuine desire for reconciliation, was too late. President Kruger had got the Free State ensnared in his meshes. The Free Staters were bound practically hand and foot, under the offensive and defensive alliance, in case hostilities arose with Great Britain, either to denounce the policy to which they had so unwisely been secretly party, or to throw in their lot with the Transvaal. War occurred, and they accepted the inevitable consequence. In September 1899 Sir Alfred Milner sent a despatch to President Steyn, informing him that the exigencies of the situation demanded that he should take some steps to protect his line of communications, and that he was stationing a force near the Orange Free State frontier. Sir Alfred Milner at the same time expressed the hope that the difference between the British Government and the Transvaal might still be adjusted, but if this hope were disappointed, he should look to the Free State to preserve strict neutrality, in which case the integrity of their territory would in all circumstances be respected. In similar circumstances Sir John Brand had remained neutral in 1881, but he was unfettered by any treaty with the Transvaal. For President Steyn and the Free State of 1899, in the light of the negotiations we have recorded, neutrality was impossible. Before war had actually broken out the Free State began to expel British subjects, and the very first act of war was committed by Free State Boers, who, on 11th October, seized a train upon the border belonging to Natal (see also STEYN and SOUTH AFRICA).

AUTHORITIES.—THEAL. *History of South Africa; South African History and Geography; The Story of the Nations—South Africa.*—HILLIER. *South African Studies.*—MACKENZIE. *South Africa: Losing it or Ruling it.*—MACKENZIE and STEAD. *South Africa: Its History, Heroes, and War.*—PRATT. *Leading Points in South African History.*—*The Times' History of the War.* (A. P. H.)

Orbetello, a town and bishop's see of the province of Grosseto, Tuscany, Italy, 24 miles south by east of Grosseto. It is situated on an artificial causeway, which connects the mainland with the peninsula of Monte Argentario. The town still has the bastions which the Spaniards built during the period (1557–1713) when they were masters of this corner of Italy, and possesses a cathedral and an Etruscan museum. There is a large convict prison, with which is connected another at Porto Ercole, on the east side of the peninsula. The mother-house of the Passionist order crowns an eminence of Monte Argentario. The salt-water lagoon (11 square miles in extent), in the middle of which the town stands, abounds in white fish, soles, and eels. Population (1881), 4449; (1899), about 3800.

Orchardson, William Quiller (1835–——), British painter, was born in Edinburgh, where his father was engaged in business, in 1835. "Orchardson" is a variation of "Urquhartson," the name of a Highland sept settled on Loch Ness, from which the painter is descended. At the age of fifteen he was sent to the Trustees' Academy, then under the mastership of Robert Scott Lauder, where he had as fellow-students most of those who afterwards shed lustre on the Scottish school of the second half of the 19th century. As a student he was not especially precocious or industrious, but his work was distinguished by a peculiar reserve, by an unusual determination that his hand should be subdued to his eye, with the result that his early things reach their own ideal as surely as those of his maturity. By the time he was twenty, Orchardson had mastered the essentials of his art, and had produced at least one picture which might be accepted as representative, a portrait of Mr John Hutchison, the sculptor. For seven years after this he worked in Edinburgh, some of his attention being given to "black and white," his practice in which had been partly acquired at a sketch club which included among its members Mr Hugh Cameron, Mr Peter Graham, Mr George Hay, Mr M'Taggart, Mr John Hutchison, and others. In 1862 he came to London, and established himself in 37 Fitzroy Square, where he was joined twelve months later by his friend John Pettie. The same house was afterwards inhabited by Ford Madox Brown.

The English public was not immediately attracted by Orchardson's work. It was too quiet to compel attention at the Royal Academy, and Pettie, Orchardson's junior by four years, stepped before him for a time, and became the most readily accepted member of the school. Orchardson confined himself to the simplest themes and designs, to the most reticent schemes of colour. Among his best pictures during the first eighteen years after his migration to London were "The Challenge," "Christopher Sly," "Queen of the Swords," "Conditional Neutrality," "Hard Hit"—perhaps the best of all—and portraits of Mr Charles Moxon, his father-in-law, and of his own wife. In all these good judgment and a refined imagination were united to a restrained but consummate technical dexterity. During these same years he made a few drawings on wood, turning to account his early facility in this mode. The period between 1862 and 1880 was one of quiet ambitions, of a characteristic *insouciance*, of life accepted as a thing of many-balanced interests rather than as a matter of *sturm und drang*. In 1865 Pettie married, and the Fitzroy Square *ménage* was broken up. In 1868 Orchardson was elected A.R.A. In 1870 he spent the summer in Venice, travelling home in the early autumn through a France over-run by the German armies. In 1873 he married Miss Helen Moxon, and in 1877 he was elected to the full membership of the Royal Academy. In this same year he finished building a house at Westgate-on-Sea, with an open tennis-court and a studio in the garden.

Orchardson's wider popularity dates from 1881. To that year's Academy he sent the large "On Board the *Bellerophon*," which now hangs in the Tate Gallery. Its success with the public was great and instantaneous, and for ten or twelve years Orchardson's work was more eagerly looked for at the Academy than that of any one else. He followed up the "Bellerophon" with the still finer "Voltaire" (see PLATE) now in the Kunsthalle at Hamburg. Technically, the "Voltaire" is, perhaps, his high-water mark. Fine both in design and colour, it is carried out with a supple dexterity of hand which has scarcely been equalled in the British school since the death of Gainsborough. The subject is not entirely happy, for it does not explain itself, but requires a previous knowledge on the part of the spectator of how Voltaire was beaten by the servants of the Chevalier de Rohan-Cabot, and how the duc de Sully failed to avenge his guest. The painter was attracted by the opportunity it gave for effective opposition of character, line, colour, and movement. The "Voltaire" was at the Academy of 1883; it was followed, in 1884, by the "Mariage de Convenance," perhaps the most popular of all Orchardson's pictures; in 1885, by "The Salon of Madame Récamier"; in 1886, by "After," the sequel to the "Mariage de Convenance," and "A Tender Chord," one of his most exquisite productions; in 1887, by "The First Cloud"; in 1888, by "Her Mother's Voice"; and in 1889, by "The Young Duke," a canvas on which he returned to much the same pictorial scheme as that of the "Voltaire." Subsequently he exhibited a series of pictures in which fine pictorial use was made of the furniture and costumes of the early years of the 19th century, the subjects, as a

"VOLTAIRE." By W. Q. ORCHARDSON, R.A.

(From a Photograph by the Photographic Union, Munich.)

rule, being only just enough to suggest a title: "An Enigma," "A Social Eddy," "Reflections," "If music be the food of love, play on!" "Music, when sweet voices die, vibrates on the memory," "Her First Dance,"—in these opportunities are made to introduce old harpsichords, spinets, early pianofortes, Empire chairs, sofas, and tables, Aubusson carpets, long-waisted gowns, delicate in material and primitive in ornament. Between such things and Orchardson's methods as a painter the sympathy is close, so that the best among them, "A Tender Chord," for instance, or "Music, when sweet voices die," have a rare distinction.

As a portrait-painter Orchardson must be placed in the first class. His portraits are not numerous, but among them are a few which rise to the highest level reached by modern art. "Master Baby," a picture, connecting subject-painting with portraiture, is a masterpiece of design, colour, and broad execution. "Mrs Joseph," "Mrs Ralli," "Sir Andrew Walker, Bart.," "Charles Moxon, Esq.," "Mrs Orchardson," "Conditional Neutrality" (a portrait of Mr Orchardson's eldest son as a boy of six), "Lord Rookwood," "The Provost of Aberdeen," and, above all, "Sir Walter Gilbey, Bart.," would all deserve a place in any list of the best portraits of the 19th century. In this branch of art the "Sir Walter Gilbey" may fairly be called the painter's masterpiece, although the sumptuous full-length of the Scottish Provost, in his robes, runs it closely. The scheme of colour is reticent; had the picture been exhibited after 1900 the colour would have been called khaki; the design is simple, uniting nature to art with a rare felicity; and the likeness has been found satisfactory by the sitter's friends. The most important commission ever received by Mr Orchardson as a portrait-painter was that for a group of Queen Victoria, with her son (afterwards King Edward VII.), grandson, and great-grandson, to be painted on one canvas for the Royal Agricultural Society. The painter hit upon a happy notion for the bringing of the four figures together, and as time goes on and the picture slowly turns into history, its merit is likely to be better appreciated.

Orchardson's method is that of one who works under a creative, decorative, and subjective impulse, rather than under one derived from a wish to observe and record. His affiliation is with Watteau and Gainsborough, rather than with those who would base all pictorial art on a keen eye for actuality and "value." Among French painters his pictures have excited particular admiration.

Orchha, or URCHHA (also called TEHRI), a native state of Central India, in the Bundelkhand Agency. Area, about 2000 square miles; population (1881), 311,515; (1891), 333,020, showing an increase of 7 per cent. Estimated gross revenue, Rs.9,00,000; no tribute. The town of Orchha, the former capital, is on the river Betwa, not far from Jhansi. It contains an imposing fort, with a palace. The town of Tehri, where the chief now resides, is about 40 miles south of Orchha. Population (1881), 18,344; (1891), 17,610. It contains the fort of Tikamgarh, by which name the town is sometimes called.

Orders of Knighthood.—The article KNIGHTHOOD in the ninth edition of this work, in the course of a general historical sketch of the origin and institution of orders of chivalry, describes in some detail the leading British, and refers incidentally to certain of the more illustrious foreign, orders.

When orders ceased to be fraternities, and became more and more marks of favour and a means of recognizing meritorious services to the Crown and country, the term "orders" became loosely applied to the insignia and decorations themselves. Thus "orders," irrespective of the title or other specific designation they confer, fall in Great Britain generally into three main categories, according as the recipients are made "Knights Grand Cross" (having for their outward adornment a cross or star and ribbon, worn over the shoulder), "Knights Commanders" (with a star or other badge, but with the ribbon worn round the neck), and "Companions" (who have a badge only, but no star). In some orders the classes are more numerous, as in the Royal Victorian, for instance (*vide infra*), which has 5, numerous foreign orders a like number, some 6, while the Chinese "Dragon" boasts no less than 11 degrees.

Orders may, again, be grouped according as they are (1) PRIME ORDERS OF CHRISTENDOM, conferred upon an exclusive class only. Here belong, *inter alia*, the well-known orders of the *Garter* (England), *Golden Fleece* (Austria and Spain), *Annunciata* (Italy), *Black Eagle* (Prussia), *St Andrew* (Russia), *Elephant* (Denmark), and *Seraphin* (Sweden). Of these the first three only, which are usually held to rank *inter se* in the order given, are historically identified with chivalry. (2) FAMILY ORDERS, bestowed upon members of the royal or princely class, or upon humbler individuals according to classes, in respect of "personal" services rendered to the family. To this category belong such orders as the Royal Victorian and the Hohenzollern (Prussia). (3) ORDERS OF MERIT, whether military, civil, or joint orders. Such have, as a rule, at least three, oftener five, classes, and here belong such as the *Order of the Bath* (England), *Red Eagle* (Prussia), *Legion of Honour* (France). There are also certain orders, such as the recently-instituted *Order of Merit* (England), and the *Pour le mérite* (Prussia), which have but one class, all members being on an equality of rank within the order.

Of the seven British orders of knighthood which existed in 1883, three—the Garter, the Thistle, and the St Patrick—still remain within their former limits, while the Bath, the St Michael and St George, the Star of India, and the Indian Empire have been all exceeded, and the last named enlarged.

Until recently Great Britain had, practically, but one order for the recognition of civil merit in the home country, that of the *Bath*—the *Garter*, *Thistle*, and *St Patrick* being confined to nobles, the *St Michael and St George* generally to colonial dignitaries and officials, the *Star of India* and the *Indian Empire* to princes and officials connected with that country. The closing years of the reign of Queen Victoria and the first two of the reign of King Edward VII. saw the institution of several British orders, the leading characteristic of which may be said to consist in a tendency to recognize merit without conferring knighthood; that is, that while the designation in the form of letters to be appended to the name of the recipient denotes membership of the order, the style or appellation of knight is absent.

The Most Eminent Order of the Indian Empire, which from its institution down to 1887 consisted of one class only—Companions—was, however, on the occasion of the Queen's Jubilee enlarged by the addition of the two higher classes of knights, viz., *Knights Grand Commanders* (G.C.I.E.) and *Knights Commanders* (K.C.I.E.), yet these two classes are less regarded as orders of merit than as conferring a certain social precedence.

The *Royal Victorian Order* was instituted by Queen Victoria on the 25th April 1896, and conferred for personal services rendered to her late Majesty and her successors on the throne. It consists of a sovereign, chancellor, secretary, and five classes — knights grand commanders (G.C.V.O.), knights commanders (K.C.V.O.), commanders (C.V.O.), and members of the fourth and fifth classes (M.V.O.), the distinction between these last divisions lying in the badge and in the precedence enjoyed by the members. The knights of this order rank in their respective classes immediately after those of the *Indian Empire*, and its numbers are unlimited. The precedence enjoyed by its commanders tends to support the view above expressed that membership of an order shall, as denoting inclusion in a select brotherhood or fraternity, be held more in honour than heretofore, and knighthood regarded more as an incident than an essential.

To the class of orders without the titular appellation "knight" belong (1) the newly-created *Order of Merit*, founded by King Edward VII. on the occasion of his coronation, fixed for 26th June 1902, but, owing to the King's serious illness, postponed to 9th August. The order is founded on the lines of the Prussian *Ordre pour le mérite* (*q.v. infra*), yet more comprehensive, including those who have gained distinction in the military and naval services of the Empire, and such as have made themselves a great name in the fields of science, art, and literature. The number of British members has been fixed at twenty-four, with the addition of such foreign persons as the Sovereign shall appoint. The nature of the order may be seen from the names of the recipients:—Earl Roberts, Viscount Wolseley, Viscount Kitchener, Sir Henry Keppel, Sir Edward Seymour, Lord Lister, Lord Rayleigh, Lord Kelvin, Mr John Morley, Mr Lecky, Mr G. F. Watts, and Sir William Huggins. (2) The *Imperial Service Order* was likewise instituted on 26th June 1902, to commemorate King Edward's coronation, and is specially designed as a recognition of faithful and meritorious services rendered to the British Crown by members of the Civil Service in various parts of the Empire, and is to consist of companions only. The numbers are limited to 425, of whom 250 belong to the home and 175 to the civil services of the colonies and protectorates. The members of the order have the distinction of adding the letters I.S.O. after their names. (3) The *Distinguished Service Order*, an order of military merit, was founded on the 6th of September 1886 by Queen Victoria, its objects being to recognize the special services of officers in the army and navy. Its numbers are unlimited, and its designation the letters D.S.O. It consists of one class only, who take precedence immediately after the 4th class of the Royal Victorian Order.

In addition to the above, there are two British orders confined to ladies. The *Royal Order of Victoria and Albert*, which was instituted in 1862, is a purely court distinction. It consists of four classes, and it has as designation the letters V.A. The *Imperial Order of the Crown of India* is conferred for like purposes as the order of the Indian Empire. Its primary object is to recognize the services of ladies connected with the Court of India. The letters C.I. are its designation.

Among decorations which are constantly seen, and are not "orders," may be mentioned the *Victoria Cross* for conspicuous bravery in battle, having as its designation the letters V.C.; the *Royal Red Cross*, instituted in 1883 for the purpose of rewarding services rendered in nursing the sick and wounded of the army and navy. It is confined to ladies, whether subjects or foreigners. The *Volunteer Officers' Decoration*, in recognition of twenty years' service as officers of the volunteer force; the *Kaisar i Hind Medal* for public services in India, consisting of two classes; the naval *Conspicuous Service Cross*, established 15th June 1901; and the *Albert Medal* for saving life, consisting of two classes.

The order of *St John of Jerusalem* (or *Knights of Malta*), closely allied to, if not actually identical with, the Teutonic orders of Austria, the Netherlands, and Prussia (*vide infra*), was instituted in 1048 as an order of knighthood in the Hospital of St John at Jerusalem. The fraternity emigrating in 1309 to Rhodes became known as that of the "Knights of Rhodes," and was in 1330 divided into eight languages, England taking sixth place. In 1530 it established itself at Malta, whence the name "Knights of Malta" (a Maltese cross being still the badge). During the ensuing centuries it decayed in importance, and, on the death of the Grand Master Fra Thomasi de Cortone in 1805, virtually ceased to exist. It was, however, revived in 1879, and the parent stem now flourishes in Malta. A branch became established in England at the Priory of St John, Clerkenwell, its present habitation, about the year 1100, as a charitable brotherhood for the relief of necessitous pilgrims to the Holy Land; and the main object of its institution was pursued under various forms until 1830, when it was revised for the purpose of performing charitable and ambulance work. Originally a Catholic order, in 1888 a royal charter of incorporation was granted, and it now, although not conferring any style like a rank or distinction, exists as a properly-constituted order. The sovereign head and patron of this order is the King; the present Grand Prior is the prince of Wales; Bailiff of Egle, duke of Connaught. It has executive officers, knights of justice (and honorary), ladies of justice (and honorary), chaplain, knights of grace, ladies of grace, and equerries. Its badges—a Maltese cross and medal (according to the classes)—may be worn in England.

The following is a list of the better-known foreign orders:—

Austria-Hungary.—(1) The order of the *Golden Fleece*, above referred to, consists of 1 class only, and was instituted in 1429 by Philip the Good, duke of Burgundy, its statutes dating from the following year. It is common to Austria and Spain, and is conferred only upon members of sovereign houses and the highest nobles in the two countries. (2) The royal Hungarian order of *St Stephen*, instituted in 1764 by the Empress Maria Theresa, consists of the Grand Master (the sovereign), twenty knights grand cross, thirty knights commanders, and fifty knights. The ribbon is crimson with two green stripes. (3) The Austrian *Iron Cross*, founded by Napoleon I. as king of Italy in 1805, consisting of 3 classes, and conferred for personal merit. (4) The *Teutonic Order of Chivalry*, founded, it is said, in 1190 by Duke Frederick de Souabe, abolished by Napoleon in 1809, was revived in 1834. It is akin to the British order of St John of Jerusalem, and is conferred upon Roman Catholics (gentlemen and ladies) who devote themselves to the interests of the ambulance service. (5) The order of the *Starry Cross*, limited to high-born ladies, was instituted in 1668 by Eleanor, widow of the Emperor Ferdinand III., in perpetual commemoration of the discovery of a piece of the true cross.

Besides those enumerated, there are several orders given for personal merit, such as the military orders of *Maria Theresa*, *Elizabeth Theresa*, and the *Leopold*.

Belgium.—*Order of Leopold*, of 5 classes, instituted by King Leopold I. in 1832 for civil and military merit. The civil *Iron Cross*, instituted in 1867, and the military cross (2 classes) dating from 1885. There are also 4 orders connected with the Congo State, instituted by Leopold II., viz., the *African Star* (6 classes), the *Royal Lion* (6 classes), the *Congo Star*, and the *Order of the Crown.*

Bulgaria.—The principal order is that of *St Alexander*, instituted in 1881, of 6 classes.

China.—The order of the *Double Dragon*, originally founded in 1862 as that of the *Imperial Dragon*, to reward the services of foreigners in Chinese service, was reorganized in 1882 and has 5 classes, the first 3 being each again subdivided into 3 grades.

Denmark.—(1) The *Order of the Elephant*, said to have been instituted in 1464 by King Christian I., and remodelled in 1693 by Christian V., has only 1 class of about 30 knights, in addition to princes of royal descent. Its distinguishing ribbon is watered light blue. (2) The *Dannebrog*, an order of merit in 5 classes, said to have been founded in 1219 by Waldemar II., was remodelled in 1693, and again in 1808. Its distinguishing ribbon is white with red edging.

France.—The *Legion of Honour*, instituted in 1802 by Bonaparte, first consul, was enlarged and its statutes modified in 1816 and 1852, and is, apart from some military decorations and a few colonial orders belonging to vassal states, such as Annam, Cambodge, Porto-Novo, &c., the only order now conferred in France. There are 5 classes, and the ribbon is crimson.

Germany.—All German sovereign states have orders in the sense of decorations or badges bestowed for civil or military merit, but certain of the principal countries possess orders which are held in great esteem, viz. :—

1. *Anhalt.*—The order of *Albert the Bear*, instituted in 1836, but possibly, as is claimed for it, dating back to the Crusades, and lately revised, has 5 classes.

2. *Baden* has 3 illustrious orders : *Order of Fidelity*, instituted 1715 by the Margrave Charles William ; the military order of Charles Frederick (3 classes), founded in 1807 ; and that of the *Zähringen Lion* (5 classes), founded in 1812, of which, however, the original first class has since 1877 been instituted as a special order of 4 classes under the name of Berthold I.

3. *Bavaria* has the high order of *St Hubert* (founded in 1444 by Gerhard V.), limited to members of the Royal House of Bavaria and to foreign sovereigns and to nobles ; ribbon red, watered, with green edging. The *St George*, instituted during the Crusades in the Holy Land, later revised by Maximilian I. at the end of the 15th century, but revised by the Elector Charles Albert in 1729, is confined to Roman Catholics and to such as have no other order. In addition to the military *Order of Maximilian Joseph* (3 classes), and the 4 illustrious ladies' orders of *Theresa* (1827), *St Elizabeth* (1766), *St Anne of Munich* (1784), and *St Anne of Würzburg* (1803), Bavaria possesses several minor orders and decorations for military and civil merit.

4. *Brunswick.*—*Henry the Lion* (founded in 1834 by the Duke William) has 5 classes, in addition to a cross of merit of 2 grades.

5. *Hanover.*—The *Order of St George* (1 class only) was instituted in 1839 by King Ernest August I., as the family order of the House of Hanover ; the *Royal Guelphic Order* (3 classes) was founded in 1815 by George, Prince Regent, and afterwards King George IV. of Great Britain ; the order of *Ernest Augustus*, instituted by King George V., 1865. These orders have not been conferred since 1866, when Hanover ceased to be a kingdom, and the *Royal Guelphic Order*, which from its institution is more English than Hanoverian, not since the death of King William IV. in 1837. The sole surviving British Knight Grand Cross (G.C.H.) is his Royal Highness Field-Marshal the duke of Cambridge.

6. *Hesse-Darmstadt*, grand-duchy, has 2 grand orders, the *Golden Lion* (instituted 1790), consisting of 1 class only, and the *Order of Louis* (1807), of 5 classes. The first named is, with few exceptions, conferred only upon such as are members of the grand-ducal house of Hesse-Darmstadt and the electoral house of Hesse-Cassel, which ceased to be a reigning house in 1866.

7. *Mecklenburg* (Schwerin and Strelitz).—These grand-duchies jointly possess 1 order, that of the *Wendish Crown*, founded in 1864 by the Grand Dukes Frederick Francis and Frederick William. It consists of 3 classes, a cross of merit, and a grand cross of the first class for ladies of Schwerin.

8. *Oldenburg.*—*Order of Merit*, of two divisions, each of which has 5 classes, conferred for distinction in art and science.

9. *Prussia* has 5 principal orders—the *Black Eagle*, founded in 1701 by the Elector Frederick I. to commemorate his connexion as king of Prussia ; it is bestowed only upon such as are of royal lineage and upon high officers of state. It is limited to knights, exclusive of princes, and confers the title "von" of hereditary nobility ; the ribbon is orange. *Order of the Red Eagle*, instituted in 1705 by George William, hereditary prince of Brandenburg-Bayreuth, was reorganized in 1712, 1810, and lastly in 1861, and, consisting of 5 classes, is given for civil and military merit. *Order of the Crown* (4 classes), founded in 1861 by King William I., is conferred for merit on the field of battle. *Order of Merit*, military and civil, originally founded by the Elector Frederick in 1667, was remodelled in 1740 by Frederick II., under the title of *Ordre pour le mérite*, and in 1842 Frederick William IV. added a special civil class for merit in arts and sciences. This order has always been highly prized, and it is worthy of note that it is the only distinction which Thomas Carlyle would accept. The family *Order of the House of Hohenzollern* (instituted 1851) ; the *Johanniter Order* or *Order of St John of Jerusalem* (*vide supra*), instituted in 1812, a revival of the old order of the Hospitallers. Of ladies' orders Prussia has that of *Louise* (instituted 1814), of 2 classes.

10. *Saxony, Kingdom of.*—The *Order of the Crown of Rue* (*Rauten-Krone*), founded in 1807 by King Frederick Augustus. It has but one class ; ribbon watered green. The military *Order of St Henry*, for valour on the field, founded 1736, has 4 classes. The *Albert Order* (*Albrecht Orden*), founded 1850, originally instituted as a distinction for merit in arts and sciences, has been enlarged by the addition of a military class. The *Order of Sidonia* (instituted 1870 for services during the war) is conferred on ladies.

11. *Saxon Duchies*, including Saxe-Altenburg, Saxe-Coburg-Gotha, and Saxe-Meiningen, have in common a general order of merit in 4 classes : that of *Ernest*, founded 1690 by Duke Frederick I.

12. *Saxe-Weimar* has as its principal order that of the *White Falcon* (founded 1732), which is by its statutes confined to twenty-four illustrious personages in the civil and military service.

13. *Würtemberg.*—The *Order of the Crown of Würtemberg*, instituted in 1818 by King William I., has been frequently remodelled, and now consists of 5 classes.

Greece.—The *Order of the Redeemer*, founded in 1829 by the fourth General Assembly of the Greeks at Argos, and modified and enlarged by King Otho in 1833, consists of 5 classes, and is a general order of merit.

Holland.—The *Order of the Netherlands Lion* (instituted 1815), to reward civil merit, consists of 3 classes ; the *Order of William* (instituted 1815) for military merit ; and the family order of the House of Nassau, the *Golden Lion* (instituted 1858). The *Teutonic Order* (*Ballei Utrecht* ; see also under Austria) was established in the Netherlands by the States-General in 1580 ; abolished by Napoleon I. in 1809, it was revived by King William I. after Waterloo. It has 3 classes.

Italy.—The *Order of the Annunciata*, said to have been founded in 1355 by Amadeus VI. of Savoy, frequently modified, last in 1809, when the number of knights, exclusive of foreign recipients, was limited to twenty, consists of 1 class only. *St Maurice and Lazarus*, instituted in 1434, when the "Lazarus," supposed to have been founded in the Holy Land in 1000, was merged into the later creation, consists of 5 classes, and is bestowed for meritorious services in all capacities rendered to the state. The numbers are unlimited. The *Military and Civil Orders of Savoy*, the former of 4 classes, instituted in 1815, and the latter instituted in 1831, of 1 class only, and limited to sixty knights "who have deserved well of their sovereign and their country." The *Crown of Italy*, founded in 1831 to commemorate the incorporation of Venetia, has 5 classes, and its numbers are practically unlimited.

Japan.—The *Sublime Order of the Chrysanthemum*, of 1 class only, and practically limited to sovereigns and members of reigning houses, was founded in 1876 by the Emperor Mutsu-Hito. The *Eastern Sun* (instituted in 1875), for civil and military merit, has 8 classes ; the *Order of the Crown* (instituted 1888), 5 classes for ladies.

Luxemburg.—The *Golden Lion* (see Holland), the civil and military order of Adolphus of Nassau (instituted 1858), has 4 classes ; to it is attached a special cross of merit for arts and sciences, of 2 classes ; the *Oaken Crown* (instituted in 1841), remodelled in 1858, and consisting of 5 classes ; it is conferred as a general order of merit.

Monaco.—The *Order of St Charles*, of 6 classes, founded by Prince Charles III. in 1863.

Montenegro.—*St Peter* (instituted 1852), 1 class only, for members of the princely family ; *Danilo* (1855), for merit, of 5 classes.

Papal.—Of the seven orders bestowed by the Pope, two stand out pre-eminent in respect of antiquity of foundation and general estimation : that of the *Holy Sepulchre* ranks with that of *St John of Jerusalem* (*q.v.*), being instituted almost simultaneously with that order and for like objects. It derives its name from the fact that investitures took place in the Holy Land. Supposed to date from 1099, it was revived by Benedict XIV. in 1746, and remodelled by Pius IX. in 1868. It has 3 classes. *Order of Christ*, instituted in 1318 by St Denis to replace on its abolition the order of Knights Templars. It has 1 class, and is conferred also by Portugal, the limitation there being to such only as are of noble lineage. The Holy See also has the orders of *Pius IX.* (instituted 1847), of 2 classes ; *St Gregory the Great* (instituted 1831), 4 classes ; and *St Sylvester*, of 2 classes (instituted 1559), conferred for services to the Roman Catholic Church.

Persia.—Order of the *Sun and the Lion*, instituted in 1808 by the Shah Fatu Ali for merit, has 5 classes. Order of the *Nichane-Aftab* for ladies, instituted in 1873 by Nassir-ed-Din. There is also a medal (in 4 classes) for science and art.

Portugal.—*Order of Christ* (see preceding notice under *Papal*) ; the military order of *St Benedict of Aviz*, founded in 1158 under the designation of the *Order of Calatrava*, was transferred to Aviz in 1187, and changed in 1789 into an order of military and civil merit, with 3 classes ; *St James of the Sword*, jointly with Spain, where it was founded in 1175, since 1862 has 5 classes, and is conferred for science, literature, and art ; *Tower and the Sword*, for merit, with 5 classes (since being remodelled in 1832), was instituted by Alphonso V. in 1450 ; *St Isabella*, a ladies' order, was founded in 1801.

Rumania.—The orders in this country are of recent foundation, and are two in number : *Order of the Star* (instituted 1877), for civil and military merit, has 5 classes ; *Order of the Crown of Rumania*, founded in 1881, also of 5 classes.

Russia.—The *St Andrew*, founded in 1698, by the Tsar Peter I., is the highest order, and admission to it confers also membership of the orders of *St Anne*, *Alexander Newsky*, and the (whilom) order of *St Stanislas of Poland*. These Russian orders likewise bestow a patent of hereditary nobility. The order of *St Andrew* is of 1 class only, the ribbon sky blue, watered ; *St Anne*, founded in 1735 by Charles Frederick, duke of Schleswig-Holstein Gottorp, was in 1797 made a Russian order by the Emperor Paul, and has 3 classes; *Alexander Newsky* is of 1 class only, and was founded by the Empress Catharine in 1725; the order of *St Stanislas* (of Poland), instituted in 1765 by King Stanislas II., revived by the Emperor Alexander in 1815 as a Russian order, has 4 classes. The *White Eagle*, also originally of Poland, where it is supposed to have been founded in 1325, was in 1831 revived as a Russian order. It has 1 class only. There are also the orders of *St Catharine* (instituted 1714) for ladies, and the *St Vladimir* for bravery, in addition to minor orders, medals, &c.

Servia.—Orders of *St Lazarus*, worn only by the king; *White Eagle* (5 classes), founded in 1883 by King Milan I.; *Takovo*, for distinguished services in the cause of Servian independence, founded 1865 by Prince Michel Obrenovitch IV. (5 classes); *St Sava*, bestowed for literature, art, and science, instituted 1883, has 5 classes; *Miloch the Great*, instituted by King Alexander I. for distinguished services.

Siam.—The *Star of the Nine Precious Stones*, exclusively conferred upon Buddhists, founded in 1869; the *White Elephant*, instituted in 1861, consists of 5 classes. In addition to these two chief orders there are the *Maha Chakri*, of 2 classes, instituted 1884, and conferred only on personages of princely rank; the *Mongut-Siam*, of 5 classes, instituted 1869; the order of *Chulachonclao*, of 3 classes, conferred only on natives, and a medal, 2 classes, founded 1887, for art and science.

Spain.—The *Golden Fleece* (*vide* Austria-Hungary, *supra*); the *Order of Calatrava*, founded in 1158 by King Sancho III. to commemorate the recovery of that town from the Moors, and confirmed in 1164 by Pope Alexander III., is an essentially military order; that of *Alcantara*, founded in 1156 by the brothers Don Suero and Gomez Fernando Barricutes under the name of order of *St Julian*, was confirmed in 1177 by Pope Alexander, and on the capture of the town of that name in 1213 became known as that of Alcantara. *St James of the Sword*, or *Compostella*, was instituted in 1175 to commemorate the finding at Compostella of the bones of the patron saint of Spain. It is purely military. The grandmastership of these last three orders was vested in the Crown of Spain by Charles V. in 1523. In addition to the above and the military order of *Malta*, or *John the Baptist* (*vide supra*, order of St John of Jerusalem), Spain has the orders of *St Ferdinand* (instituted 1811 by the Cortes); *Notre Dame de Montesa* (instituted 1319 by James II., king of Aragon), purely military; *St Herménégilde* (instituted 1814), military; the royal order of *Isabella the Catholic*, 3 classes (instituted 1815 by King Ferdinand VII.); *Isabella II.* (instituted 1833); the *Illustrious Order of Charles III.*, 4 classes (instituted 1771); three naval and military orders of merit; the ladies' order, *Maria-Louise* (instituted 1792), for noble ladies; and the order of *Bienfaisance*, for distinguished and humane services, in 3 classes.

Sweden.—*Order of the Seraphim* (blue ribbon), said to have been founded in 1285, and reinstituted in 1748, consists of 1 class, and is limited to twenty-four Swedish and eight foreign members. *Order of the Sword* (yellow ribbon), instituted in 1522 by Gustavus Wasa, and remodelled, the last time in 1814, has 6 classes; order of the *Pole Star* (black ribbon), has now 4 classes, and was founded in 1748 and remodelled in 1844; the *Order of Wasa* (green ribbon), instituted in 1772, has 6 classes; *Charles XIII.*, for Freemasons of the higher ranks, has a red ribbon.

Norway.—Order of *St Olaf*, founded in 1847, has 5 classes, and is a general order of merit.

Turkey.—*Nichan-i-Iontiaz*, an order of merit, of 1 class only, instituted in 1879 by Abdul Hamid II.; *Nichan-i-Iftikhar*, or *Order of Glory*, instituted in 1831 by the Sultan Mahmoud II.; the Imperial Order of the *Osmanie*, instituted in 1862 by Sultan Abdul Aziz, has (since 1867) 4 classes; the *Medjidie*, founded in 1851, has 5 classes, and is largely bestowed, the lowest class consisting of more than 6000 members, irrespective of foreigners; order of *Hanédani-al-Osman*, of 1 class only, instituted in 1895, and conferred solely on Turkish princes; the ladies' order of *Nichan-i-Chéfakat* (instituted in 1878) has 3 classes.

The writer is much indebted to Sir Albert W. Woods, K.C.B., Garter King of Arms, for kind assistance in the portion of the article affecting the British Empire. In compiling the list of foreign orders the *Almanach de Gotha* has been largely utilized.

(P. A. A.)

ORDNANCE.

I. Naval Gunnery (British).

The ordnance carried in recent British warships ranges from the 12-inch 46-ton gun forming the armament of the turrets of the *Majestic* class of battleship to the rifle-calibre Maxims carried by all ships for the armament of their boats and as field guns. The heaviest gun actually afloat in the British navy is the 16·25-inch B.L. gun of 111 tons, two of which are mounted in the *Benbow* and two in the *Sanspareil.* Though in themselves efficient weapons, the great weight of these guns limited the number carried in any ship to two, and owing to the undesirability of risking so large a proportion of the armament if an accident occurred to one of these guns, the type has not been, and is not likely to be, repeated. The next gun in point of weight is the 16-inch M.L. 80-ton gun, of which four are mounted in the *Inflexible;* this gun was the last development of the obsolete muzzle-loading principle. The 13·5-inch B.L. 67-ton gun forms the turret or barbette armament of many of the battleships which, if not quite in the first rank in view of the very rapid development of battleship construction in recent years, are at any rate worthy of a place in the line of battle in the most powerful squadron afloat. These guns form the barbette armament of the six battleships of the *Royal Sovereign* class, and are mounted in the turrets of the *Hood*, *Nile*, and *Trafalgar.* In the *Majestic* class and subsequent classes of battleships the 12-inch 46-ton gun has been substituted for the 13·5-inch gun.

As compared with the 13·5-inch gun, the 12-inch offers the following advantages:—

1. *Reduced Weight.*—This must always be a most important consideration governing the choice of guns for the sea service. Not only is the weight of the gun itself a matter of importance, but a lighter gun will admit of lighter loading appliances and mounting; a smaller area of armour will be required for its protection, and its ammunition will be lighter. The saving of weight in the armament can then be devoted to improved armour protection, increased supply of ammunition, or to increased strength of hull or weight of propelling machinery.

2. *Improved Facility of Working.*—It is obviously an advantage that as much as possible of the working of the gun should be performed by manual labour, provided that the rapidity of fire is not diminished, and that those operations for the performance of which hydraulic or other power is employed should be capable of being performed, in the event of the failure of such power, by manual labour. In practice the breech of the 12-inch gun is always opened and closed by hand, while every other operation in loading and firing the gun can be similarly performed in case of breakdown of the hydraulic arrangements. In the case of the 13·5-inch guns, though the operations of opening and closing the breech and of loading can be performed by hand, the means of doing so are exceedingly inconvenient and involve considerable reduction in the rate of fire, while for the other operations of elevating the gun, running it in and out, and training the turret, the gun is entirely dependent on hydraulic power. In the British navy hydraulic power is universally used for the manipulation of the heaviest guns, though in several foreign navies electricity is preferred. The chief advantages of hydraulic power are noiselessness, and facility in locating the cause of a failure.

3. *Increased Rapidity of Fire.*—Improvements in the form of mounting, the reduced weight of the projectile, and the substitution of a cordite charge for the heavier powder charge, have diminished the time required to load and fire a round from 2 min. 30 secs. to about 1 minute.

4. *Improved Ballistics.*—The advance in the sciences of gun construction and of explosives has enabled the ballistic power to be so increased that the penetrative power of the 12-inch gun is slightly greater than that of the 13·5-inch, in spite of the reduction in the weight of the projectile.

5. The possibility of *loading* the guns *in any position* of the turret. To load the 13·5-inch guns it was necessary to train the turret (or barbette) to a fixed position, in which the hydraulic rammers, which were entirely outside the turret, could ram the projectile and charge into the gun. The arrangements for this "fixed loading position" are found in the earlier ships of the *Majestic* class, but are accompanied by arrangements for loading

the guns in any position of the turret by means of hydraulic rammers. In addition to the gain in rapidity of loading, the guns can be kept continually pointed in the direction of the enemy, and will thus expose the smallest possible target to his fire. Fig. 1, which has been kindly supplied by Sir W. G. Armstrong, Whitworth and Co., shows a 12-inch gun with its mounting and loading arrangements as fitted in the *Canopus* class of battleships.

Authorities differ as to whether the armoured structure shown in Fig. 1 is more properly designated a "turret" or a "barbette." A turret is essentially a circular armoured structure which protects the breech portion of the guns and revolves with them, and in which elliptical ports are cut, through which the guns pass; while the armour of a barbette is fixed, the whole of the gun when in its firing position being above it and unprotected, the barbette armour protecting the loading and other machinery only. The turret system involved a much greater weight of armour and, as this weight could not be carried high up in the ship, a less height of the guns above the water-line, and consequently increased difficulty in fighting them in a heavy sea. It was considered that these disadvantages were too great a price to pay

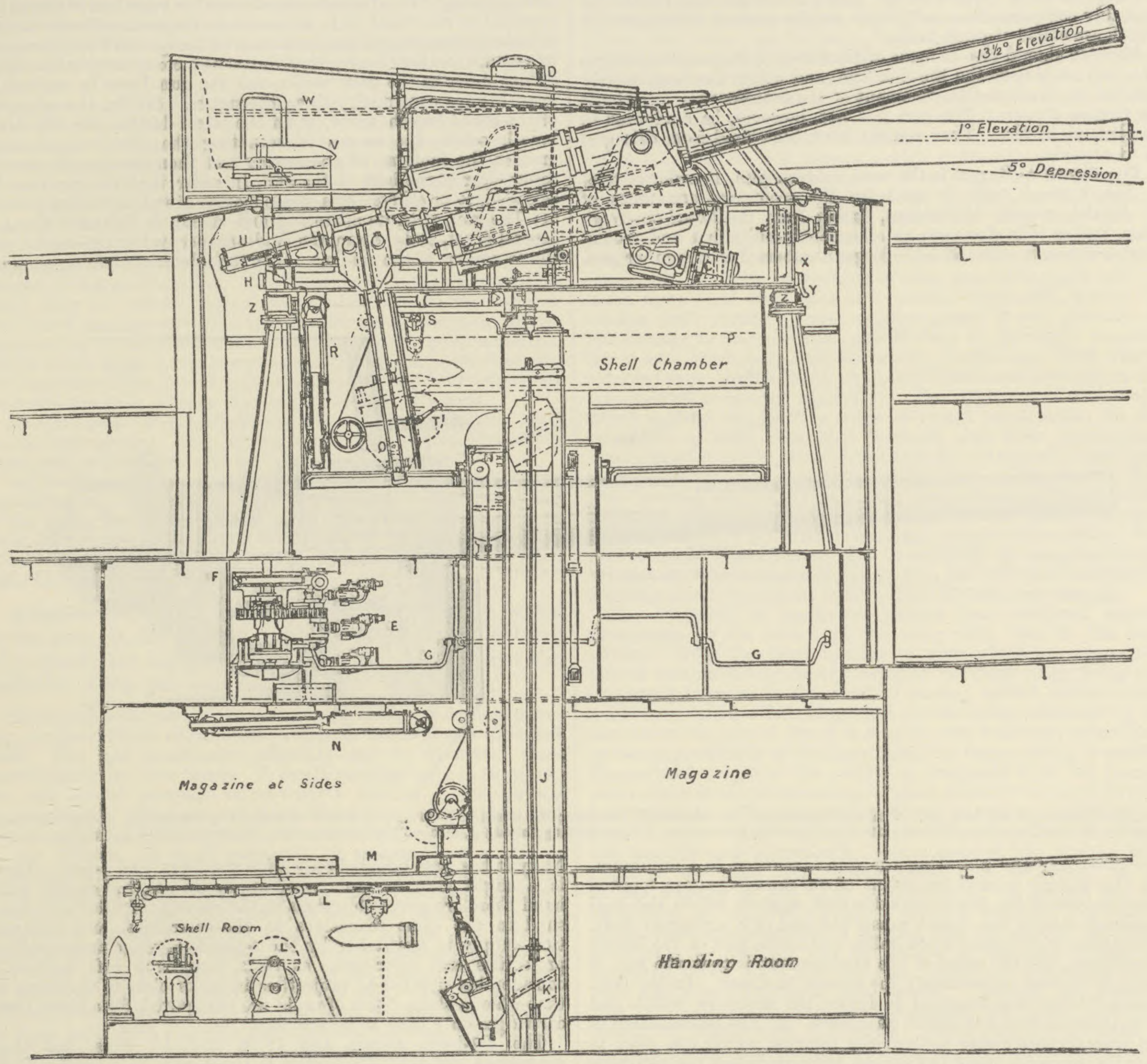


FIG. 1.—Diagram of a 12-inch Gun, with Mounting and Loading Arrangements. A, Slide; B, recoil cylinder; C, elevating cylinder; D, sighting hood; E, hydraulic turning engine; F, brake on turning shaft; G, winch handles for turning by hand-power; H, training rack; J, ammunition trunk; K, cartridge hoist; L, hydraulic and hand arrangements for lifting shell in shell-room; M, platform for working hand-winch for shell hoist; N, hydraulic cylinder and ram for raising shell to shell chamber; P, shell chamber; Q, loading-hoist; R, hydraulic cylinder and ram for working loading-hoist; S, travelling crane; T, hand-winch for working loading-hoist; U, hydraulic rammer; V, hand-loading arrangement; W, hand-loading chamber; X, securing bolt; Y, buffer stop; Z, Z, rollers.

for the protection of the breech portion only of the guns, and the barbette system has therefore been almost universally adopted in British naval construction since 1890. In the *Majestic* class and subsequent battleships, while the guns are entirely above the thick fixed armour, they are protected by a shield revolving with them, and the thickness of this shield, which varies from 10½ inches in front to 4 inches in rear, is such that it is a moot point whether it is justifiable or not to designate it a "turret."

The 12-inch gun shown in Fig. 1, known as Mark VIII., forms the main armament of all the most recent British battleships. The 12-inch Mark IX., which embodies certain improvements in breech mechanism and ballistics, is mounted in the *Formidable* and her sisters.

The modern gun next in size to the 12-inch is the 10-inch, weighing 29 tons. It was adopted for the "main armament" of three battleships only, the *Renown*, *Barfleur*, and *Centurion*, and is worked entirely by hand, the barbettes in which the guns are mounted (in pairs) being trained by steam. The 10-inch gun has also been used in the re-armament of the *Thunderer* and *Devastation*, which originally had M.L. guns in their turrets; but no more are being made.

The object of the main armament of battleships, generally speaking, is to pierce the heavy armour of the enemy, and to inflict damage on his *matériel* by the explosion of heavy shell. The object of the secondary armament, composed in all British modern battleships of 6-inch Q.F. guns, is to demoralize the enemy by a rapid and continuous shell fire.

Modern first-class cruisers have in some cases a couple of 9·2-inch guns mounted forward and aft, and capable of training from right ahead and right astern respectively through an arc of about 120° on either side. These guns are known usually as "chase guns" and their objects are, in the first place, to enable the cruiser to deliver a very heavy blow when chasing or being chased, with accuracy at long ranges, and secondly, to pierce the armour of battleships or armoured cruisers and to inflict serious damage on their *matériel* by the explosion of heavy shell.

The 9·2-inch guns are worked entirely by hand, with the exception that the turn-tables on which they are mounted are in some cases turned by electricity. In the British navy they are not known as "quick-firing" guns, although their rate of fire probably compares favourably with similar guns in foreign navies which are called "quick-firing."

Mention should also be made of the 8-inch Q.F. gun, the designs of which are due to the Elswick firm, and which has been largely utilized by them in the armament of the cruisers they have built for foreign Powers. The gun has not, however, been adopted in the British service. Four rounds have been fired from this gun in 64 seconds.

The 6-inch Q.F. gun is the next modern gun, in order of size, to the 9·2-inch, and is used for the secondary armament of all British modern battleships, dating from the *Royal Sovereign* class, and as it is also used in all recently-built first and second class cruisers, it exists afloat in larger numbers than any other gun. It is also the largest gun whose projectiles, each weighing 100 ℔, can be loaded into the gun by manual labour without the aid of mechanical appliances, and it is consequently the largest gun to which the "quick-firing" principle, properly so called, can be applied.

Comparing the 6-inch Q.F. gun, whose normal rate of aimed fire may be taken as about a round every 15 seconds, with its immediate predecessor, the so-called "6-inch B.L." gun, firing at an average rate of about a round every 45 seconds, there are the following differences of principle in the gun, mounting, and ammunition. (1) The charge is contained in a brass cylinder, instead of a silk cloth bag. This renders unnecessary the operation of sponging, required in the 6-inch B.L. to ensure no fragments of smouldering silk cloth remaining in the chamber after firing. (2) The gun recoils in a cradle to which the sights are attached, consequently the sights do not move as the gun recoils, and the gun layer is enabled to keep his eye continually along the sights. (3) By the adoption of the coned breech screw, or in the latest designs the "Welin" breech screw, the means of actuating the breech mechanism enables the motions of unscrewing and then turning the breech screw clear of the bore of the gun, in order that the gun may be reloaded, to be effected by a single motion of an "actuating lever." (4) The gun, with its mounting and shield, is balanced about a central pivot, and the gun and cradle are accurately balanced about the trunnions of the cradle, so that the labour of training the gun

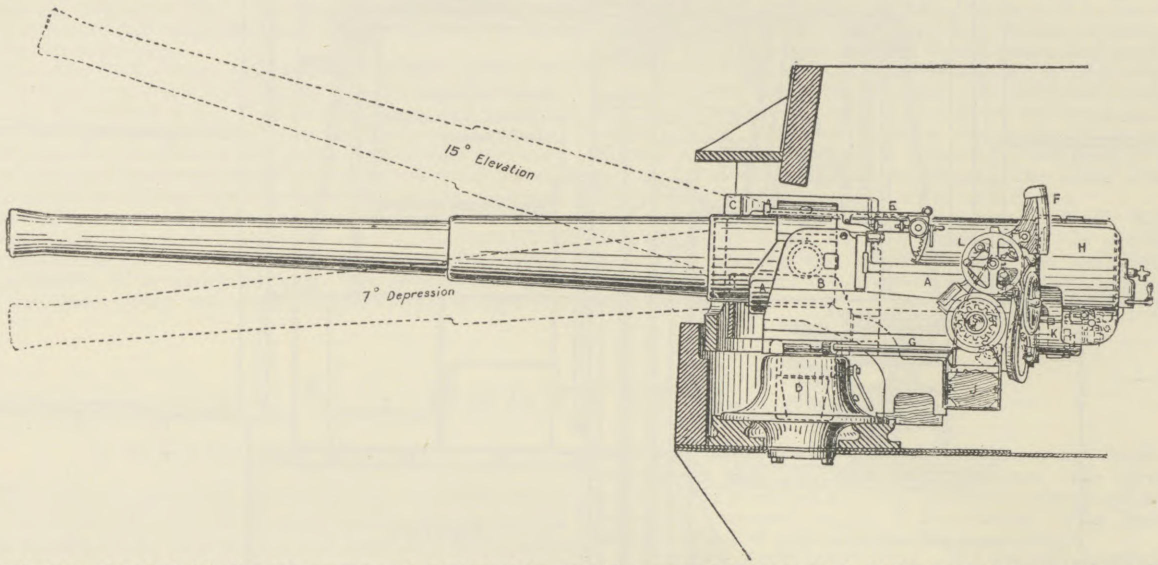


Fig. 2.—Diagram of a 6-inch Q.F. Gun and Mounting. A, Bracket of carriage; B, trunnion bearing; C, 3-inch shield; D, pivot piece; E, bar and drum sight; F, shoulder-piece; G, web-plate for supporting battery box; H, protecting shield; J, electric firing battery box; K, breech ring; L, training wheel.

and mounting and elevating the gun is reduced to a minimum. (5) The charge is fired by means of an electric primer screwed into the base of the brass cartridge case, against which the final motion of closing the breech causes the end of a striker to butt. The striker is insulated electrically, and forms part of the breech mechanism, and the effect of the arrangement is that the gun is ready to be fired immediately the breech is closed. In the B.L. guns a "tube" was required to ignite the cartridge, which had to be inserted after the breech was closed. (6) The introduction of the brass cartridge case enables the rammer, which was used to push the projectile home to its place, to be abolished, the cartridge itself doing this duty.

The features above described differentiate the Q.F. from the B.L. gun, although all of them are not necessarily applied in any particular gun and mounting. Thus in the latest type of 6-inch gun (known as the Mark VII.), which is mounted in the *Formidable* and her sisters, the cartridge case is not employed, the charge being contained in a silk cloth bag. Thus a sponge has to be employed, and a tube has to be used, which is, however, inserted with the breech open, so that its use does not entail delay. Fig. 2 shows a 6-inch Q.F. gun and mounting, as fitted to the *Canopus* class of battleships.

Naval nomenclature divides the Q.F. guns into two classes, the "heavy" and the "light." The "heavy Q.F." guns include the 6-inch, 4·7-inch, and 4-inch guns, the "light Q.F." guns, the 12-prs., 6-prs., and 3-prs. In connexion with smaller guns than the 6-inch, the question of "simultaneous" *versus* "separate" loading arises. In simultaneous loading, the projectile is secured into the mouth of the cartridge case, and cartridge and projectile are entered together, one operation being thus saved as against separate loading, in which cartridge and projectile are entered separately. Some foreign navies employ simultaneous loading with the 4·7-inch and all smaller Q.F. guns, but in the Royal Navy it has been adopted only with the 6-prs. and 3-prs. There is a slight gain in rapidity of fire by its use, but on the other hand there are grave objections to the stowage of filled and fuzed shell in the same magazines as the cartridges, and ammunition supply is facilitated by the separate stowage and supply of projectiles and cartridges, as it is considered safe to keep a considerable number of projectiles in racks close to the guns, so that when a sharp burst of rapid fire is required for a short time, cartridges only have to be provided.

The 4·7-inch, 4-inch, and 12-pr. (3-inch) guns, and their mountings, are generally similar to the 6-inch, on a smaller scale. The 4·7-inch Q.F. gun is largely used in the armament of second and third class cruisers of modern types, while the 4-inch gun is used in third-class cruisers.

The general introduction of the heavy Q.F. gun may be said to date from 1890. There were at that time large numbers of 6-inch B.L. guns in the service, and although after that date no new ships were armed with this gun, it was not feasible to re-arm with the Q.F. gun the ships designed for the B.L. gun. In addition to its greatly increased length, the change of mounting would have entailed great constructive alterations and considerable expense. The 6-inch B.L. guns have, however, been considerably altered with a view to improving their rapidity of fire. Practically all 6-inch B.L. guns now afloat have been so altered, and they are known as "Quick-Firing Converted," or Q.F.C. guns.

In the British navy modern guns of calibres below that of 4 inches are designated in accordance with the weight of the projectile they fire. There are three modern guns of under 4-inch calibre, the 12-pr., 6-pr., and 3-pr., and they are all light Q.F. guns. The principal duty of the light Q.F. gun in modern ship armaments is the repelling of torpedo-boat attack. They might also be used in a ship action for the attack of unprotected or partially protected guns' crews and for the destruction of unprotected parts of the hull and superstructure of the enemy by shell-fire. Opinions are, however, divided as to whether their effect in a ship action would be sufficient to warrant the exposure of their crews, as owing to the number of the guns, they are necessarily mounted in unprotected positions, and are protected only by shields. The 6-pr. was introduced about 1880 for defence against torpedo-boat attack, the 3-pr. being introduced at the same time as a lighter gun for the same purpose, capable of being more conveniently mounted in the tops, boats, and parts of the superstructure not sufficiently strong to withstand the effects of the recoil of the 6-prs. The rate of aimed fire with these guns is from ten to fifteen rounds per minute.

About 1893 the increase in size of torpedo-boats and the advent of the destroyer gave rise to a demand for a heavier projectile than that of the 6-pr. gun to ensure their disablement. The 12-pr. gun was therefore introduced for that purpose, and has taken the place of the 6-pr. in all ships built since that date. No 6-prs. are now being made except for the armament of destroyers, but the 3-pr. is retained for the armament of the fighting tops and of boats, and also for torpedo-boats. The mounting, breech mechanism, and loading and firing arrangements of the 12-pr. are generally similar to those of the 6-inch and other Q.F. guns. There are two 12-prs. in the service, known as the 12-cwt. and 8-cwt. guns. They are generally similar, except in length and in weight of charge of cordite. The 12-cwt. gun is that mounted on board ship for defence against torpedo-boat attack, while one or two 8-cwt. guns are carried in each ship for use as field guns, and as armament of the 42-feet launches, the largest pulling-boats carried. These 8-cwt. guns, whose energy of recoil is of course considerably less than that of the 12-cwt. guns, are also provided with mountings on board the ship, whence they can be used as ship guns.

Machine guns for naval purposes do not differ from those used in the land service. They are supplied to ships primarily for the armament of the boats, and for landing as field guns.

All double-banked pulling-boats and steam-boats are fitted with arrangements for mounting one or two guns, according to the size of the boat; the object of the boat armaments being for use in river operations or as guard boats, and for covering a landing. Three descriptions of gun are used, the 12-pr. 8-cwt. and 3-pr. light Q.F. guns, and the Maxim gun.

Ammunition.—Five descriptions of projectile are in use in the navy, in all cases the weights of the different natures of projectile for any gun being the same, in order that the ballistics of the gun may not vary.

These projectiles are the armour-piercing shot, and armour-piercing, common (filled either with powder or lyddite) and shrapnel shell. The last-mentioned projectile may be dismissed from consideration in a few words. A small quantity only is supplied, for such special purposes as covering a landing, or for use in a bombardment. Shrapnel would not be used in a ship action, and none is supplied for the most modern guns of large calibre, such as the 12-inch. A small proportion of armour-piercing shot is supplied to ships for all guns of 6-inch and larger calibres. As their name implies, they are designed with a view to piercing the thick armour of the enemy, which protects her most vulnerable parts, such as her water-line and her engines and boilers. An armour-piercing shot striking a lightly armoured or unarmoured part of the enemy's side will do a comparatively small amount of damage, as its effect will be limited to its own path. Taking into consideration the extreme difficulty of striking the exact point aimed at when both one's own ship and the enemy are moving rapidly, and both the bearing and the range are quickly changing, it is not generally considered that the chance of injuring a vital part of the enemy is compensated for by the small amount of damage which would be done if another part of her were struck. By far the larger proportion of the projectiles carried on board ship is composed of common shell, which may be looked upon as the projectiles, *par excellence*, of naval artillery. The design of a common shell provides for the maximum weight of bursting charge consistent with the walls of the shell being sufficiently strong to withstand the shock of discharge and the pressures in the bore of the gun. All the common shell constructed of recent years have pointed heads, and in the case of powder-filled shells are ignited by means of a percussion fuze screwed into the base of the shell. Shells filled with lyddite have their fuse in the nose of the shell, which is of course not pointed, as there appears to be a slight risk of a premature burst of the shell occurring with a base fuze, and this risk cannot be accepted in the case of lyddite shell. Common shells, whether filled with powder or lyddite, are only effective against very thin armour, or against the unarmoured portions of a ship's structure. A common shell, generally speaking, is capable of penetrating a thickness of mild steel armour equal to about $\frac{1}{3}$ of its calibre before bursting, and if it penetrates the ship's side, will burst from 4 to 10 feet in rear of it. An effective shell should on bursting break up into a number of fragments which will be projected with great velocity in all directions, and it will probably set fire to any inflammable material in its vicinity.

The effect of common shell was shown in the battles of the Yalu and of Santiago. In the former case the Chinese ships, with the exception of the two battleships, were wrecked by common-shell fire; their guns were disabled, communications to the engine-rooms shot away, and *personnel* destroyed, and eventually the water-lines suffered so much that the ships sank, although intact below the protective deck. The Chinese ships were, as a rule, not provided with common shell, but one such shell bursting in the 4·7-inch gun battery of the *Matsushima* disabled three guns, exploded a quantity of 4·7-inch cartridges, and killed or wounded some seventy officers and men. At Santiago, although their water-line belts saved the Spanish ships from sinking, the ships were set on fire by the American shells; and as the fire-mains were shot away, the fires could not be put out, and the ships had to be run ashore, after suffering enormous loss among the crews of their unprotected guns.

Comparing the effects of the lyddite and powder-filled common shells—the former will detonate with extraordinary rapidity on striking even a $\frac{1}{2}$-inch steel plate. If a lyddite shell strikes thin armour, its effect will probably be only a splash on the armour, as the detonation takes place before the shell has time to penetrate. If the shell strikes an unarmoured side, it will make a very large hole, and its effect inside the ship, though violent enough to pulverize everything in close proximity to it, will be much more local than that of a powder-filled shell, and as the lyddite shell breaks up into smaller pieces, it will probably do less damage to material than will be done by the larger pieces of the powder-filled shell. On the whole, the greatest effect will be obtained from lyddite shells when they strike and detonate on the funnel or other casings amidships. The large area of 4-inch and 6-inch armour employed in ships of recent construction for the protection of their secondary batteries and their ammunition supply has led to the introduction into the service of a third type of shell, known as the armour-piercing shell. This shell is filled with powder, and differs only from the common shell in that its walls are thicker and consequently its bursting charge smaller, generally about 5 per cent. of the total weight of the shell. The shell is made with a special view to carrying its bursting charge through the thin armour of the enemy, and will penetrate before bursting about two-thirds of its calibre of mild steel armour.

The adoption of smokeless powder has conferred greater advantages on the attack in the navy even than in the land service. With the large number of guns which are necessarily carried comparatively closely together on board ship, firing was frequently impeded by the clouds of smoke; indeed, under certain conditions, such as a following wind, the advantage conferred by the increase in the rate of fire of Q.F. guns was well-nigh neutralized by the impossibility of distinguishing the target owing to smoke. The reduced weight of the cordite as compared with the powder ammunition is also an advantage of great value in the naval service.

Armaments.—The gun armament of a modern battleship is divided into four classes, known as the main, secondary, auxiliary, and machine-gun armaments. Some account has already been given of the guns constituting these four divisions: as far as the number of the guns is concerned, we appear in the battleships of the British navy to have reached a point at which there is a consensus of opinion that the general principles governing the number and disposition of the guns cannot be improved upon, since the four last classes of battleships built vary but very slightly in this respect. Taking the *Canopus* (Fig. 3) as a typical ship for description, her main armament consists of four 12-inch B.L. guns. These guns are mounted in pairs in turrets on the quarter-deck and forecastle, each turret having a total arc of training of 240°, the fore turret training from ahead through 120° in either direction, and the after turret from astern through 120° in either direction. This principle of mounting the heavy guns, which has for many years been that adopted in the British navy, has the advantages that while the ahead and astern fire is carried out over parts of the ship which would be unoccupied in action, and while the remainder of the armament would in no way be interfered with, it enables the whole of the four heaviest guns to be in action at the same time through an arc of 120°, namely 30° before and abaft either beam. It is open to the disadvantage, which is, however, more apparent than real, that two of these guns only can be brought to bear ahead or astern. An alternative plan, which has been largely adopted in the French and other navies, for mounting the guns of the main armament is to have one gun only on the forecastle and one on the quarter-deck, the other two being mounted amidships, one on either side, with arcs of training of 180°, namely, from ahead to astern. In theory this plan enables three guns to fire ahead and three astern, but in practice it is probable that so much damage would be caused to the superstructure, and the guns of the secondary armament would be so much interfered with if the 'midship guns were fired on or close to the middle line, that the advantage is a very doubtful one. The disadvantage that only three guns can be brought to bear on or about either beam is undoubtedly a grave one.

The secondary armament, in the *Canopus* as in all the most modern British battleships, consists of twelve 6-inch Q.F. guns (Fig. 2). Four of these guns are mounted on the main deck and two on the upper deck, on each side. Each gun has an arc of training of 120°. The foremost upper-deck and the foremost main-deck gun on each side train from ahead to 30° abaft the beam, and the after upper-deck and after main-deck guns from astern to 30° before the beam, while the two middle guns on each side train from 60° before to 60° abaft the beam. Thus all the guns of the secondary armament can be brought to bear on or about the beam bearing, while four guns can train ahead and four astern. Each gun is isolated in a separate casemate, protected in front by 6-inch and in rear by 2-inch armour, a system by which the maximum protection from shell-fire is obtained, and the disposition of the casemates is such that the fire of one gun cannot interfere appreciably with the crews of adjacent guns. This point is one to which special attention has been paid in British ships, but the same cannot be said for many foreign battleships, in which the attempt to provide for a heavy bow and stern fire has led to a probability of considerable interference between adjacent guns.

The auxiliary armament of the *Canopus* consists of ten 12-pr. Q.F. guns, four of which are mounted on the main deck and six on the upper deck. These guns are primarily intended to repel attacks by torpedo-boats, and are unprotected except by shields. It is doubtful whether they would even be manned in a ship action, as their crews would be exposed to almost certain destruction, and they could exert no very great influence on the result of the action. In addition to the 12-pr. guns, three 3-pr. Q.F. guns are mounted in each of the fighting tops, on carriages which admit of being traversed throughout the circumference of the top. These guns also are of great value for repelling a torpedo-boat attack, and are used also for the armament of the larger boats. The machine-gun armament, consisting of eight rifle-calibre Maxims, is disposed as conveniently as possible about the bridges and superstructure. The guns are intended principally for the armament of boats, and it is highly improbable that they would be manned in a ship action. Fig. 3 shows the position of the main and secondary armaments in the *Canopus* with their arcs of training.

The armaments of first, second, and third class cruisers resemble generally in principle those of battleships. The first-class cruisers carry in some cases a 9·2-inch gun at either end as their main armament, and in all cases their secondary armament is similarly disposed and protected to that of a battleship. The *Europa* class, however, carry no guns heavier than the 6-inch, the 9·2-inch guns being replaced by two pairs of 6-inch guns on the forecastle and quarter-deck respectively. These guns are protected by shields only, which are open in rear, and are

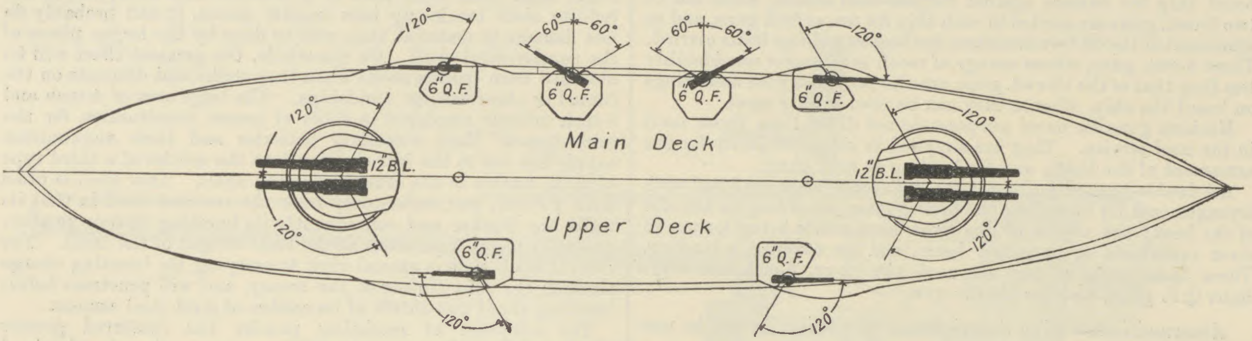


Fig. 3.—Plan of Gun Decks of H.M.S. *Canopus*

undoubtedly extremely vulnerable; it is, further, questionable whether a ship of the size of the *Europa*, which could not decline action with any foreign cruiser, would not fight at a considerable disadvantage, having no gun of greater armour-piercing power than the 6-inch. The same remark applies to the somewhat smaller *Kent* class, but their 6-inch guns on the forecastle and quarter-deck are mounted in pairs in small turrets, and so are better protected. Recent second-class cruisers carry an armament of 6-inch and 4·7-inch guns. The latest and largest, *i.e.*, the *Hermes* class, carry eleven 6-inch guns, while the *Apollo* class, which are some 2000 tons smaller, carry a 6-inch on the poop and forecastle and three 4·7-inch guns on each side. All the guns of the second-class cruisers are on the upper deck, and are protected only by shields. Third-class cruisers, the class being known as the P class, from the initial letter of their name, carry 4·7-inch and 4-inch guns. The armament of torpedo-boat destroyers consists of a 12-pr. on the conning platform forward and five 6-prs. The small armament of the modern British cruisers has excited much controversy; many foreign cruisers, and notably some built at Elswick for the Japanese and Chilian Governments, carry a much greater weight of armament on the same or a smaller displacement. Thus the Japanese *Asama* and *Tokiwa*, of 9700 tons, carry an armament of four 8-inch and fourteen 6-inch guns; whilst the British *Drake* class, of approximately the same displacement (9800), carry fourteen 6-inch guns only.

Organization.—The organization of a large ship for action is necessarily highly elaborate; the complement is based upon it, and each man borne upon the books, whatever duty he may perform in the internal economy of the ship, has his station and duty in action allotted to him.

The most important duty is, of course, that of manning the guns. Taking the *Canopus* again as a typical battleship, we find that twenty-two men are required as the "turret's crew" to man each pair of 12-inch guns. Of these three the captain of the turret and the captains of the two guns are men specially selected for general smartness and aptitude, and as being quick and accurate shots; a certain number more are seamen gunners trained in one of the gunnery schools at Portsmouth, Devonport, or Sheerness; these men are required for the responsible duties of working the hydraulic levers other than those for training the turret and elevating the guns; while the remainder of the turret's crew are usually younger men who have received only such gunnery training as can be given on board their own ship, and are called "trained men." The 6-inch guns are each manned by a crew of eight men, one of whom has been specially selected or trained and is known as the "captain of the gun," while the remainder of the gun's crew consists partly of seamen gunners, who perform the more important duties at the gun, and any one of whom is prepared to take the captain of the gun's place in case of necessity, and of "trained men." The 12-prs. have each a crew of four men, the 3-prs. of three, and the Maxims of two, one of whom at each gun is always a seaman gunner. A proportion of the guns, generally four 6-inch and four 12-prs., is allotted to the Royal Marines, who receive a training in naval gunnery similar to that given to the seamen, the Royal Marine Artillery corresponding in this respect to the seamen gunners, and the Royal Marine Light Infantry all being trained men.

The guns are of course dependent for their efficiency on the arrangements for the supply of ammunition to them, and the greater rate of fire possessed by modern guns of all calibres has caused increased attention to be given to this point. As far as organization of the *personnel* is concerned, no difficulties are presented by the supply to the 12-inch guns, each pair of which is provided with its own magazine and shell-room, which are manned by some twenty-five men to each pair of guns. The arrangements for the supply of 6-inch and 12-pr. ammunition are briefly as follows, the important principle to be borne in mind being that while the supply must be rapid enough to conform to the rate of fire of the guns, no accumulation of ammunition can be permitted, on account of the danger of its ignition by bursting shell. At the fore and after ends of the spaces devoted to the engines and boilers, and immediately below the protective deck, is a space usually known as the "cross-passage." Into this space the hatches open from the 6-inch and 12-pr. magazines and shell-rooms, which are situated below the cross-passages. The cross-passages are connected on each side of the ship by a long passage cut out of the coal bunkers or out of the engine- or boiler-rooms, from which a direct supply of ammunition to each 6-inch gun is arranged by means of an endless rope whip passing from the casemate in which the gun is mounted through a vertical armoured tube into the ammunition passage. The supply to the 12-pr. guns is similarly arranged, but the whips are not protected by armour, and each hoist has usually to serve for a pair of guns. The 6-inch shells having been removed from their racks in the shell-rooms and the cartridges from their boxes in the magazines, are placed in bags fitted with rope beckets for hooking to the whips. They are then hoisted by endless whips into the cross-passages, carried to the bottoms of the ammunition tubes, and thence whipped up as required by the guns. It will be seen that a considerable number of men are required for these operations, all of which are performed by hand, and in the *Canopus* class some eighty men are actually required for the 6-inch ammunition supply and another eighty men for the 12-pr. The supply of 3-pr. and Maxim ammunition is not of such importance. A considerable quantity of 3-pr. ammunition is arranged to be stowed in the tops, and would be placed there before going into action, and the Maxims, as has already been observed, would probably not be manned in a ship action. The torpedo-tubes, of which the latest British ships carry four only, all of which are submerged, are manned by crews consisting principally of highly-trained "S.G.T.'s" or seamen gunner torpedo-men.

In addition to the crews for guns and torpedo-tubes, and to the men employed in the supply of ammunition in action, men are required for the following duties: buglers, messengers, men to attend voice-tubes and to man steering-wheels, fire brigade (consisting of the carpenters and shipwrights and a portion of the stokers), men to transport and attend the wounded, and armourers.

It is not easy to foresee the future developments of naval gunnery; generally speaking, the tendencies are towards lighter but more powerful guns with increased rates of fire, using bare charges and firing shell of increased armour-piercing capability; better protection for guns and their crews and for ammunition supply; constructive improvements having for their object the acceleration of the ammunition supply, and more careful selection of and higher training for captains of guns and gunnery ratings generally. (S. FR.)

II. ARMY (BRITISH). (*a*) GUNS.

The controversy of M.L. *versus* B.L. guns, carried on for several years prior to 1880, was finally settled in favour of the B.L. gun. The necessity for a very long gun in order to develop the high power required in modern ordnance was one of the main factors in the case.

The following table gives the various descriptions of B.L. ordnance in the service and their use, exclusive of those purely naval and dealt with under "Naval Gunnery":—

Description.	Weight.	Muzzle Velocity. f.s.	Maximum Range by Range Table. yards.	Use and Remarks.
	lb.			
2·5 inch	400	1440	4,000	Jointed or screw guns for mountain artillery.
10-pr.	418	1289	6,000	
	cwts.			
12-pr.	6	1585	6,000	R.H.A. batteries: light short gun for mobility.
15 ,,	7½	1581	6,000	R.F.A. batteries: as powerful as possible without loss of mobility.
30 ,,	20	1621	6,300	Heavy Indian field batteries.
4-in.	26	1900	7,700	Siege train and guns of position.
5 ,,	40	1750	8,700	
	tons.			
6 ,, (up to Mark VI.)	5	1960	10,000	Guns of 6-in. and upwards are employed for coast batteries. The latest marks of 6-in. and 9·2-in. are new types, of great length, with high muzzle velocity.
6 ,, (Mark VII.)	7·4	2456	12,000	
8 ,,	13	2000	8,000	
9·2 ,, (up to Mark VII.)	22	2065	10,000	
9·2 ,, (Marks IX. & X.)	27	2601	13,800	
10 ,,	29	2040	11,500	
12 ,, (up to Mark VII)	46	1914	8,000	
	cwts.			
5-in. howitzer	9	...	4,900	Field and siege purposes in Imperial service.
5·4 ,, ,,	13	...	4,800	Field and siege purposes in Indian service.
6 ,, ,,	25	...	5,200	Siege equipment in India.
6 ,, ,,	30	...	5,200	Medium unit of siege trains in Imperial service.

The howitzers are short pieces, and of large calibre compared to their weight, to enable them to fire a shell containing a large quantity of explosive. As they use charges of various weights in order to obtain any angle of descent for the shell, no muzzle velocity is given in the table.

Q.F. Guns.—About the year 1881 it was found that a more rapid rate of fire than could be obtained by means of the B.L. guns of that day was necessary. This was due to various causes, such as increased speed of torpedo-boats and the necessity for attacking the unarmoured or lightly armoured portions of ships with a heavy shell fire, &c. This high rate of fire was obtained by the introduction of guns known as Q.F. (quick-firing), in which some of the main features were—(1) Rapid means of opening the breech; (2) the charge being contained in a brass case with its own means of ignition, and in the lighter descriptions in one with the shell; (3) the mounting being adapted for the rapid service of the gun. Until the year 1898 guns of this type, up to and inclusive of 6-inch calibre, continued to be made. Except with the 3- and 6-prs., percussion firing was by no means rapid. In endeavouring to overcome this difficulty and to produce a more powerful gun than the then existing 6-inch Q.F., it was found that, at any rate for certain calibres, a B.L. gun could be produced which could be fired quite as rapidly as the corresponding Q.F., and was free from the disadvantage mentioned above. The main features which cause this gun to be classified as B.L. are: (1) The charge is bare (not in a brass case); (2) the system of obturation and firing is similar to that of other B.L. guns, viz., pad obturator, and lock and tubes for firing. Only in mounting and style of opening the breech does it resemble the Q.F. type. A Q.F. gun may now therefore be defined as one which employs "case ammunition," the nomenclature being entirely unconnected with the rate of fire.

Q.F. Guns in the Land Service.

Description.	Weight.	Muzzle Velocity.	Method of Closing Breech.	Use and Remarks.
	cwts.			
15-pr.	6½	1608	Breech screw.	A certain number of field batteries are armed with these guns.
3-pr. and 6-pr. Hotchkiss	5 and 8	1873 1818	Wedge.	Chiefly as armament of coast batteries, against torpedo-boat attack, defence of mine fields. Against ships' tops, &c.
3-pr. and 6-pr. Nordenfelt	4 and 6	1920 1818	Wedge and block.	
12-pr.	12	2197	Coned breech screw.	
4·7 inch	41	2150	Coned breech screw.	Armament of coast batteries for the attack of lightly armoured parts of ships. The 4·7-inch can also be used as a gun of position.
	tons.			
6-inch.	7	2154	Coned breech screw.	

The following table enables a comparison to be drawn between the ballistics of the old and newer descriptions of service ordnance:—

Description.	Muzzle Velocity.	Weight of Projectile.	Muzzle Energy.	Rate of Fire. Aimed rounds per min. (approx.).	Penetration Mild Harveyed Steel. Inches.
	f.s.	lb.	tons in²		
64-pr. R.M.L. 6·3 inch	1390	64	897	1	...
6-inch B.L. (Mark VI.) old typo	1960	100	2663	1	9·9
6-inch B.L. (Mark VII.) new type	2456	100	4185	4	13·77
6-inch Q.F.	2154	100	3217	4	11·4

Heavy Guns.

				One round.	
9-inch R.M.L.	1440	256	3,695	1′ 30″	12·96[1]
9·2 B.L. (Mark VII.) old type B.L.	2065	380	10,348	1′ 30″	18
9·2 B.L. (Mark X.) new type B.L.	2601	380	17,830	¾ min.	24·5

[1] Wrought iron.

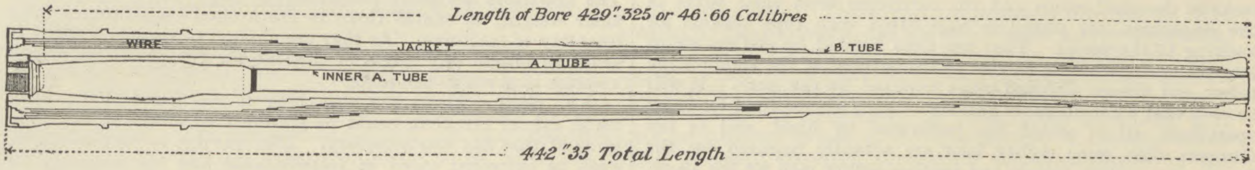


FIG. 1.—Section of 9·2-inch B L. gun, Mark X. 28 tons.

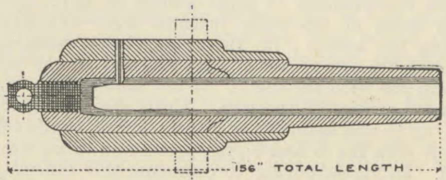


FIG. 2.—Section of 9-inch R.M.L. Gun, Mark V. 12 tons; length of bore, 125 inches.

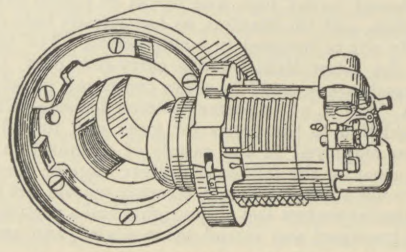


Fig. 3.—Cylindrical Block with Interrupted Screw (ordinary pattern).

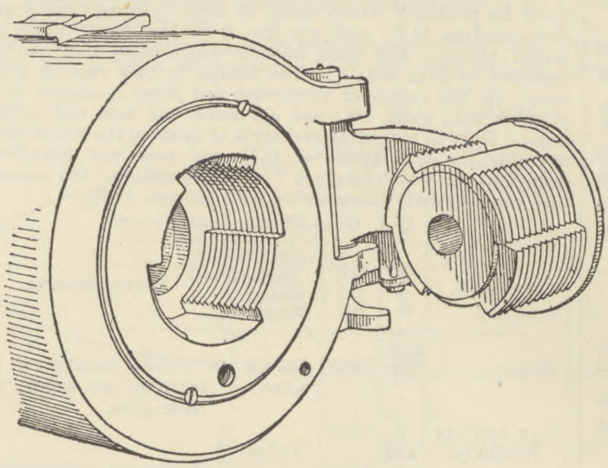


FIG. 4.—Interrupted Screw (Welin pattern).

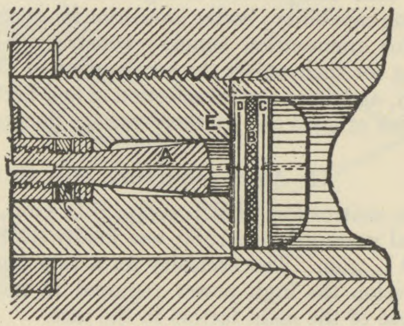
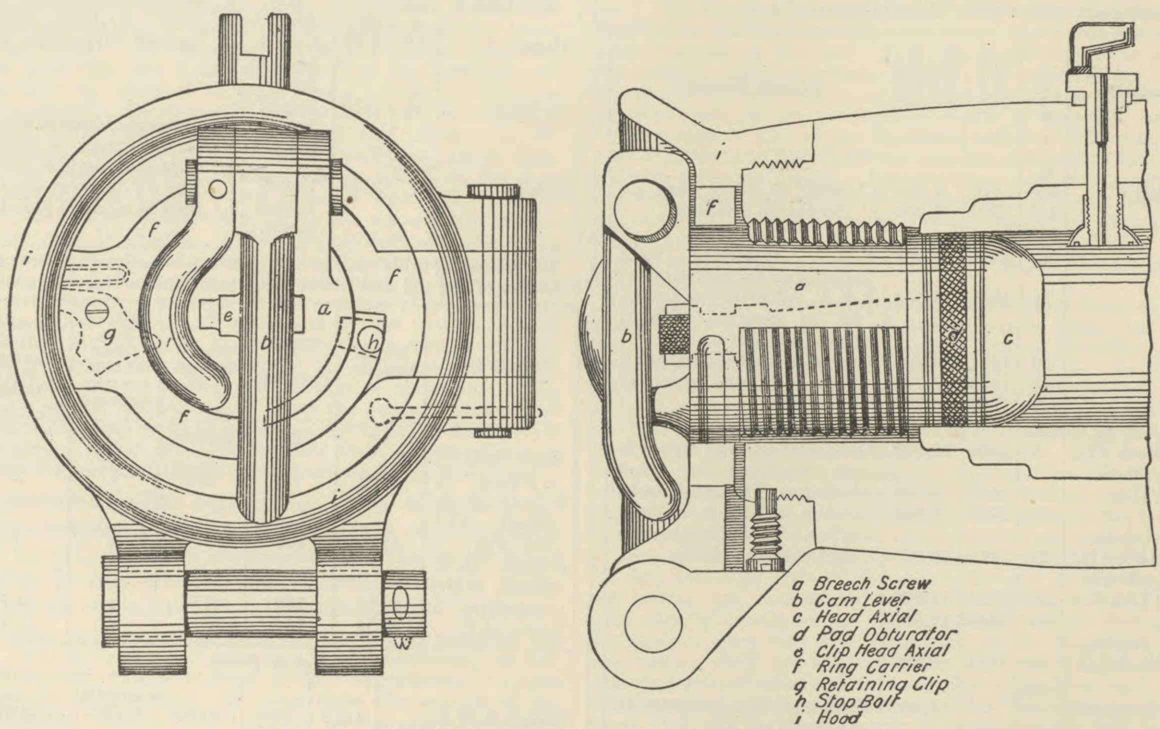


FIG. 5.—Pad Obturator.



FIGS. 6 and 7.—Diagram of Breech Mechanism of Ordnance B.L. 15-pr. Gun, Mark I.

Construction.—When B.L. guns were first introduced their construction was very similar to that of the later R.M.L. guns—that is, they consisted of an inner tube of steel supported by one or more coils of wrought iron. At this date the manufacture of steel had not arrived at the state of perfection to which it has now attained, and

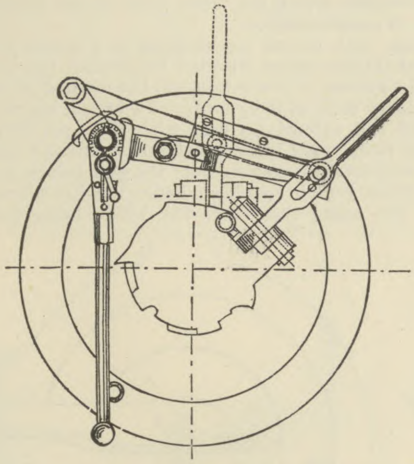


FIG. 8.—Apparatus for turning Breech Screw.

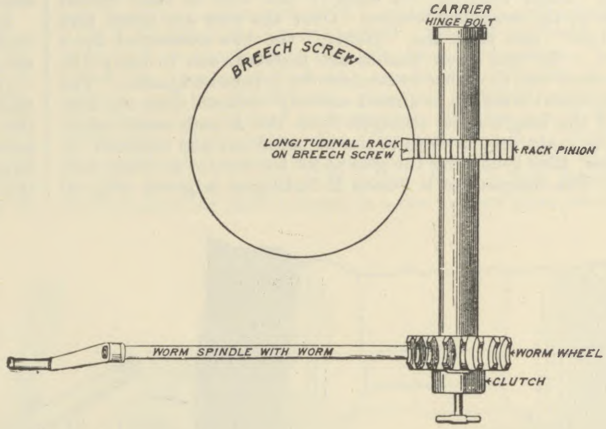


FIG. 9.—Apparatus for withdrawing and swinging Breech Screw of Heavy Gun.

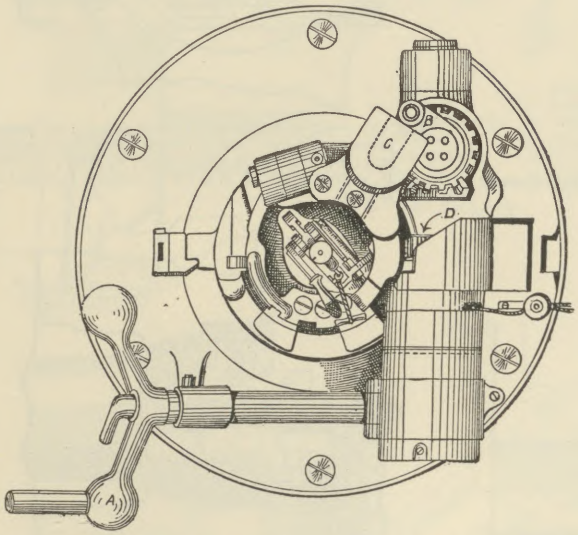


FIG. 10.—Diagram of the Breech Mechanism of 9·2-inch B.L. Gun, Mark IX.

consequently for gun construction its use was limited; but as the manufacture improved it gradually replaced wrought iron, and in the majority of the B.L. guns is the only material used. In the earlier classes, in which the guns are composed of steel hoops and tubes, the building up is on the same lines as with R.M.L. guns; that is, the outer parts are shrunk on, and so placed in a state of initial tension, while the inner tubes are correspondingly compressed.

During the last few years, however, the "wire system of construction" has been applied to many guns. The wire, the section of which is ·06 inch thick and ·25 inch wide, merely takes the place of some of the intermediate tubes, and is wound on in successive layers, of which there are a considerable number. As the tension can be varied at every layer if necessary, the gun is, as it were, one made up with an enormous number of outside hoops all put on at a different shrinkage: in this way full advantage can be taken of the strength of the material; in a thick hoop, shrunk on, it is impossible to do so. Other advantages are: (1) that the material can be tested all over; (2) that a flaw cannot spread; (3) that for a less external diameter than formerly a gun of equal strength can be obtained; (4) that the material in itself is stronger than steel in the mass. Although thus giving great circumferential strength to a gun, it gives little or none longitudinally; this has to be obtained by means of tubes either under or over the wire, or by a combination of the two.

Fig. 1 shows the construction of one of the latest B.L. guns

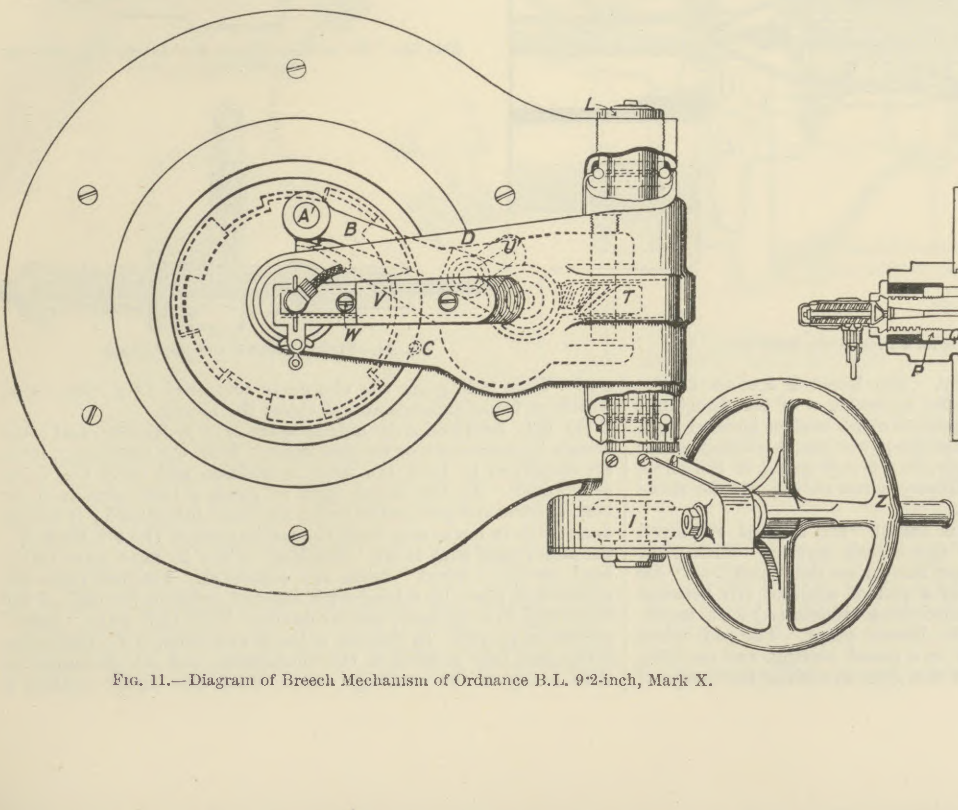


FIG. 11.—Diagram of Breech Mechanism of Ordnance B.L. 9·2-inch, Mark X.

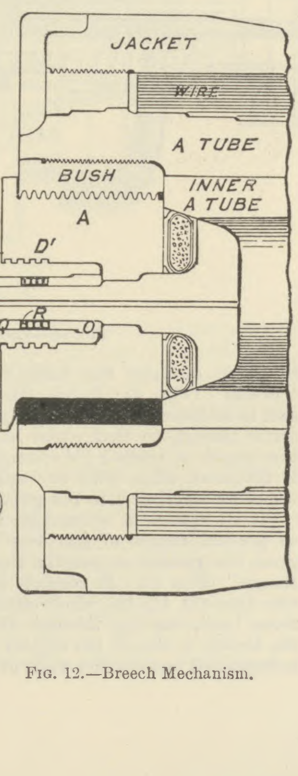


FIG. 12.—Breech Mechanism.

used in both land and naval services. It consists of an "inner A tube," fitted into an "A tube"; the wire is then wound on these at the necessary tension. Over the wire are fitted first a "B tube" and then the "jacket," the two connected by a shoulder. In rear screw bushes are inserted, one to carry the breech screw and the other to connect the A tube and jacket. The circumferential strength is almost entirely obtained from the wire coil, and the longitudinal strength from the A and outer tubes. When the inner tube is worn it can be bored out and replaced by a new one, thus rendering the gun as fit for service as when first issued. The diagram of a 9-inch R.M.L. gun is given (Fig. 2) to show the revolution which has taken place in gun construction since the time of muzzle-loaders.

Before dealing with breech mechanisms as a whole, it will be well to consider (1) the means adopted for closing the breech of the gun, (2) the system of obturation, (3) the method of firing.

(1) The ordinary method is by means of a breech screw. That first introduced and extensively used with B.L. guns is (Fig. 3) the cylindrical block with interrupted screw thread: this type necessitates a withdrawing motion from the gun before it can be swung clear of the breech opening; hence the introduction for Q.F. guns of the coned type (Fig. 23), which being cut away

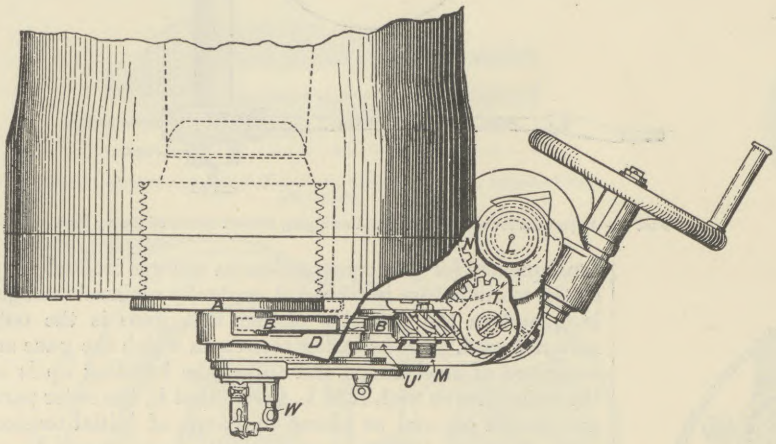


Fig. 13.—Diagram of Breech Mechanism of Ordnance B.L. 9·2-inch, Mark X. Part of carrier frame and gun removed to show gearing of pinion and links.

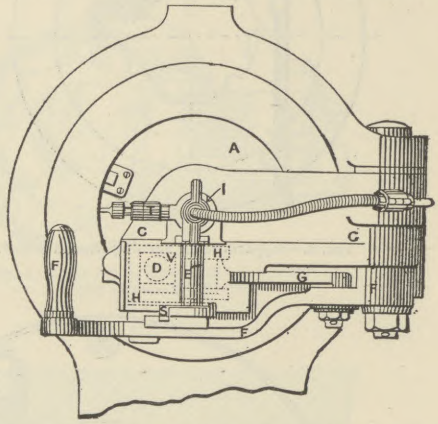


Fig. 22.—"B" or Single Motion Mechanism. A, Breech screw; B, screw fixing breech screw; C, carrier arm; D, stud; E, S, safety stop; F, lever; G, link; H, sliding block; I, J, parts of striker; V, bush; T, trigger.

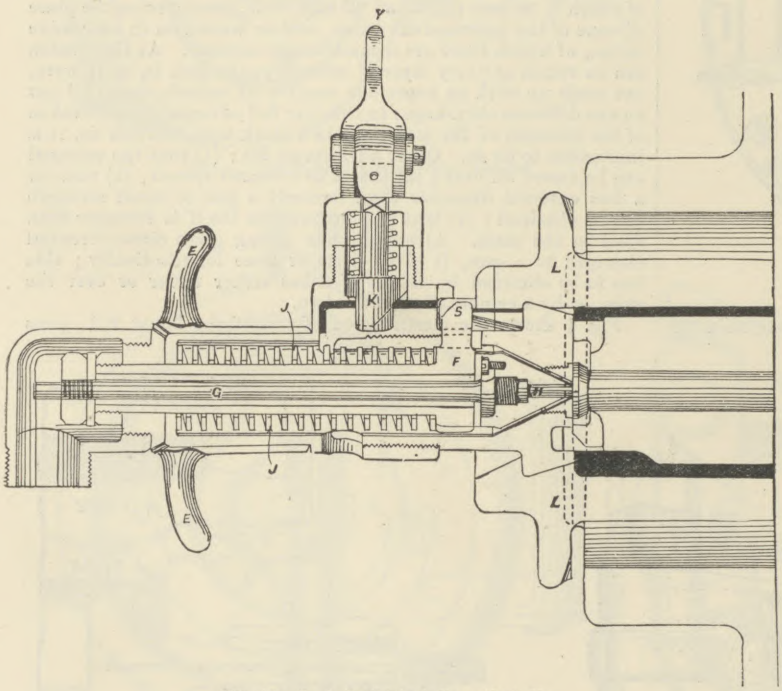


Fig. 14.—Lock for 9·2-inch Gun, Mark X.

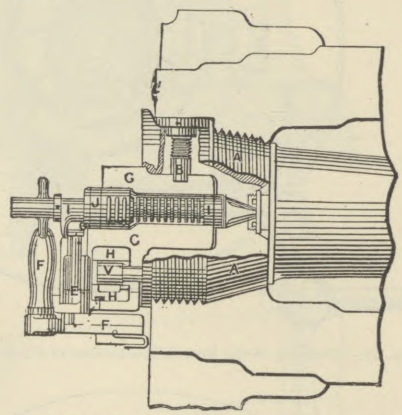


Fig. 23.—"B" or Single Motion Mechanism. (For lettering see Fig. 22.)

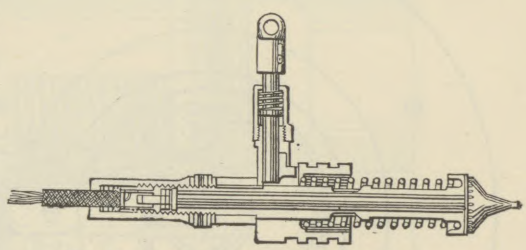


Fig. 24.—Striker (electric and percussion).

in front, obviates the difficulty. The latest is known as the "Welin" (Fig. 4): it has all the advantages of the foregoing, and in addition a much larger portion of its surface covered with screw thread, so that equal holding power can be obtained for less length of screw; for example, in a 6-inch gun ⅔ of the screw is threaded, while with the ordinary screw only ½ can be made use of for holding it in the gun.

(2) By system of obturation is meant "the method employed to prevent escape of gas over the breech screw." With B.L. guns the system is usually that known as the "pad" or "De Bange" (Fig. 5). It consists of a pad of asbestos (B) between two discs (D, C), the whole carried on a spindle (A) with mushroom head, passing through the breech screw. The pad, when the breech is closed, fits tightly on a coned seating, and on firing is expanded against the walls of the gun, so sealing the escape of gas. With Q.F. guns the charge is contained in a brass case, which on firing expands and so closes the breech.

(3) B.L. field and siege ordnance are fired by friction, and other classes by percussion or electric tubes. With the two latter, locks are employed to keep the tube in position and carry the firing mechanism. In the latest type of guns, a lock, combined for both electric and percussion firing, has been introduced; it will be dealt with in connexion with the mechanism of the 9·2 Mark X.; the tubes used with it are "wireless," while in most guns in the land service "wired" tubes are employed. Friction tubes are retained in place by a head with bayonet joint on the end of the vent (Fig. 7) or by some similar device. With Q.F. guns "locks" are not employed. In the case of the 3- and 6-prs. Q.F., percussion firing gear only is fitted to the mechanism, and acts in connexion with a cap in the cartridge case. With the higher calibres a

"striker" is used; it can be adapted for either "electric" or "percussion" firing in connexion with either a "primer" or "tube" in the case (Fig. 24).

Turning now to the breech mechanisms themselves, that of the 15-pr. Mark I. field gun (Figs. 6, 7) is simple and effective, though not so rapid in action as that of the latest pattern Mark IV., which is classed as a "single motion" mechanism. The breech is opened by raising a cam lever (*b*) and turning it to the left as far as it will go; the breech screw is then withdrawn from the opening through a ring carrier (*f*) for a certain distance, and afterwards carrier and screw together swing round on the hinge bolt to the right. In the closed position a projection or cam on the lever folds down into a recess in the carrier or gun, and so prevents the screw from turning when the gun is fired; this is a very important point with all B.L. or Q.F. guns, and is technically termed "locking the breech screw." The older-pattern medium guns, such as 4-inch and 5-inch, &c., have mechanisms of a similar nature for opening and closing the breech, but with the higher calibres, such as the 9·2-inch guns and upwards, some form of power-gaining appliance is necessary. In the case of the older descriptions this consists of a "ratchet lever gear" for turning the screw, and "control mechanism" for withdrawing and swinging into the open position. These are shown in Figs. 8 and 9. An improvement on this is found in a few modern guns, such as the

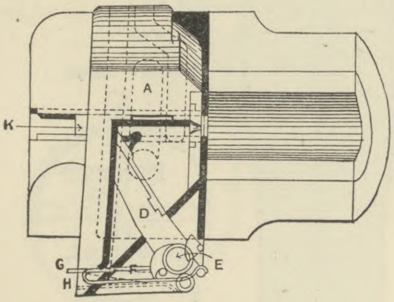


Fig. 15.

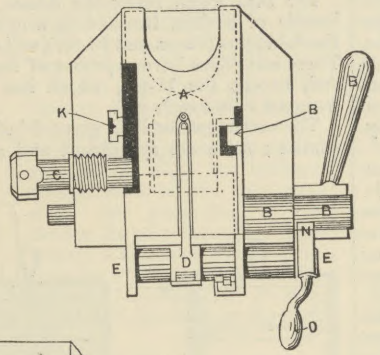


Fig. 16.

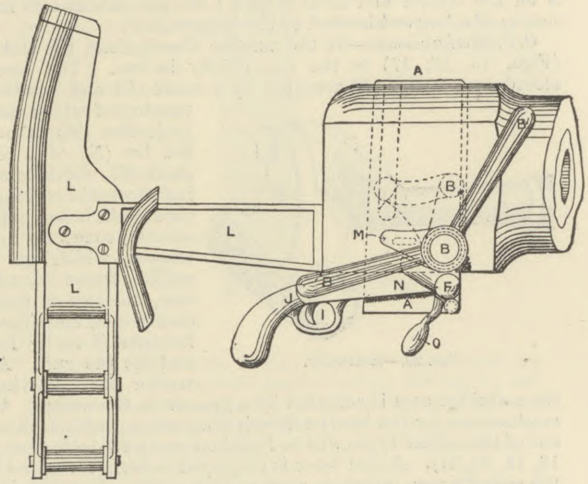


Fig. 17.—Diagram of Breech Mechanism of Hotchkiss 6-pr. Q.F. Gun.

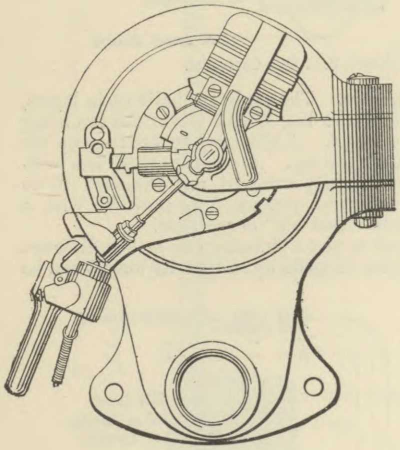


Fig. 18.

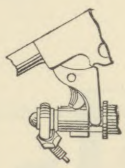


Fig. 19.

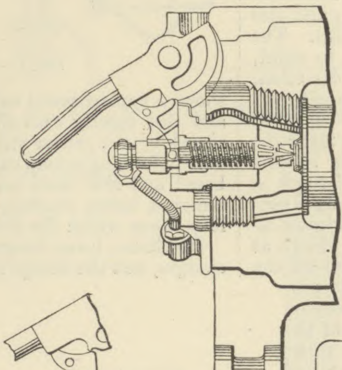


Fig. 20

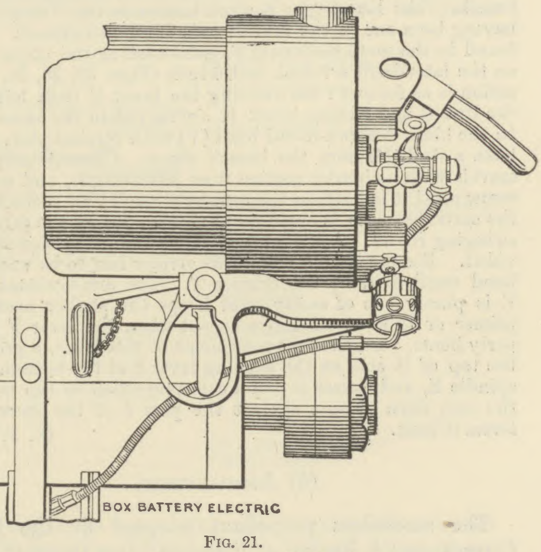


Fig. 21.

9·2 IX., where the ratchet lever gear is done away with, and a crank and pinion worked by the "control mechanism" is fitted to the top of the hinge bolt for the purpose of turning the screw, so that in this case the mechanism may be said to be "single motion"; for instance, turning the lever A (Fig. 10) opens the breech, by first turning the crank B into the roller path C on the screw and forcing it over, then by means of a pinion (D) on the hinge bolt, acting on a horizontal rack on the side of the screw, drawing the latter out and finally swinging it round into the open position.

The latest type of mechanism will now be described in connexion with the 9·2 X. (Figs. 11, 12, 13). The screw A is of the "Welin" pattern, and is carried on an arm (D) instead of in a ring; the obturator is of the pad system, only known as the "steep cone" pattern, as will be seen on comparing it with that of the 15-pr.; the advantage gained thereby is that the least withdrawal movement clears it off its seating and enables it to be swung round into the open position. The turning of the screw is effected by means of a hand-wheel[1] (Z) working a shaft with worm, connected to a worm wheel (I) on the hinge bolt L; the latter revolving causes a pinion (N) which is on it to act on another pinion (T) on which are skew bevel teeth; these cause a link (U) pivoted at M to revolve, and draw with it another link (B), to which it is pivoted. Now B fits at A′ on to a stud on the breech screw, and so the turning is effected. When sufficient turn has been given to the screw it becomes fixed to the arm by a catch (C), consequently further movement of the lever Z causes the arm and screw to swing round into the open position. The breech screw is connected to the arm by an interrupted screw thread (D′), so that in turning it moves slightly to the rear on the arm and presses against a sleeve (O) which conveys the pressure back through a spring (R) and washer (Q) to the nut P

[1] This has now been replaced by a lever across the face of the breech.

on the axial vent; in this way the pad is pulled off its seating and made to follow up the screw.

The lock which is combined for electric and percussion firing is shown in Fig. 14; it is carried on a slide box (L) and has a guide bolt (W) (Fig. 11) which fits into the sliding plate V. This plate is actuated by being connected to a cam groove (U′) carried by the link U; as soon as the link revolves the plate is drawn to the right, carrying the lock with it, and so the gun cannot be fired unless the breech is properly closed. The movement of the lock actuates an extractor which ejects the fired tube; a new tube is then put in, and in closing the breech the lock resumes the firing position. For electric firing, a lead passes along the arm D and makes contact with the insulated needle G through which the current is conveyed to the tube; the return circuit is an "earth one." For percussion firing the handle E is pulled to the rear; this draws back the striker F which includes needle G and firing pin H, against the main spring J, until the trigger K engages in front of the projection S on the striker and holds it back; the gun can then be fired by means of a lanyard hooked to the trigger at Y.

Q.F. Mechanisms.—Of the smaller descriptions, the Hotchkiss (Figs. 15, 16, 17) is the one chiefly in use. The breech is closed by a wedge (A) actuated by a crank (B) and handles, the turning of which causes a projection (M) to bear on the toe (N) of a rocking shaft (E), which in revolving effects the cocking. On closing the breech, a trigger sear (G) comes up under a trigger, which on being pulled forces down the sear, releases it from the cock notch, and allows the hammer D to fly forward and fire the gun. An extractor for throwing out the cartridge case is actuated by a groove in the wedge. Of the mechanisms for the heavier descriptions employing breech screws, one of the earlier types will be found on many 4·7-inch guns (Figs. 18, 19, 20, 21). A cam lever is employed to lock, turn, and swing the coned screw, which is carried on an arm. A striker is used, which for percussion firing is automatically cocked in opening the breech. The latest type is often known as the "single motion," having been one of the first of this kind introduced. It will be found in the more modern Q.F. guns such as the 12-prs., and also on the later-built 4·7-inch and 6-inch (Figs. 22, 23, 24, 25). The action is as follows: On drawing the lever F from left to right, the link G and sliding block H are moved in the same direction. In the block is a gun-metal bush (V) with vertical play, and in the bush a stud (D) from the breech screw. Consequently this stud travels with a circular motion from left to right, and so turns the screw until it is held on the arm by a catch; an extractor to start the cartridge case is acted on at C (Fig. 25) by the carrier arm in swinging round. A striker for electric and percussion firing is provided. For percussion firing this striker has to be withdrawn by hand until held by the trigger T. The arrangement shown at E is purely one of safety, and keeps the striker needle off the primer or tube at all times except when the lever F is properly home. On the first movement of this lever, a groove on the top of it acts on the turning lever S at the bottom of the spindle E, and causes it and a cam projection on top to turn; the cam then presses against the part I of the striker and forces it back. (C. P. M.)

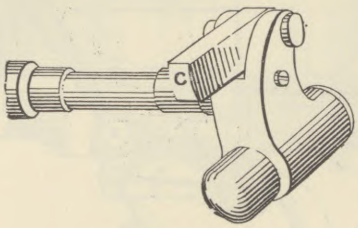


FIG. 25.—Extractor.

(*b*) AMMUNITION.

The smokeless propellant adopted by the British Government is known as "cordite" (see PROPELLANTS). It is used for all arms, the only variation being in the diameter and length of the sticks employed. On account of the importance of a clear front, in order to sustain a rapid fire, smokeless powder is a necessity with quick-firing guns, and confers advantages upon the defenders of a position which can scarcely be too highly estimated.

Cartridges.—The charge of a gun is made up in a convenient form for handling and loading, for which purpose the cordite is enclosed in a cartridge, made of silk cloth or of red shalloon. These materials fulfil the necessary conditions for a cartridge: to be strong enough to bear reasonable knocking about on service, to allow the flash from the tube to penetrate and still be of close texture, and—most important—to consume entirely and not leave smouldering fragments in the bore.

Cordite is somewhat difficult to ignite in a gun, and so every cartridge has a primer of fine-grain gunpowder, placed so as to intercept the flash from the tube; the outer side of this primer is made of shalloon, to allow the flash to penetrate with greater ease. The charge for heavy guns, above the 6-inch, is made up in separate cartridges containing $\frac{1}{2}$ and $\frac{1}{4}$ charges, both for convenience in handling and to allow a reduced charge to be used. In order to ensure uniform results, the space allowed for the charge in the chamber of the gun should not vary from round to round.

For B.L. guns, below the 6-inch, the cartridge consists of a bundle of cordite, inserted in a cylindrical bag, of shalloon for the field guns (12-pr. and 15-pr.), and of silk cloth for the remainder. These cartridges have a primer of fine-grain powder covering each end, except the 15-pr., which has a piece of gun-cotton yarn wrapped round each end.

The cartridges for B.L. guns, 6-inch and upwards, are generally similar; some are cylindrical and some slightly coned. Fig. 1 shows a typical coned cartridge. The cordite is built up in layers, and tied tightly with silk. The bag is silk cloth, the top being closed by the primer stitched on. A silk cord becket runs up the centre, forming a loop outside the top. Above the primer is a millboard and silk cloth cover, lightly attached, and intended to be removed before loading, for which purpose it is provided with a loop, upon which the words "Tear off" are printed.

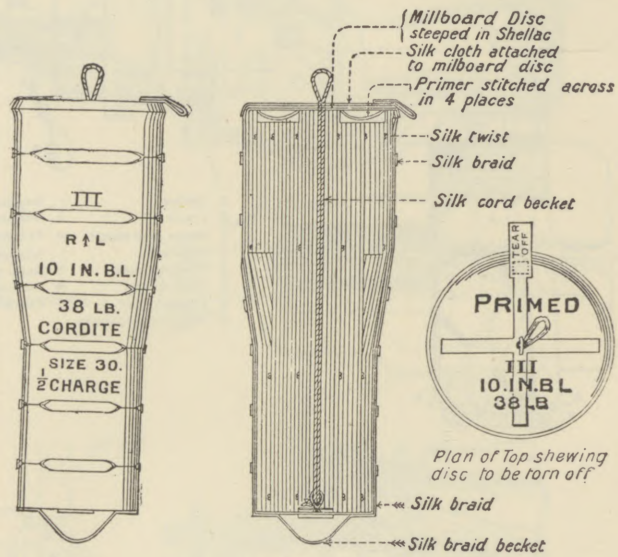


FIG. 1.—10-inch B.L. Gun Cartridge.

Howitzers, being designed to give a plunging fire, require different charges, and the charge must be made up so that its weight can be easily altered. B.L. howitzer cartridges are all made on the same model, the material being shalloon. Small-sized cordite is used, and the charge is formed of a mushroom-shaped core, on the stalk of which three rings containing cordite are placed. The bottom

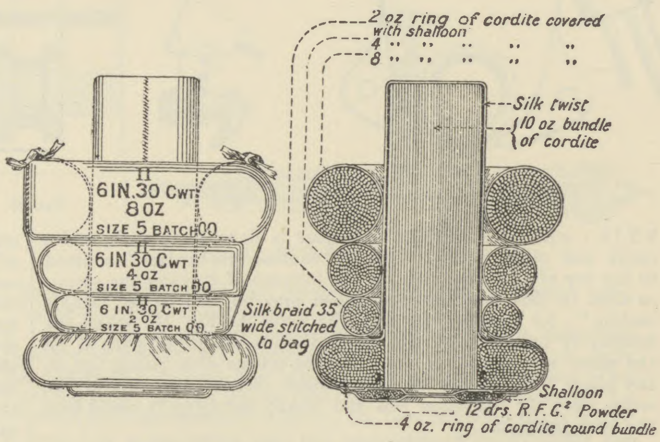


FIG. 2.—6-inch B.L. Howitzer Cartridge.

of the core contains the primer. The rings can be tied to the core by two silk braids, and thus a handy means of varying the charge is provided, since the core alone, or core and one or more rings, may be used (Fig. 2). The table at the end gives the weights of a few important cartridges.

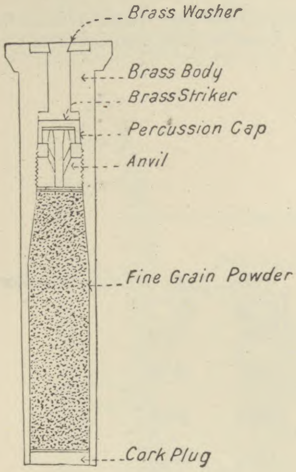


FIG. 3.

These cartridges are ignited in the gun by means of "tubes," fired by percussion, electricity, or friction. They are known as "vent-sealing tubes," by which is understood a tube which fits accurately into the top of the vent and is held in it by the lock of the gun. The force of the explosion expands the tube against the walls of the vent, and so prevents escape of gas past it, while the internal arrangements of the tube preclude the possibility of gas forcing its way through. This system is necessary because B.L. guns are axially vented, and the forcible expulsion of a tube might injure the men behind the gun; and also because the rush

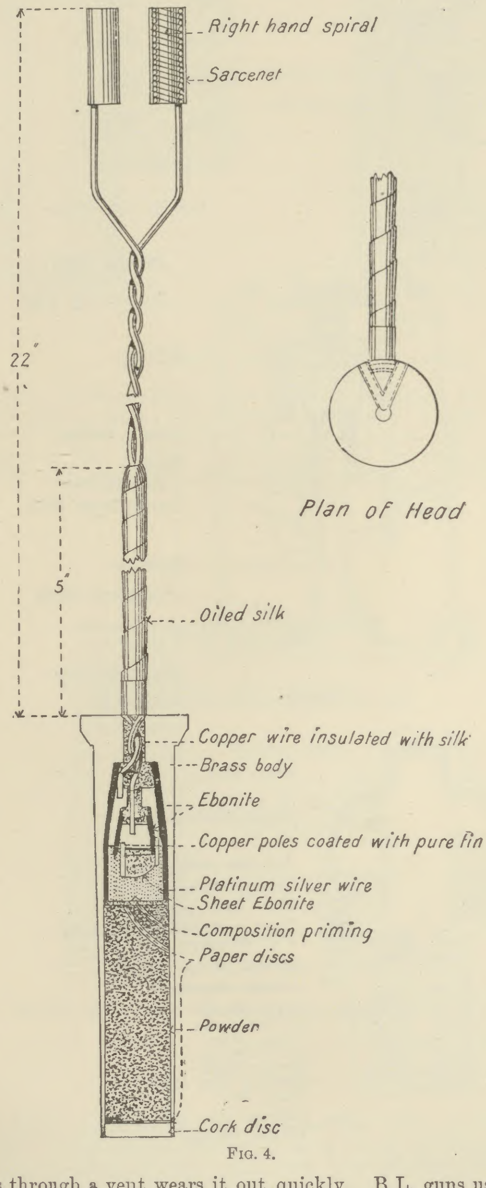


FIG. 4.

of gas through a vent wears it out quickly. B.L. guns use tubes designated by the letter "P," except in the case of field guns and howitzers, which take "T" friction tubes. There are three "P" tubes, one percussion and two electric. The "T" tube is held in the vent by a bayonet joint at the end of the vent. The outer dimensions of the three "P" tubes are the same; their construction will be understood from the figures.

Fig. 3.—The percussion tube has a striker, below which is a percussion cap on an anvil, the body of the tube being filled with pistol powder. The striker of the gun lock forces the striker against the cap and so fires the tube.

Fig. 4.—The *Electric "P" tube* has two insulated wires led into the interior and attached to two insulated brass cones. These cones are connected by a thin wire or "bridge" of platinum-silver, which is surrounded by "priming composition" (gun-cotton dust and mealed powder). The remainder of the tube is filled with powder. The tube is held in by the lock and the wires connected to the leads from a battery; on a current passing, the bridge is heated to incandescence and thus fires the priming composition.

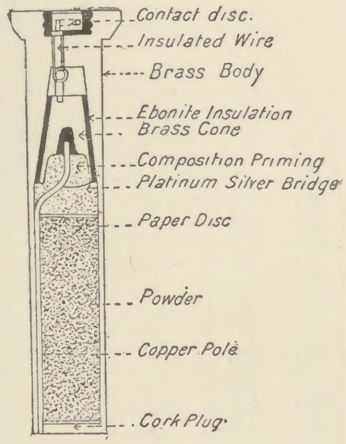


FIG. 5.

Fig. 5.—In the *Wireless Electric "P" tube* the mechanism of the lock makes electrical contact with an insulated patch in the head of the tube. This patch is connected by an insulated wire with a brass cone, also insulated, between which and the side of the tube is the "bridge," surrounded by priming composition. The current passes through the lock to the insulated patch, thence through the bridge, which it heats, to the side of the tube, and back to the battery through the metal of the gun and mounting—technically known as an "earth return." This tube is used by guns having "wireless" electric locks.

Fig. 6.—The "T" tube is simple in its construction. The head fits into the bayonet joint, and the tube is fired by the withdrawal of the friction wire by means of a lanyard, which fires the friction

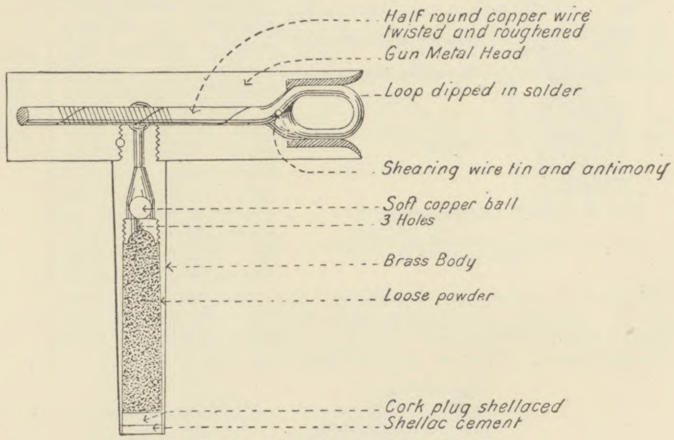


FIG. 6.

composition and so the tube. The copper ball is driven by the explosion into the cone above it, and so prevents escape of gas through the tube. The larger muzzle-loading guns use vent-sealing tubes, friction and electric; distinguished by the letter "V."

Projectiles.—The following projectiles, which will be briefly considered in their order, are fired from B.L. guns: common, lyddite, and shrapnel shell, armour-piercing (A.P.) shot and shell, and case shot. A few fire star-shell, and Palliser shot are occasionally used. The shells are made of steel.

For the same calibre, the weight of a modern B.L. projectile is greater than that of a R.M.L.; for example:—

12-inch R.M.L., weight of projectile, 714 lb.
12-inch B.L. Mark VIII., weight of projectile, 850 lb.

A convenient way of expressing the relation between the weight of a projectile and the calibre of the gun is given by the fraction $\frac{w}{d^3}$

(w=weight of projectile in pounds, d=diameter of bore in inches). For the latest guns $\frac{w}{d^3}$ is approximately equal to 0·5.

These projectiles are caused to rotate by a "driving band" of copper, pressed into a groove round the base, which takes the rifling of the gun. It is known as the "Vavasseur broad driving band." The heavier projectiles have a driving band with a lip or gas-check.

This is intended to prevent rush of gas past it and so help to lessen the erosion of the bore. A white band painted round a projectile near the point denotes that it is made of steel, though all steel shells have not got it; and a red band signifies that the shell is filled or "live."

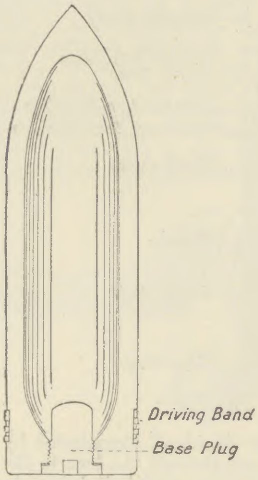


Fig. 7.—Pointed Common Shell (cast steel).

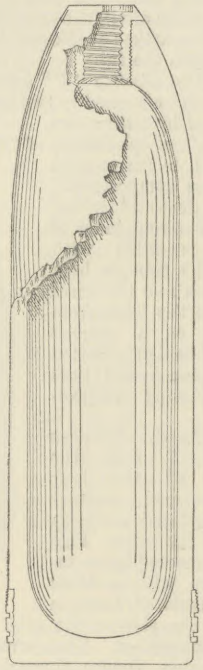


Fig 8.—Lyddite Shell (forged steel).

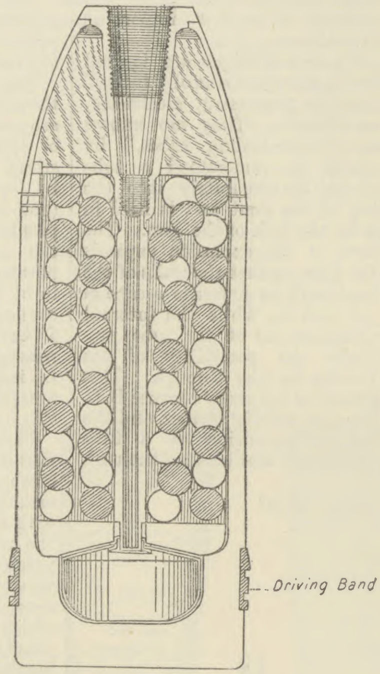


Fig. 9.—Shrapnel Shell (steel).

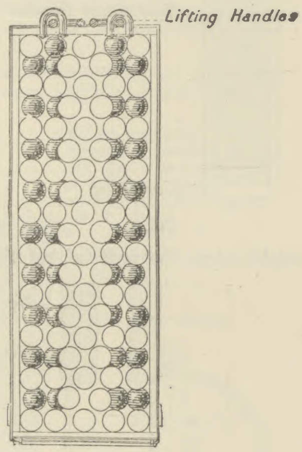


Fig. 10.—Case Shot.

Common shells are of two sorts, the ordinary common taking a fuze in the nose, and the pointed common taking a base fuze. These shell are really locomotive mines containing bursting charges of powder. The bursting charge is in a bag, to prevent premature ignition from friction with the walls of the shell, and consists of a mixture of pebble and fine-grain powders, known as "P" mixture. A common shell will penetrate a little over half its calibre of Harveyed steel with a striking velocity of 2000 feet per second. They are painted black (Fig. 7).

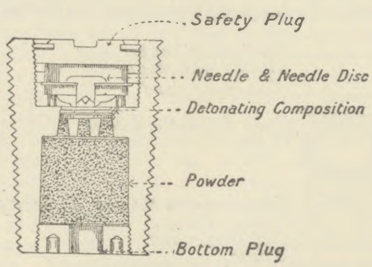


Fig. 11.—Direct-Action Percussion Fuze (scale ⅝).

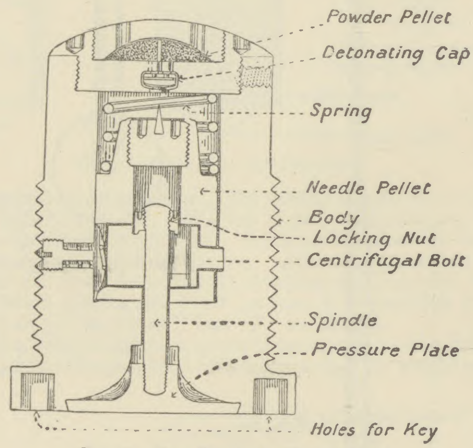


Fig. 12.—Base Percussion Fuze (scale ⅝)

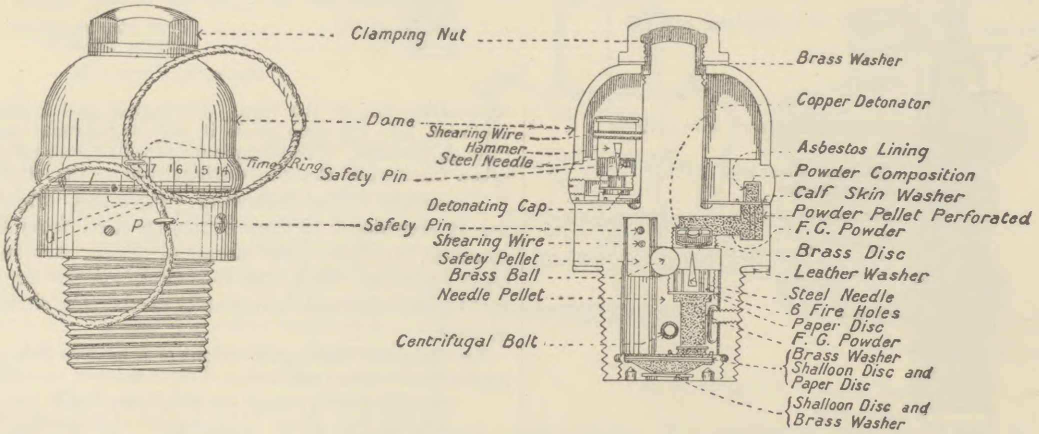


Fig. 13.—Time and Percussion Fuze (scale ⅝).

The long-felt want of a shell containing a high explosive, to be detonated on impact, is now supplied by *lyddite shells.* These are carefully made of forged steel with a solid base, to prevent an chance of premature explosion in the gun, which would be disastro

They resemble common shell. The shell is filled with lyddite, with a central hole for the exploder; a percussion fuze is used. The same shell will contain a greater weight of lyddite than of P mixture, and roughly the explosive effect of a lyddite shell may be taken as about three times as great as that of a powder shell of the same size. Lyddite shells, when properly detonated, have great local shattering effect; the tough steel is broken up into a large number of fragments, ranging in size from a pea to pieces weighing three or four pounds. These pieces are projected in every direction with great force, some even having a backward effect. The greatest effect is perhaps to the right and left of the line of fire, and any living creature near the explosion would be riddled by tiny fragments of steel. It has been stated that the blast kills at considerable distances, but the evidence of this is inconclusive, and the effect may rather be looked for in the small pieces of steel. In this respect the effect is entirely different from that of a powder charge, which would tear the same shell into a few large pieces and would have no backward effect at all. Lyddite shells are used with B.L. and Q.F. guns, the smallest being the 4-inch. The largest at present is the 10-inch. They are practically the only shell fired from the 5-inch and 6-inch B.L. howitzers. They are painted yellow (Fig. 8).

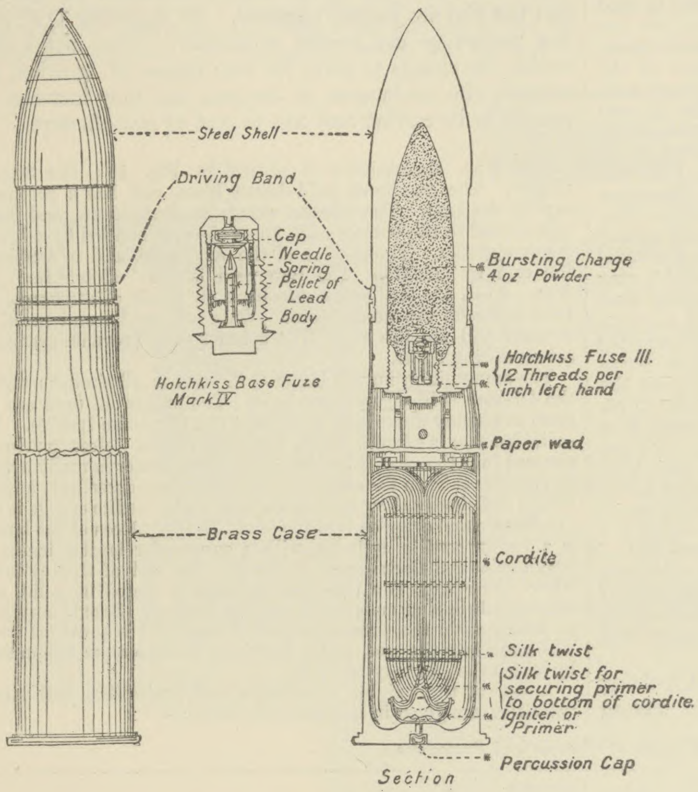


FIG 14.—6-pr. Q.F. Cartridge (scale ⅓).

The *shrapnel* shell is essentially a man-killing projectile, and depends for its effect upon the number of bullets it contains. The bursting charge is in the base, and is only sufficient to blow off the head, which is lightly attached, and thus release the bullets with which the body of the shell is filled. A central pipe conveys the flash from the fuze to the bursting charge. A time fuze is used, and is set so as to burst the shell while it is in the air, from 60 to 80 yards short of the target, and the bullets then stream forward in a cone-shaped shower, covering a large front. For effect the bullets should have a striking velocity of not less than 400 feet per second. Field guns use practically only shrapnel. They are painted black with a red tip (Fig. 9).

Armour-piercing shot are fired from the heavier guns, and, as their name indicates, are used for the destruction of armour, and have no bursting charge. They are pointed projectiles made of steel specially hardened. Roughly, with a striking velocity of 2000 feet per second an A.P. shot should perforate two calibres of wrought iron, one calibre of Harveyed steel, or ⅘ calibre of Krupped armour. They are painted black with a white tip and a white band below it. A.P. shells are fired from B.L. and Q.F. guns, and are made of hardened steel. They have a small bursting charge of powder and a base fuze. They are thicker in the point and shoulder than a common shell. Their penetrative power is slightly below that of A.P. shot. They are painted black with two white bands near the tip.

Case shot are fired from the majority of B.L. guns, and are used at short ranges. They consist merely of a weak envelope filled with bullets. The envelope must be strong enough not to break up before leaving the gun (Fig. 10).

In order to explode shell at the right moment "fuzes" are used. These are either "percussion" (of which there are two descriptions, one to act on "impact" and the other on "graze") or "time" fuzes, which can be set so as to act after some predetermined interval of time. Time fuzes usually contain an alternative percussion arrangement, and are known as "time and percussion" fuzes. An example of each kind is illustrated in the figures.

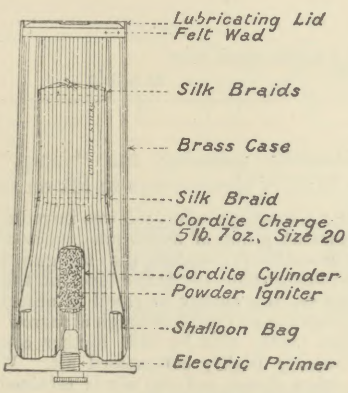


FIG. 15.—4·7-inch Q.F. Cartridge (greatly reduced scale).

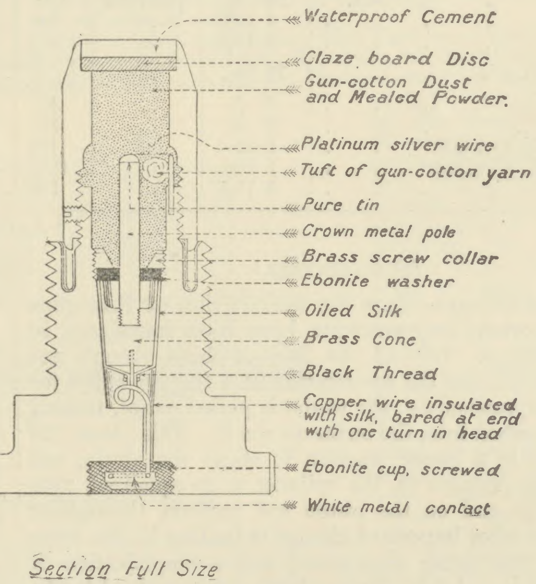


FIG. 16.—Electric Primer

The *direct-action* fuze is intended to act upon impact, and its construction will be understood from the figure. On impact the needle is crushed in against the detonator and so fires the fuze. This fuze screws into the nose of the shell (Fig. 11).

The *base fuze* is of the graze type. In it a needle pellet is prevented from movement by a "centrifugal bolt," which has a heavy head and is withdrawn by the spin of the shell, thus unlocking the pellet and permitting it to strike the detonator, when the shell is checked by grazing. For safety the centrifugal bolt is kept in position by a locking nut on a spindle connected to a pressure plate, which is forced in on discharge and so raises the nut. The spiral spring round the top of the pellet prevents premature action while the shell is in flight. This fuze is used with pointed common and A.P. shell (Fig. 12).

The time and percussion fuze consists of two distinct parts. The lower half of the fuze contains the percussion part, on the graze principle. A needle pellet is locked by a centrifugal bolt, as in the base fuze, and has also a ball preventing its forward movement. This ball is kept in place by the safety pellet, which is suspended on a shearing wire. On discharge the inertia of the pellet breaks this wire, the pellet falls into a recess, and the ball follows it. On graze the needle pellet flies forward. Connecting this part with the time part is a channel filled with powder. Opposite this channel, on the outside of the fuze, is the setting mark, a black triangle. The time part consists of a ring covered by a dome and clamped by a nut. On the under side of this ring is a groove, running nearly round, filled with slow-burning composition. At one end of the composition is a percussion cap with a hammer suspended on a thin wire above it. On discharge the hammer falls and lights the end of the composition, which burns slowly round until it reaches the connecting channel, when the fuze is fired. The outside of the ring is graduated from 0 to 18, and the fuze is set by turning the ring till the required graduation is opposite the setting mark, and clamping the nut. The gas evolved by the burning composition escapes through a side hole. Before use the safety pellet and the hammer are supported by safety pins, which are withdrawn before loading. The fuze burns about 12·5 seconds, corresponding to a range of about 3700 yards in the 12-pr. of 6 cwt., or 4100 yards in the 15-pr. A larger fuze of similar design burns 16 seconds. These fuzes are used in shrapnel shell (Fig. 13). A fuze of similar size and design to the first of the two above described, but burning for 22 seconds, has recently been issued. This time fuze corresponds to a range of about 5800 yards in both these guns.

Q.F. Ammunition.—The ammunition for quick-firing (Q.F.) guns differs from that already described in having the charge enclosed in a metal case, containing means of ignition at the base. The case acts as an obturator by being expanded against the inside of the gun. In the smallest Q.F. guns, the 6-pr. and 3-pr., "fixed ammunition" is used; that is, the shell is attached to the case and the two are loaded together. In the other Q.F. guns the projectiles are loaded separately. The metal cases enable the charge to carry its own means of ignition, and simplify the mechanism of the gun, but they increase the weight to be carried and add to cost of manufacture.

The 6-pr. ammunition is shown in Fig. 14; the 3-pr. is similar. The case is of solid-drawn brass, and has a percussion cap in the base. The cordite charge is dropped in, and has a primer tied to the bottom; the space above it is filled by a brown-paper cylinder. The shell is of the A.P. type, and is secured in the case by indents. The fuze used is the "Hotchkiss" base fuze. In it, the lead pellet sets back on shock of discharge, and thus unmasks the needle point. On graze, needle and pellet fly forward and fire the cap. The spiral spring prevents premature action during flight.

The ammunition for the larger Q.F. guns is all similar; that of the 4·7-inch is illustrated as a type. The projectiles fired are the same as already described; all except the 12-pr. fire lyddite. The cartridge case is of solid-drawn brass, having an "electric primer" screwed into the base (Figs. 15, 16). This primer is really a wireless electric tube on the same principle as already described; and the figures sufficiently show its construction. The cordite charge is tied in a bundle and dropped into the case. In the bottom of the bundle is a hollow cordite cylinder, with a gunpowder igniter inside it. The nose of the electric primer fits into the end of this cylinder. Above the charge is a wad, and the case is closed by a lid, containing lubricating material to prevent fouling. Should anything go wrong with the primer, a steel "adapter" is provided which will screw into the case, and is bored out to take a percussion tube, by which the gun may be fired.

A few of the weights of charges and projectiles, and muzzle velocities, are given in the following table:—

Table of Weights of Charges and Projectiles.

Gun.	Weight of Charge. Cordite.	Made up in ½ or ¼ Cartridges.	Weight of Projectile.	Bursting Charge of Common Shell.	Muzzle Velocity. Feet per Second.	Remarks.
	lb oz.		lb	lb oz.		
13·5-inch B.L. gun . . .	187 0	½ and ¼	1250	85 9	2016	
12 ,, ,, Mark VIII.	174 0	,, ,,	850	80 13½	2367	
9·2 ,, ,, ,, IX. & X.	103 0	,, ,,	380	31 14	2643	Lyddite shell for all 9·2-inch guns in land service
6 ,, ,, ,, VII.	20 0	½ and full	100	9 13	2493	Lyddite shell
15-pr. ,, . . .	0 15¾	...	14	...	1569	Only shrapnel and case shot
12-pr. ,, . . .	0 11 7/16	...	12½	...	1553	,, ,, ,,
6-inch Q.F. gun . . .	13 14	...	Same as 6-inch B.L.	Same as 6-inch B.L.	2154	Fires lyddite shell
4·7 ,, ,, . . .	5 7	...	45	4 14	2150	,, ,,
4 ,, ,, . . .	3 9	...	25	3 3	2300	,, ,,
12-pr. of 12 cwt. Q.F. . .	1 15	...	12½	1 8½	2197	
6-inch B.L. Howitzer . .	1 12	...	120	18 14 *	779	Lyddite shell only
5 ,, ,, . . .	0 11 7/16	...	50	9 15 *	782	,, ,, as a rule

* Lyddite.

T. H. C.

(c) CARRIAGES.[1]

Coast Artillery.—Since the introduction of B.L. guns many important improvements have been introduced in gun mountings. One of the first of these, though not entirely novel, was the substitution of a tension buffer for one in compression, *i.e.*, the piston is pulled out of, instead of being pushed into, the buffer on recoil. This places the piston rod in a better position to stand the strain, and enables the pressure in the cylinder to be equalized, thus making the pull on the piston rod uniform throughout recoil. Another important change is loading in the firing position, time being thus saved and a simplification of gears effected. Again, the gun-layer can now stand to the hand-wheel whilst the gun is fired. An improvement in the principle of construction was the lowering of the carriage, considerably reducing the "jump," *i.e.*, the tendency of the front of the carriage to lift on firing.

Hydro-Pneumatic Mountings.—In 1888 was introduced the first of a large and important group of hydro-pneumatic disappearing mountings. The essential principle is that the gun, mounted on a low site, shall on firing recoil below the level of the protecting parapet. In doing so, the energy of recoil is absorbed, chiefly by forcing a large volume of liquid through a narrow opening or "recoil valve," but partly also by still further compressing a large volume of already highly compressed air. When recoil ceases the recoil valve closes, and the air is retained at a very high pressure, ready to raise the gun to the firing position again after loading.

Fig. 1 shows a general view of the 6-inch B.L. disappearing mounting, Mark IV.; Fig. 2 is a vertical, and Fig. 3 a transverse section through the recoil cylinder.

The gun trunnions (Fig. 1) are supported by the two arms of the elevator A, which is pivoted to the front of the lower carriage at B. The breech is supported by the two elevating bars C, whose lower ends are attached to the elevating arcs D. These arcs are worked by the elevating gear actuated by the hand-wheel E. The arcs are struck with the bars C as radii and their centres are

[1] The following abbreviations are employed in this article. R.M.L., Rifled muzzle-loader. B.L., Breech-loader. Q.F., Quick-Firing. H.P., Hydro-pneumatic.

the positions of the upper ends of these bars with the gun in the loading position, so that elevation can be given whilst the gun is being loaded. The lower carriage rests on a ring of live rollers G which are free to traverse round on a circular racer H, motion being given by traversing gear actuated by the hand-wheel I. Supported by vertical stanchions attached to the lower carriage is a horizontal circular shield J through which the gun rises to the firing position. Shield sights by which the gun can be laid for line are shown at KK. The manganese bronze ram F which is attached to the elevator by the crosshead L, is forced on recoil into the central chamber of the recoil cylinder (Figs. 2 and 3), the cylinder being supported by trunnions resting in the brackets of the lower carriage at M. There are ten chambers NN[1] (Figs. 2, 3) all of which are connected at the bottom with the recoil valve chamber O, and therefore with one another. Nine of these contain liquid in their lower portions, and highly compressed air above, and are connected at the top by a channel P to equalize the pressures in each chamber. The tenth chamber N′, which is

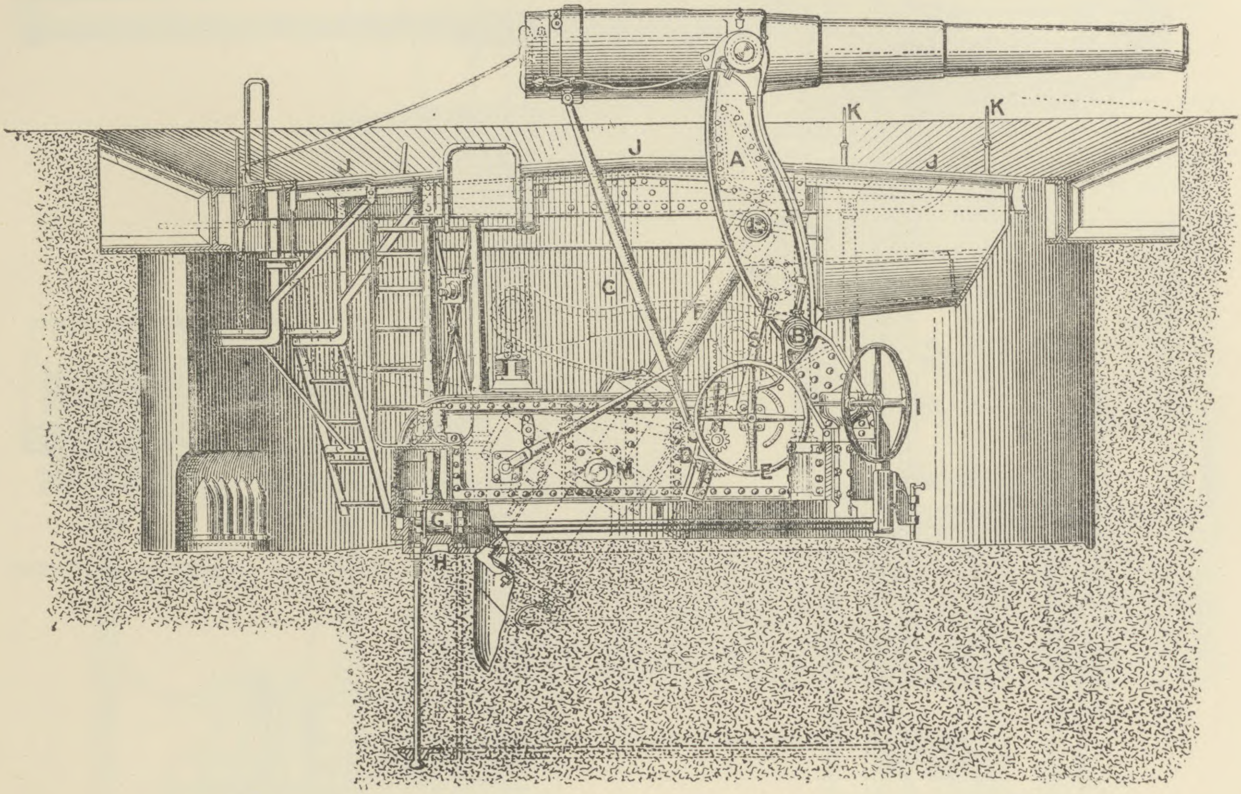


Fig. 1.—Diagram of a 6-inch B.L. Disappearing Mounting, Mark IV.

situated lowest in the cylinder, contains liquid alone, and has at its upper end the raising valve Q. On recoil, the liquid in the central chamber is forced by the ram through the recoil valve R, into the outer chambers N, thus further compressing the air. R being a non-return valve the air is maintained in this highly used consists of methylated spirits, mineral oil, distilled water, and carbonate of soda.

Heavy Barbette Mountings.—Figs. 4 and 5 represent the Mark V. mounting for the 9·2-inch B.L. gun, the latest development in heavy barbette mountings. Though resembling the H.P. group in the joint use of liquid and air, this mounting possesses the great advantage of having a separate chamber for each, thus eliminating aëration.

9·2-inch Mounting.—Fig. 5 shows a general view of the mounting, Fig. 4 a longitudinal section through the cradle to a larger scale. The gun, which is trunnionless, and to which is attached the crosshead A, recoils in the cradle C, supported by guides D, which slide in longitudinal grooves in the cradle. To the crosshead is attached the buffer cylinder B, so that on recoil, the gun, guides, crosshead, and buffer move together. The cradle of cast

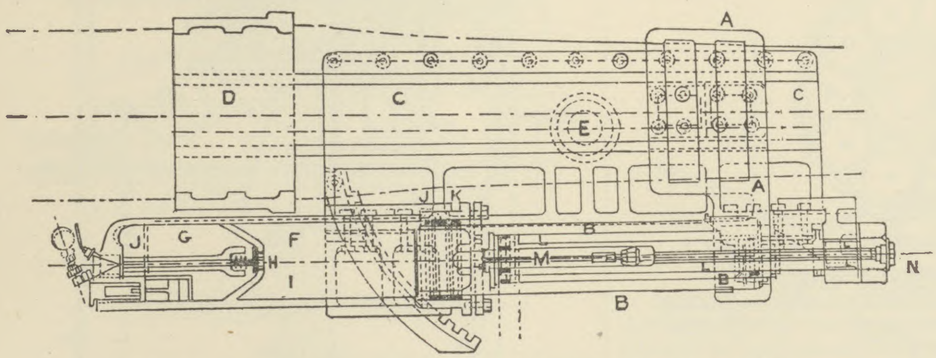


Fig. 4.—Longitudinal section through cradle of 9·2-inch B.L. Gun shown in Fig. 5.

compressed state during loading. The gun is raised by pushing the lever S (Fig. 1) to the front, which actuates the rack T, thus opening Q, which allows the air in the nine chambers to force liquid from the tenth chamber N′ into the central ram chamber, lifting the ram. U is a pump by which the gun can be pumped down at drill. Worked by the lever V, it sucks the liquid from the ram chamber and delivers it against the air-pressure into the nine chambers N.

A serious drawback to this type of mounting is the aëration of the liquid due to the churning it receives on recoil. The liquid steel with trunnions E resting in trunnion holes in the lower carriage, has attached to it in rear the air-chambers F and G in one manganese bronze casting, in which a high initial pressure is maintained. To the front of the cradle is attached the piston and piston rod L, in one forging. On recoil the buffer is drawn over the piston, whilst simultaneously the buffer cylinder is forced into the front air-chamber F, further compressing the air and forcing the bulk of it through the valve H into the inner chamber G. At the conclusion of recoil the expansion of the air forces the buffer, and with it the gun, to the front. The valve H closes and the air has to pass through a narrow hole before it can act on the end of the buffer, thus preventing any violent action. To prevent leakage of air between the air-chamber and buffer there is an ingenious arrangement consisting of a gland K, packed with a viscous liquid. This liquid packing is in communication with an "intensifier" I by means of a pipe J. This consists of a cylinder containing a piston and rod, the front face of which is in communication with the air-chamber, whilst in rear of it there is liquid communicating with the pipe. On recoil, since the front face of the piston is greater than the rear, the pressure exerted

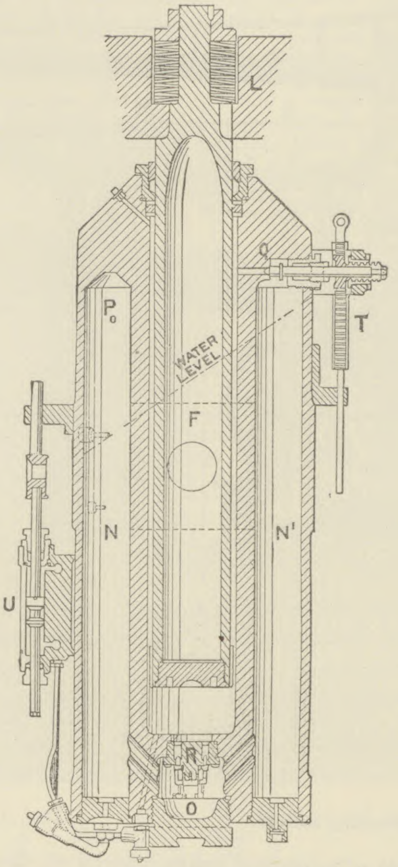


Fig. 2.—Vertical Section through Recoil Cylinder of Fig. 1 (on enlarged scale).

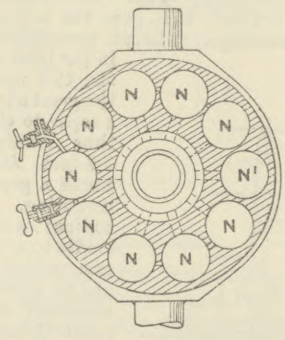


Fig. 3.—Transverse Section through Recoil Cylinder of Fig. 1 (on enlarged scale).

on the liquid is greater than that of the air, and the gland K is made air-tight. To prevent the gun from returning too violently to the firing position there is a "control ram" M bolted into the rear end of the buffer, the action of which is the same as that described for the 6-inch Q.F. It is adjusted by means of a long valve spindle and sleeve projecting from the end of the piston-rod at N. To lessen the labour of elevating, the cradle trunnions are supported on a ring of hard steel balls, but since the jar of firing would damage them, it is arranged that the trunnions shall take a bearing in the solid trunnion holes of the lower carriage at the instant of firing. The mounting is supplied with an automatic sight, and the gears used for elevating and traversing the gun present no very special features. The arrangements for loading present a good example of the way in which heavy charges are

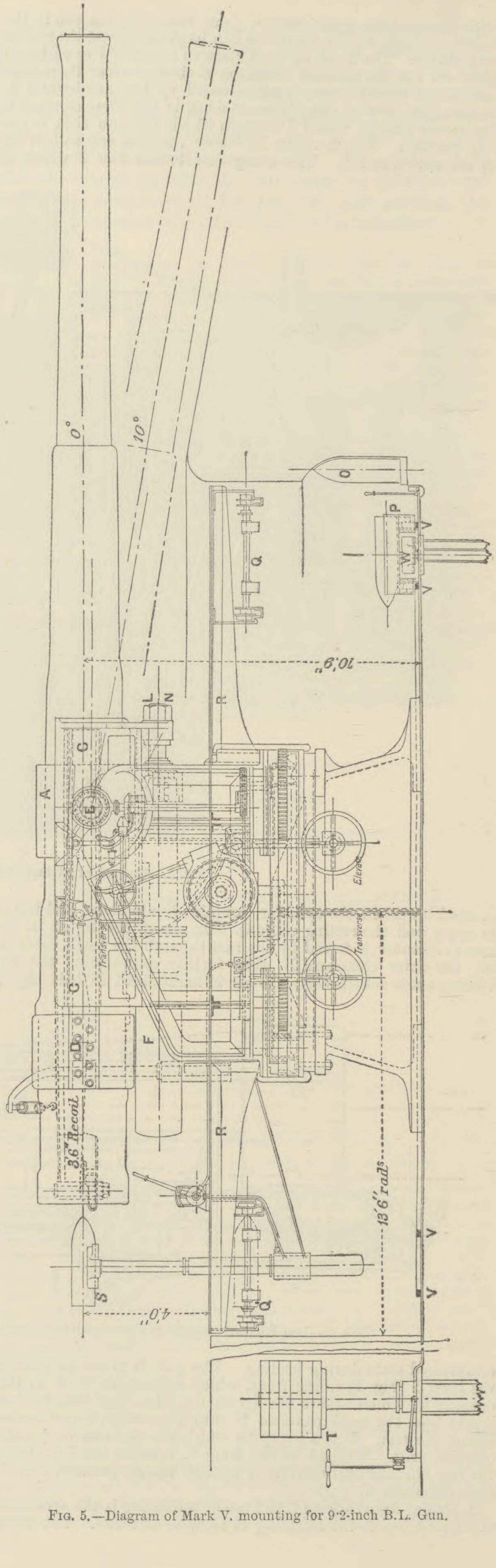


Fig. 5.—Diagram of Mark V. mounting for 9·2-inch B.L. Gun.

handled. The projectiles as seen in the recess at O are tilted into the carrier P, which runs on the circular rails V until the shot is over the ram W by which it is raised, and transferred to the carrier Q, which runs on circular rails underneath the shield RR to Q′. Here it is raised by the ram S, until opposite the breech. There is a hydraulic accumulator, T.

Quick-firing Gun Mountings.—In 1890 the first of the important group of Q.F. gun mountings was introduced, and the

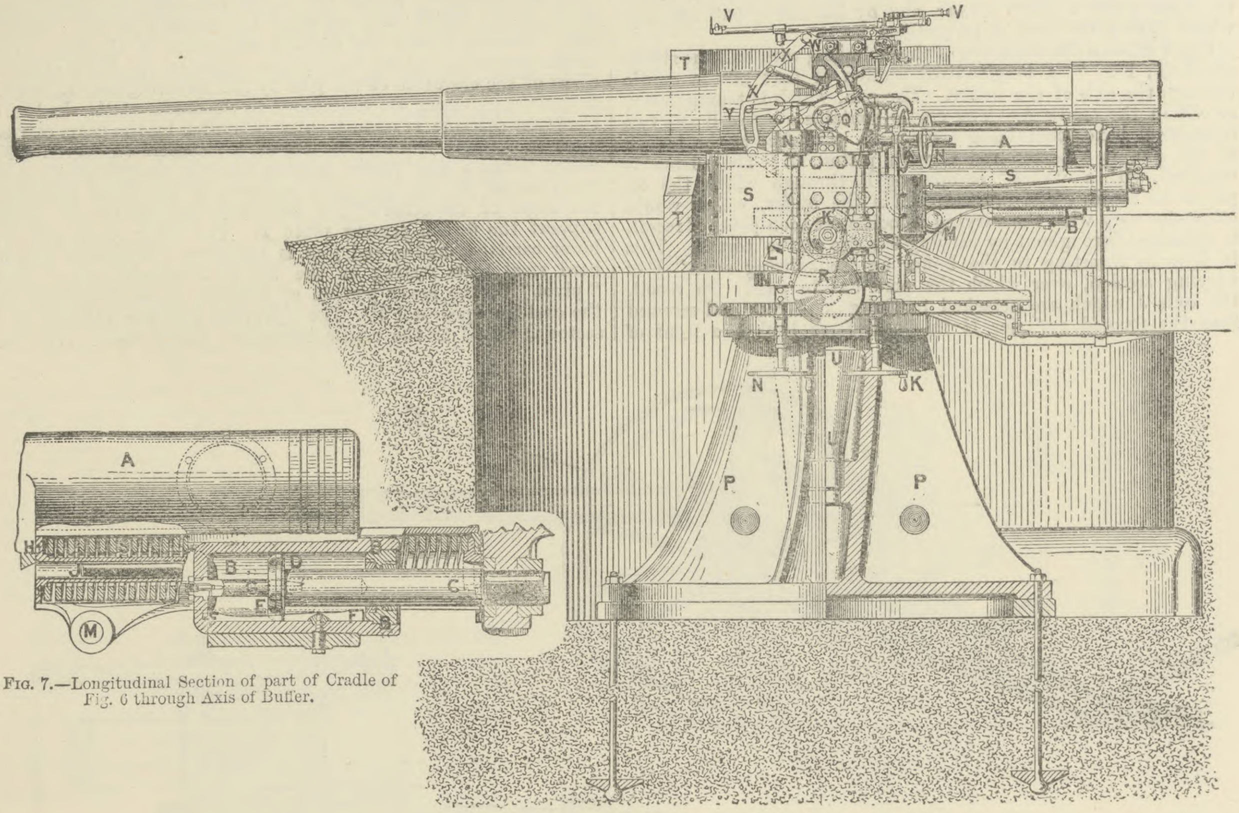


Fig. 7.—Longitudinal Section of part of Cradle of Fig. 6 through Axis of Buffer.

Fig. 6.—Diagram of Side Elevation of 6-inch Mounting, with half of Shield removed.

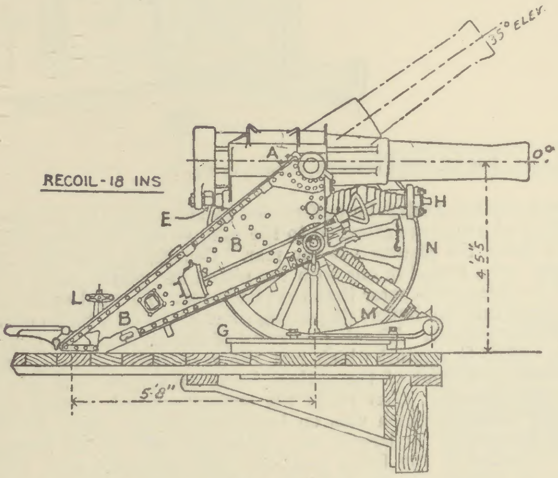


Fig. 8.—Diagram of 6-inch B.L. Siege Howitzer.

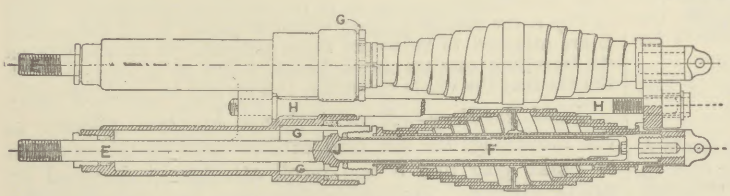


Fig. 10.—Hydraulic Buffers of 6-inch B.L. Siege Howitzer.

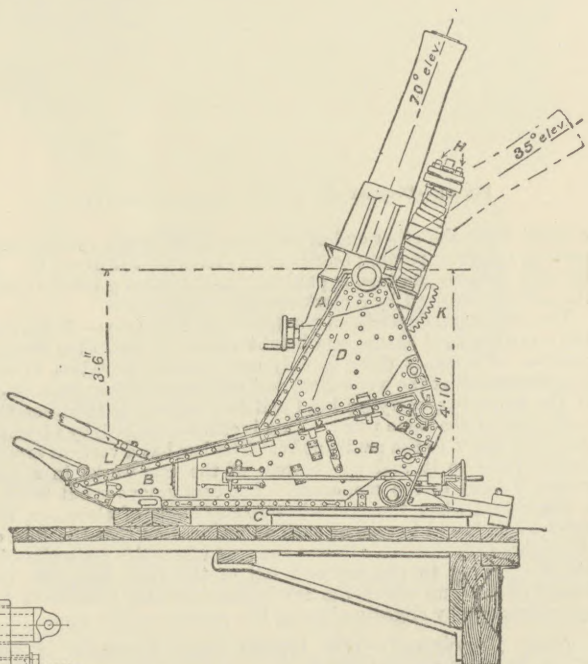


Fig. 9.—Showing Fig. 8 lowered and with Wheel removed.

latest development of this type is the Mark II. mounting for the 6-inch gun.

Six-inch Mounting (Figs. 6, 7).—The principles aimed at in its design are—

1st, Compactness; 2nd, adequate protection for the gun detachment, gears, mounting and breech of gun; 3rd, increased rate of fire, by arranging that the gun shall return to and be loaded in the firing position, at any angle of elevation, instantly after recoil; by enabling the gun-layer personally to elevate and train the gun; by the introduction of "an automatic sight," thus doing away with the necessity for setting sights, and making the gun independent of range-finders; by placing the sights on the cradle, thus enabling the layer to keep his eye to the sight whilst actually firing; and by the use of ball bearings which lighten the work of traversing.

Fig. 6 shows a side elevation of the mounting with half the shield removed; Fig. 7, a longitudinal section of part of the cradle through the axis of the buffer. The gun, which is trunnionless, recoils in the cradle A. The cradle contains a buffer B and two cylindrical boxes containing springs S. Attached to the breech of the gun is a piston-rod C with piston D. The piston is supplied with a "port" or opening E, through which the oil passes on recoil. The pressure inside the buffer, which would otherwise vary with the varying velocities at each point of recoil, is equalized throughout by varying the size of the port E. This is done by inserting in the buffer an "equalizing strip" F of varying section, over which the port has to pass. On recoil, the rods J which are attached to the gun in rear and screwed into the flanged cylinder H in front, force back the front of the springs S, whose rear ends butt up against the rear of the spring boxes. After recoil the springs return the gun to the firing position. To prevent their doing this too violently, the piston rod has a cylindrical hole in front which becomes filled with oil on recoil. Before the piston can come up against the front of the buffer, this oil must be displaced by the "control ram" G which checks the forward movement of the gun. The cradle trunnions resting in trunnion holes in the lower carriage allow of the elevation of the gun by the elevating gear K, which drives the elevating arc L attached to the cradle at M. In Fig. 6 the lower carriage is almost entirely hidden by the gears carried upon it, namely the elevating gear K; the traversing gear N, which works a spur pinion gearing into the rack O attached to the pedestal P; the elevation indicator Q and R for recording the angle of elevation of the gun; and the brackets S which support the 6-inch armour plate T. The whole weight of the lower carriage, cradle, and gun is taken by a horizontal ring of hard steel balls resting on the top of a massive forged steel "pivot" U, the lower portion of which is shown supported in the cast-iron pedestal P. The elevation indicator consists of a sector Q bolted to the cradle trunnion. To its edge is attached

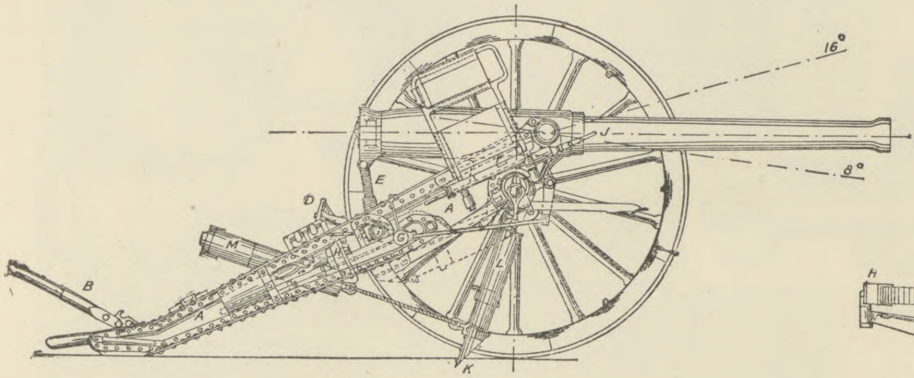


FIG. 11.—Diagram of 15-pr. B.L. Carriage, Mark III.

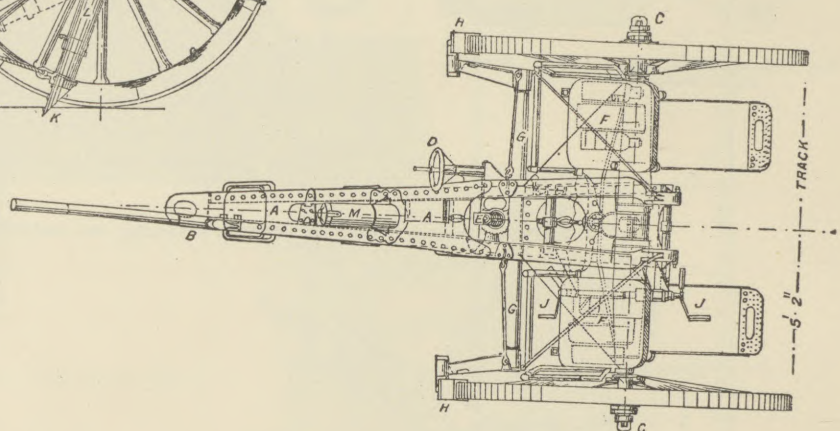


FIG. 12.—Plan of Carriage shown in Fig. 11

a metal tape, the other end of which is fixed to the spindle supporting a pointer reading angles of elevation on the drum R. As the gun elevates the tape is paid up, the slack being taken in and the pointer revolved by a clock spring.

The *Auto-sight* depends on the following principle:—If the gun has a certain fixed charge and height above the sea, then for any position of a target there is only one suitable elevation of the gun to strike it at the water-line, and only one suitable inclination of the sight bar, carrying hind and fore sights, to intersect the water-line at the same point. This is effected (Fig. 6) by pivoting the sight bar V to the cradle at W. The bar has a vertical arm X rigidly fixed to it, and the bottom of the arm works in a cam groove Y fixed to the mounting. The cam groove is cut to such a shape that when the gun takes up any angle of elevation, the sight bar is forced to assume such an inclination that the line of the sights cuts the water-line at the spot where the projectile will hit it. Owing to the rise and fall of the tide, however, the height of the gun above the sea varies, but this is allowed for approximately by slightly altering the position of the cam.

Siege Carriages.—The typical siege howitzer is the 6-inch B.L. of 30 cwt. (Figs. 8, 9, 10).

Six-inch Howitzer Carriage.—Fig. 8 shows the gun and cradle A mounted on its travelling carriage, from which it can be fired up to angles of 35°; whilst in Fig. 9 the wheels have been removed, the trail B has been lowered on to the pivot plate C, and secured to a pivot plug screwed into the plate; to the trail is fitted the top carriage D, and when the gun and cradle are mounted thus, 70° elevation can be given. The gun recoils through the cradle in which are two hydraulic buffers side by side (Fig. 10), the piston rods E of which are attached to the gun, so that the recoil of the gun draws the pistons J to the rear. Considering now the right buffer only, forged in one with the piston and piston-rod is a tail rod F of larger diameter than the piston-rod. This rod on recoil is dragged into the buffer, displacing some of the oil which entirely fills the cylinder. The displacement of the oil forces the front of the buffers G, against which rest the rear ends of the springs, forward, the front of the springs being prevented from moving by the rods H. After recoil the springs expand, setting up a liquid pressure which acts on both faces of the piston J. The rear face being the largest, the piston and with it the howitzer are returned to the firing position. The elevating gear, which can be placed on the left side of either the trail or the top carriage, actuates the arc K bolted to the left side of the cradle. The mounting, as in Fig. 8, is traversed by handspikes; whilst in Fig. 9, the ends of a chain which is passed round the capstan L are attached to hold-fasts right and left. With the gun on its travelling carriage an anchorage buffer M is used to check the recoil of the whole mounting, and springs to run it up again.

Field Artillery.—A great change has been effected in the mountings for the field artillery gun by the addition of brake gear and a non-recoil attachment designed by Sir G. Clarke. The object has been by controlling the recoil of the carriage to increase the rate of fire, and reduce the labour of running up. Most of the Continental Powers have tried to attain the same object, the usual plan being the adoption of some form of plough attached to the point of the trail, digging into the ground, and reducing recoil.

The design of field artillery guns and carriages is so absolutely limited by the weight that can fairly be put behind a team of six horses, that the field artillery equipment must necessarily be only a compromise.

Figs. 11 and 12 represent the Mark III. carriage for the 15-pr. B.L. gun—Fig. 11 in elevation, Fig. 12 in plan.

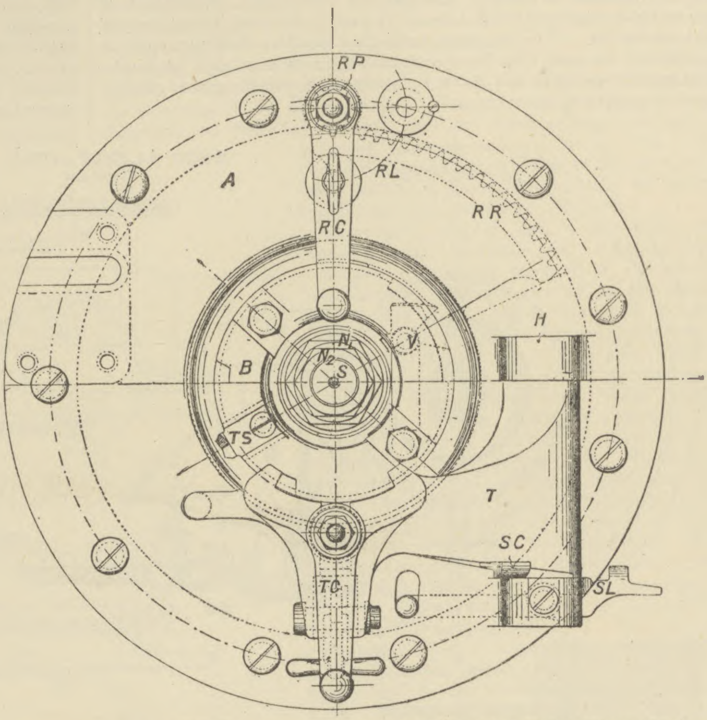
15-pr. Carriage.—The trail A is built up of plate and angle steel. There is a socket B for the handspike used in laying. The axletree C is of tubular steel and fastened to the breast of the trail. The elevating screw E is telescopic, thus giving increased rapidity in laying. It is worked by bevel gearing actuated by the hand-wheel D. Two rounds of ammunition are carried in each of the axletree boxes F, which are fitted as seats for the gunners. The travelling brake consists of the shaft G with arms and brake blocks H, the whole being forced on to the wheels when necessary by a system of levers and rods, actuated by the screw with handles J. The arrangement for checking recoil consists of a spade K attached to the bottom of a telescopic case, containing springs L, and hinged underneath the breast of the carriage. The spade is attached by a steel wire rope to a rod compressing a second set of springs in the steel cylinder M. On recoil the plough is forced into the ground. The cylinder L telescopes, compressing the springs and allowing the carriage to recoil. The rope simultaneously tautens and compresses the springs in M, which after recoil expand and return the gun to the firing position.

Mountain Carriages.—The carriage for the 2·5-inch gun is packed for transport on three mules. One carries the axletree, a second the wheels and elevating gear, and a third the trail. Each mule in addition carries a number of small stores. It requires about ten seconds to assemble the carriage. (C. R. B. O.)

III. United States.

The material of the United States artillery is divided into four general classes, namely, mountain, field, siege, and sea-coast guns.

The mountain artillery comprises the 1″·65 and 3″ Hotchkiss rifles, and their mounts and ammunition. The field artillery comprises the 3″·2 and 3″·6 rifles, and the 3″·6 mortar. These pieces are all breech-loaders of gun-steel, and have conical gas check seats, cylindrical powder chambers of larger diameter than the bores and connecting with them by a slope forming a seat for the rotating band. The tops of the lands at the beginning of rifling are also cut away, forming a slope to allow the band to be gradually forced to its full depth in the rifling. These general features are followed in the manufacture of all guns. The 3″·2 and 3″·6 rifles consist of a tube and jacket assembled by shrinkage. The former gun is intended for horse artillery, the latter for field batteries. In practice, however, the former is generally used for all purposes. The field carriage is made of steel, weighing 1300 pounds. It is of the usual type, having recoil on the ground, which is restrained by bowspring brakes fastened to the axle and engaging over the wheels. This brake also serves as a travelling brake, a simple arrangement permitting it to be thrown on or off the wheels when desired. The wheels used in the field and siege service are of the Archibald pattern. The limbers, except in minor details, are the same for carriage, caisson, and battery waggon, the bodies of which are made of metal. The limber and caisson chests are the same, and are made of wood covered with canvas and reinforced by iron. Each is divided into three compartments, the end ones containing twenty-one projectiles each in bronze supports, and the middle one forty-two cartridges and two haversacks. The limber complete with ammunition weighs 1780 pounds, and the caisson and limber complete with ammunition, 4607 pounds. The ordnance department of the army has designed a 3″ field rifle to supplant those now in service, when a suitable non-recoil carriage shall have been selected. It has also decided upon a 5″ field



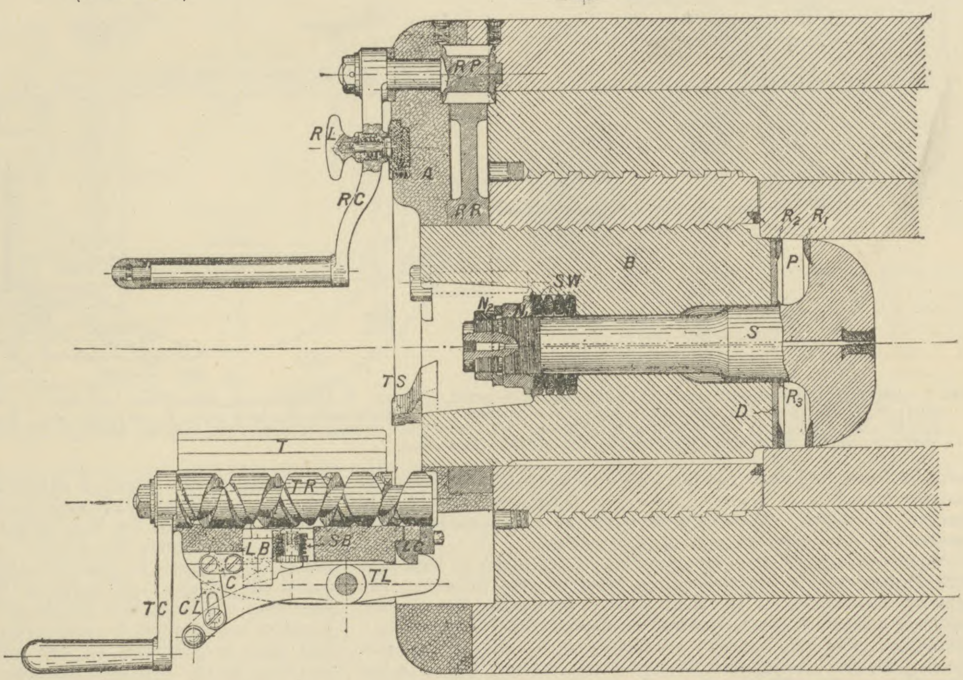


Fig. 1.—Diagram of Breech Mechanism of 8-inch B.L. Rifle (steel, 14½ tons). A, breech-plate; B, breech-block; C, cam; CL, cam links; D, gas check disc; H, hinge-pin; LB, lock bolt; LC, tray-latch catch; N_1, spindle nut; N_2, lock nut; P, gas check pad; R_1, R_2, R_3, split rings; RC, rotating crank; RL, rotating crank lock; RP, rotating pinion; RR, rotating ring; S, obturating spindle; SB, spring bolt; SC, securing catch; SL, securing latch; SW, spindle-washers; T, tray (console); TC, translating crank; TL, tray-latch; TR, translating roller; TS, translating stud; V, vent-cover.

howitzer, the carriage for which will resemble the field carriage, and awaits the determination of the latter. The data for these two guns are included in the tables at the end. The 3″·6 mortar, consisting of a single forging of steel, is a short piece intended for vertical fire against troops protected by entrenchments or irregularities of the ground from the direct fire of field guns, and will be largely supplanted by the field howitzer. The maximum range is about 3450 yards, and the charges required to cover all ranges from 400 to 3450 yards are four in number. The carriage, weighing 275 pounds, is made of cast steel in one piece. Elevation is given by a quadrant, and a clamp is provided to fix the mortar at any elevation. The carriage rests on a wooden platform, and is restrained in recoil by heavy ropes attached to stakes in front. Changes in azimuth are given by means of a pointing scale graduated to $\frac{1}{1000}$th of the range.

The field artillery ammunition comprises cast-iron shell, shrapnel, and canister. A steel shell holding a larger bursting charge is also provided for the howitzer. The canister, containing 226 balls, consists of a hollow cylinder of malleable iron, the rear end closed by a cast head. Around the case are several slits, their ends overlapping to secure a thorough breaking up on discharge. There are several small holes through the head through which the gas enters on discharge, driving the balls forward and assisting in the destruction of the case. The shrapnel contains 162 hard lead balls, assembled in circular layers, and held in position by cast-iron separators, which increase the effect of the explosion by furnishing additional fragments. The base is made of cast-iron threaded to the interior of the cylindrical case. Recent improvements have had in view the omission of the separators permitting the addition of a number of lead balls con-

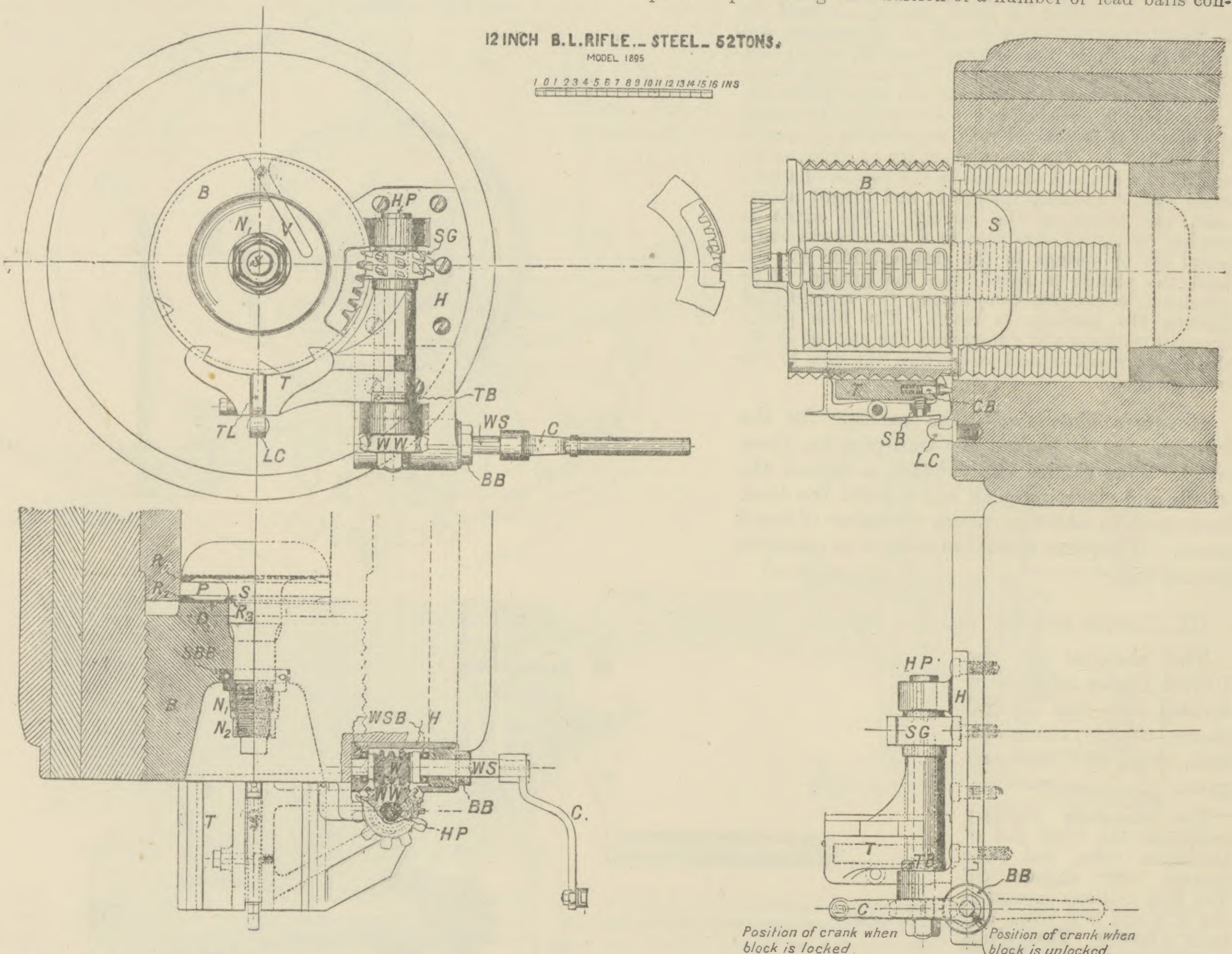


FIG. 2.—Diagram of Breech Mechanism of 12-inch B.L. Rifle (steel, 52 tons). B, breech-block; BB, bronze bushing; C, crank; CB, catch bolt; D, gas check disc; H, hinge-plate; HP, hinge-pin; LC, tray-latch catch; N_1, spindle nut; N_2, lock nut; P, gas check pad; R_1, R_2, R_3, split rings; S, obturating spindle; SB, spring bolt; SBB, spindle ball-bearing; SG, spiral gear; T, tray (console); TB, tray ball-bearing; TL, tray latch; V, vent-cover; W, worm; WS, worm-shaft; WSB, worm-shaft ball-bearings; WW, worm-wheel.

tained in steel jackets. The head of the shrapnel, containing the powder chamber, is made of cast-iron, bored and threaded to receive the fuse. The body is made of a lap-welded tube weakened for fracture by grooves in the sides.

Siege Artillery.—This comprises the 5″ rifle, the 7″ howitzer, and 7″ mortar, all breech-loading rifled pieces, following the general description of the field guns. Excepting the mortar, which is a single forging, they are constructed on the "built-up" principle. The rifle consists principally of a tube, jacket, and sleeve, the tube being unsupported for a distance of 56 inches from the muzzle. The carriage for the rifle consists essentially of two steel flasks parallel to each other, connected by a bottom and top plate and transom. The carriage is similar in general design to the field carriage, except that the trunnions of the gun are relatively much higher from the ground, the axes of the trunnion beds being 72 inches above the horizontal platform upon which the carriage rests. The elevating apparatus is a double screw similar to that in the field carriage. A limber is provided for travelling, which also serves for the howitzer carriage. This and the howitzer carriage are mounted on a wooden platform weighing about 5100 pounds, and having a metal pintle to which the carriages are attached through the medium of a hydraulic cylinder to restrain their movement in recoil, after which they are moved forward by handspikes. The carriage weighs 2820 pounds, and permits the gun to be fired at any elevation from minus 10 degrees to plus 38 degrees. The howitzer consists essentially of the same parts as the rifle. The carriage, while somewhat similar to that for the rifle, differs from it in that the howitzer is permitted to recoil upon it, thus reducing the strains. The piece is mounted on two trunnion carriages upon slides inclining to the rear and downwards at an angle of 18°, upon which it has a recoil of 6 inches. Recoil on the slides is checked by hydraulic cylinders placed in front of the trunnion carriages, and in the rear by two courses of springs, one on each side, serving also to return the piece to the firing position. The height of the trunnions of the piece is the same as that for the siege rifle, although in a more recent design this height has been reduced to 60 inches. The wheels, weighing 375 pounds each, are the same as for the siege rifle. The weight of the carriage, including the wheels and hydraulic brakes, is about 3000 pounds, and the howitzer can be elevated from minus 5° to plus 40°. The 7″ mortar fills the need of the service for a piece for vertical firing in siege operations against strongly entrenched and covered positions, and is adapted to use the same projectiles as the howitzer. It consists of a single forging with trunnions combined, whereby a construction of satisfactory strength with minimum weight is best obtained. The service required is to deliver relatively heavy projectiles at short or moderate ranges, to supplement the curved fire of the howitzer by vertical fire at medium ranges, and to cover the field at shorter ranges which are inaccessible to the howitzer. The projectile of normal weight is fixed at 125 pounds, having a velocity of 700 F.S., with a maximum range of about 4200 yards. The carriage is made of steel plate, and in its method of checking recoil and returning the piece to the firing position resembles the howitzer carriage. It is, however, not a wheeled carriage, but rests upon a wooden platform to which it is fastened by cast steel clip plates bolted down. Traversing is effected by pinch bars engaging in teeth cast in the plates. Elevation is accomplished by bars fitted into sockets bolted to the faces of the trunnions, the piece being clamped in any position by a screw through the left cap square. The limits of elevation for ordinary fire are from plus 30° to plus 65°. The wooden platform weighs 3720 pounds and the carriage 1720 pounds. This platform is not quite heavy enough to secure proper stability, at least in loose soil, but in view of the fact that it must be transported, reliance must be had on material gathered near the place of use for a solid sub-construction, to which the platform can be secured by means of holding-down bolts provided for the purpose. Cast-iron and steel shell and shrapnel are used with siege artillery depending upon the results desired. The shrapnel is similar to that described for field artillery, except that a central tube extends from the powder chamber to the head of the base. The 5″ shrapnel contains 280 hard lead balls and other parts, making the number of pieces before firing 356. The howitzer shrapnel contains 390 balls, and a total of 461 pieces. The mortar shrapnel contains 449 balls and other parts, making the total number of pieces before firing 550. As an instance of the manner in which these shrapnel behave in service, it may be noted that in some recent firings the howitzer shrapnel gave about 800 dangerous fragments.

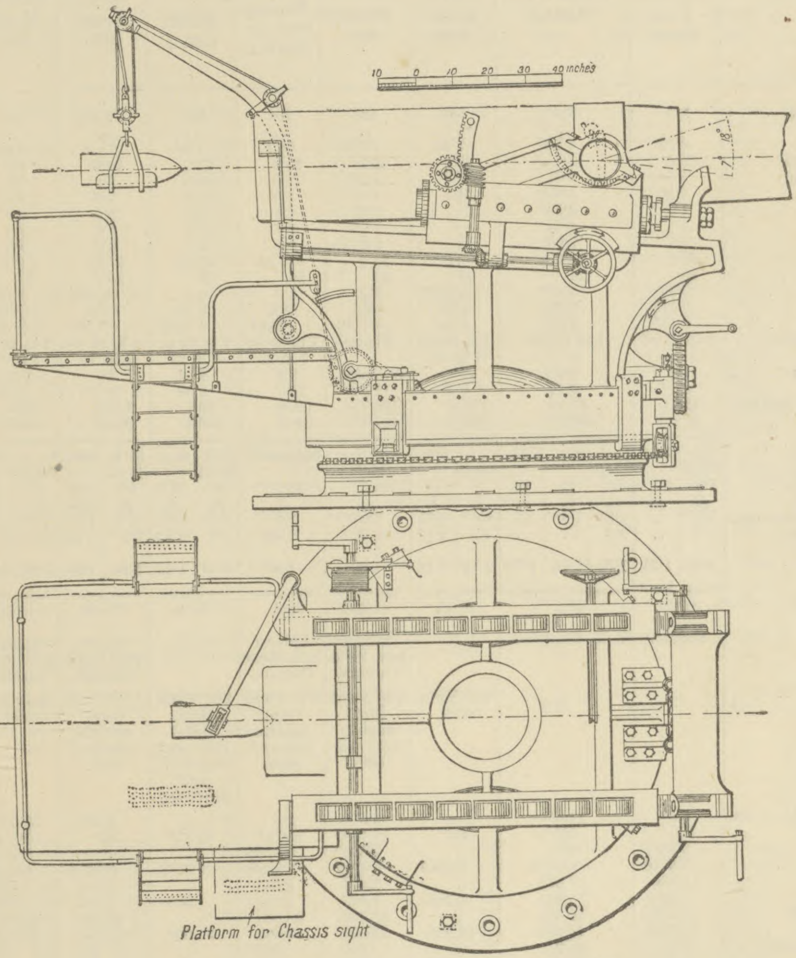


Fig. 3.—Diagram of Barbette Carriage for 8-inch B.L. Rifle.

Coast Artillery.—The sea-coast artillery consists of 5-inch and 6-inch rapid-fire guns, 8-inch (Fig. 1), 10-inch, and 12-inch rifles (Fig. 2), and 12-inch mortars; with the exception of the mortars model of 1886, which have cast-iron bodies with steel jackets, these are built up of gun steel, and all are breech-loading with rifled bores. The number of hoops has been successively reduced, as steel manufacturers have become able to make larger forgings, and the greater length of the hoops much increases the stiffness of the guns. In the 5-inch guns the tube is given an initial tension, in addition to that caused by the shrinkage of the jacket, by heating and cooling from the interior. There are also a number of 6-pounder rapid-fire guns on wheeled carriages, and 15-pounder rapid-fire guns on a form of pillar-mounting. The 5-inch rapid-fire guns are mounted in barbette on pillar-mount carriages, similar to the Armstrong pattern, and on pedestal mounts, which are very similar in all countries. The 6-inch rapid-fire guns are mounted on pedestal mounts and on disappearing carriages, arranged to be manœuvred by one man. In the latter mounting rapidity of fire is somewhat sacrificed for cover, but six or seven rounds per minute can be attained.

The 8-inch, 10-inch, and 12-inch rifles are mounted on barbette or disappearing carriages, depending upon their situation. The barbette carriages are all of the same design, and differ only in size and weight (Fig. 3). They are of the centre pintle form, and consist essentially of two side frames mounted on a turn-table, and a top carriage, consisting of trunnion beds and recoil cylinders. Where strength permits a superior quality of cast-iron is used for the construction of the larger parts. The turn-table proper for all carriages consists of an upper and lower roller path, between which are forged steel conical rollers, securely held in place by concentric distance rings. The top carriage rests, on each side, on steel rollers mounted in U-shaped recesses in the tops of the side frames, which have an inclination upwards and to the rear of 4°. The piston-rods pass through lugs which project upwards from the front ends of the rails, and are secured by the necessary nuts and check-nuts. The front surface of these lugs and rails is planed as a shoulder for a shield to protect the cannoneers, which has not yet been supplied. During recoil the pistons remain stationary, the top carriage with its cylinders being drawn over them. The energy of recoil is taken up by the uniform resistance which the liquid in the cylinders offers to being driven through varying orifices caused by throttling bars, whose inner surfaces are curved. After recoil, the gun returns to the firing position by the action of gravity.

The gun is pointed in azimuth and elevation by suitable gearing. A crane is provided for raising the projectile to the breech of the piece, and a loading platform of suitable dimensions to permit the operation of loading to be performed by the necessary number of men, is attached in rear. The carriage permits the gun to be traversed 320°, and elevated from minus 7° to plus 15°. The gun can be laid by means of a telescopic sight attached to the right trunnion, or to a standard on the right side frame, or by the indirect method.

The disappearing carriages are of the "Buffington-Crozier" type (Fig. 4). The turn-table, chassis rails, or side frames, and top carriage, are similar in general design to those for barbette carriages. The trunnions of the gun rest in trunnion beds at the upper ends of the gun levers, which are pivoted near the middle point upon an axle resting in beds in the top carriage. The lower ends of these levers are joined to a steel crosshead, from which the counter-weight is suspended. This crosshead clips over vertical guides cast on the inside of the chassis rails, by which it is constrained to move in a vertical direction. Ratchet teeth are cut on the front faces of the clips to be caught by pawls pivoted to the chassis rails, and in this way the counter-weight is held up, and the gun is prevented from returning to the firing position after recoiling. The counter-weight is just sufficient to raise the gun to the firing position when loaded. The energy of recoil is absorbed as described for barbette carriages. Equality of resistance in the cylinders, as in the barbette carriages, is obtained by connecting their pressure ends by an equalizing pipe. Pointing in azimuth is performed by suitable

U.S. ARMY

WEIGHTS, DIMENSIONS, &c.		Mountain Artillery. Hotchkiss 1·65-inch B.L. Rifle.	Mountain Artillery. Hotchkiss 3-inch B.L. Rifle.	Field Artillery. 3-inch B.L. Rifle, Model 1898.	Field Artillery. 3·2-inch B.L. Rifles. Model 1885.	Field Artillery. 3·2-inch B.L. Rifles. Models 1890 and 1890 M.I.	Field Artillery. 3·2-inch B.L. Rifles. Model 1897. ϕ	Field Artillery. 3·6-inch B.L. Rifle, Model 1891.	Field Artillery. 3·6-inch B.L. Mortar, Model 1890.	Field Artillery. 5-inch B.L. Howitzer, Model 1898.
Weight	Pounds	121	216	835	829	794	830	1,200	245	1,150
Weight	Tons	..	..	..	..	..	..	..	..	..
Total length	Feet	3·83	3·76	7·43	7·56	7·31	7·31	7·79	2·05	5·66
Length of bore	Calibres	25·0	13·0	28·0	26·0	25·2	25·2	23·5	5·3	12·0
Maximum diameter, breech	Inches	5·03	6·7	8·8	9·56	9·0	9·0	9·8	7·8	11·8
Diameter of muzzle	"	2·55	3·94	4·5	5·1	5·0	5·0	6·0	5·4	7·0
Diameter of trunnions	"	1·8	2·56	..	3·8	3·8	3·8	3·8	3·8	..
Length of trunnions	"	1·8	2·44	..	2·25	2·7	2·7	3·0	2·5	..
Distance between rim bases	"	4·7	7·09	..	9·5	9·5	9·5	9·5	9·5	..
Distance of axis of trunnions from muzzle	"	27·3	26·5	..	60·4	57·719	57·35	57·25	14·6	..
Rifling: Number of grooves		10	24	24	24	24	24	26	20	30
Rifling: Width " "	Inch	0·36	0·276	0·2927	0·3	0·3	0·3	0·3162	0·4454	0·3736
Rifling: Depth " "	"	0·012	0·026	0·03	0·05	0·04	0·04	0·04	0·045	0·05
Rifling: Width of lands	"	0·157	0·117	0·10	0·1188	0·1188	0·1188	0·1188	0·12	0·15
Rifling: Twist	Calibres	1 in 29·83	1 in 25·59	1 in 50 to 1 in 25	1 in 30	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 40 to 1 in 25	1 in 50 to 1 in 25
Powder chamber: Diameter	Inches	1·8	3·16	3·2	3·8 max.	3·6	3·32	3·9	3·8	5·2
Powder chamber: Length	"	4·6	3·72	6·58	11·508	10·7	5·58	12·275	2·835	3·85
Powder chamber: Capacity	Cubic inches	11·71	27·12	55·0	109·7	110·3	50·0	148·5	33·2	92·0
Total capacity of bore	" "	93·6	292·0	630·2	714·7	690·5	648·3	905·5	200·0	..
Projectile: Kind		C.I. Shell / Case.	C. I. Shell / Shr. / Case.	C. I. Shell / Shr.	C. I. Shell.	Shrapnel.	C. I. Shell / Shr.	C. I. Shell / Shr.	C. I. Shell / Shr.	C. I. Shell / C. S. Shell / Shr.
Projectile: Weight, filled	Pounds	2·0 / 2·8	12 / 12 / 12	15 / 15	13·5	13·5	13·5 / 13·5	20 / 20	20 / 20	45 / 45 / 45
Projectile: Ratio, weight to weight of piece		$\frac{1}{60}$ / $\frac{1}{43}$	$\frac{1}{19}$ / $\frac{1}{19}$ / $\frac{1}{19}$	$\frac{1}{55}$ / $\frac{1}{55}$	$\frac{1}{61}$	$\frac{1}{61}$	$\frac{1}{50}$ / $\frac{1}{50}$	$\frac{1}{60}$ / $\frac{1}{60}$	$\frac{1}{12}$ / $\frac{1}{12}$	$\frac{1}{26}$ / $\frac{1}{26}$ / $\frac{1}{26}$
Projectile: Weight of bursting charge, rifle powder	Pounds or ozs.	1·7* / ..	6·3* / 1·9* / ..	9·6* / 3·0*	7·0*	3·5*	7·0* / 3·5*	12·8* / 4·0*	12·8* / 4·0*	2·3 / 1·2¶ / 12*
Projectile: Length	Calibres	3·5 / ..	3·5 / .. / ..	4·2 / 3·1	3·0	2·4‖	3·0 / 2·4‖	3·3 / 2·5‖	3·3 / 2·5‖	3·0 / 2·6 / 2·4‖
Projectile: Sectional density $\frac{W}{\pi r^2}$		0·91 / 1·31	1·70 / 1·70 / 1·70	2·12 / 2·12	1·68	1·68	1·68 / 1·68	1·96 / 1·96	1·96 / 1·96	2·3 / 2·3 / 2·3
Travel of shot	Inches	37·2	36·2	77·42	71·991	69·8	75·05	72·275	16·065	56·15
Powder: Kind: Brown or Black		Mortar.	I. K. Granular.	..	Sphero hex. Field Cannon.	Sphero hex. Field Cannon.	..	Sphero hex. Field Cannon.	Sphero hex. Field Cannon.	Sphero hex. Field Cannon.
Powder: Kind: Smokeless		..	..	3·0″ Field Gun.	3·2″ Field Gun, models 1885 and 1890.	3·2″ Field Gun, models 1885 and 1890.	3·2″ Field Gun, model 1897, and Siege Gun, and Howitzer.	3·2″ Field Gun, models 1885 and 1890.	·30-Calibre Rifle.‡	Field Gun.
Powder: Weight (see note): Brown	Pounds or ozs.	5·5*	14·0*	..	3·5	3·5	..	4·375	15·0*†	4·0
Powder: Weight (see note): Smokeless	" "	$2\frac{5}{16}$*	$4\frac{1}{2}$*	20*	18·75*	18·75*	15·25*	23*	6·0*†	1·4
Powder: Density of loading: Brown		0·8127	0·9	..	0·8832	0·8783	..	0·8155	0·7816†	1·2807
Powder: Density of loading: Smokeless		0·3416	0·2870	0·6606	0·2952	0·2936	0·5276	0·2680	0·3127†	0·4482
Muzzle velocity: Brown	F.S.	1,460	870	..	1,685	1,685	..	1,550	650†	1,000
Muzzle velocity: Smokeless	F.S.	1,313	885	1,725	1,685	1,685	1,685	1,550	690†	1,000
Maximum pressure per square inch: Brown	Pounds	13,340	15,000	..	35,000	35,000	..	35,000	16,000†	27,000
Maximum pressure per square inch: Smokeless	"	13,000	13,500	32,000	35,000	35,000	35,000	35,000	17,000†	20,000
Muzzle energy: Brown	Foot-tons	29·6	63·0	..	266	266	..	333	59†	312
Muzzle energy: Smokeless	"	23·9	65·2	310	266	266	266	333	66†	312
Penetration in steel at (De Marre Formula, normal impact). Muzzle: Brown	Inches	1·6	1·4	..	3·8	3·8	..	3·9	1·1†	2·6
Penetration: Muzzle: Smokeless	"	1·3	1·5	4·5	3·8	3·8	3·8	3·9	1·2†	2·6
Penetration: 1000 yards: Brown	"	..	..	..	..	..	..	..	..	..
Penetration: 1000 yards: Smokeless	"	..	..	..	..	..	..	..	..	..
Penetration: 2500 ": Brown	"	..	..	..	..	..	..	..	..	..
Penetration: 2500 ": Smokeless	"	..	..	..	..	..	..	..	..	..
Penetration: 3500 ": Brown	"	..	..	..	..	..	..	..	..	..
Penetration: 3500 ": Smokeless	"	..	..	..	..	..	..	..	..	..

Projectiles (abbreviations): C. I. = cast iron.
Shr. = shrapnel.
C. S. = common steel.
A. P. = armour-piercing.
D. P. = deck-piercing.

Powder Note.—The weights given are approximate. The exact weight giving the standard muzzle velocity is determined from the acceptance test and issue for charges.

CANNON, 1900.

SIEGE ARTILLERY.					SEA-COAST ARTILLERY.								
5-inch B.L. Rifles.		7-inch B.L. Howitzers.		7-inch B.L. Mortar, Model 1892.	8-inch B.L. Rifle, Model 1888 M.II.	10-inch B.L. Rifles.		12-inch B.L. Rifles.		16-inch B.L. Rifle, Model 1895.	10-inch B.L. Mortar, Model 1890.	12-inch B.L. Mortars.	
Model 1890.	Model 1898.	Model 1890.	Model 1898.			Model 1888 M.II.	Model 1895.	Model 1888 M.II.	Model 1895.			Cast-Iron Body, Model 1886.	Steel, Model 1890 M.I.
3,660	3,639	3,710	3,650	1,715	32,218	67,183	66,700	117,127	115,000	282,000	16,734	31,920	29,120
..	..	..	..	..	14·5	30·0	30·0	52·0	51·0	126·0	7·5	14·25	13·0
2·15	11·91	8·48	8·27	4·86	23·21	30·6	30·76	36·66	36·88	49·25	9·80	10·75	11·76
7·0	27·0	12·7	12·7	7·0	32·0	34·0	35·0	34·0	35·0	35·0	10·0	9·0	10·0
5·0	15·0	16·7	16·6	13·8	30·0	38·5	37·0	46·2	44·5	60·0	31·5	41·75	38·0
8·0	8·0	10·0	10·0	10·5	14·0	16·8	17·5	20·2	21·0	28·0	17·5	22·5	21·0
5·8	5·8	7·0	7·0	7·0	10·0	12·0	12·0	14·5	14·5	..	10·0	12·0	12·0
3·3	3·3	4·0	4·25	4·0	6·0	6·75	6·75	8·0	8·0	..	6·5	6·0	8·0
5·0	15·0	18·0	18·0	14·3	32·5	42·0	42·0	50·2	50·2	..	33·3	44·0	40·0
6·25	95·8	64·6	64·2	34·15	183·0	243·05	240·3	291·1	289·6	379·65	74·12	79·1	89·6
0	30	42	42	28	48	60	60	72	72	96	60	68	72
0·3736	0·3736	0·3736	0·3736	0·6354	0·3736	0·3736	0·3736	0·3736	0·3736	0·3736	0·3736	0·379	0·3736
0·05	0·05	0·05	0·05	0·055	0·06	0·06	0·06	0·06	0·06	0·06	0·06	0·07	0·06
0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·175	0·15
n 50 to in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 40 to 1 in 15	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 50 to 1 in 25	1 in 40 to 1 in 20	1 in 40 to 1 in 25	1 in 40 to 1 in 20
5·7	5·7	7·2	7·2	7·25	9·5	11·8	11·8	14·2	14·2	18·8	10·5	12·4	12·5
15·15	15·15	7·465	7·465	4·18	51·0	65·49	65·49	77·68	77·68	107·2	17·24	16·05	21·13
402·5	402·5	316·7	316·7	182·8	3,619	7,123	7,123	12,185	12,185	29,387	1,554	2,021	2,676
824·5	2,816·7	3,499·0	3,499·0	1,951·0	14,109	29,003	29,788	50,900	51,371	121,391	8,096	12,598	14,259

I. ell.	C. S. Shell.	Shr.	C. I. Shell.	Steel Shell.	Shr.	C. I. Shell	Steel Shell	Shr.	A. P. Shot	A. P. Shell	C. I. Shot	A. P. Shot.	A. P. Shell.	C. I. Shot.	A. P. Shot.	A. P. Shell.	C. I. Shot.	A. P. Shot	A. P. Shell	C. I. Shot	D. P. Shell	C. I. Shell	D. P. Shell.		Torpedo Shell.		C. I. Shell.	
5	45	45	105	105	105	125	125	125	300	300	300	575	575	575	1,000	1,000	1,000	2,400	2,400	2,400	575	575	800	1,000	800	1,000	800	1,000
[illegible]	$\frac{1}{81}$	$\frac{1}{81}$	$\frac{1}{35}$	$\frac{1}{35}$	$\frac{1}{35}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{13}$	$\frac{1}{107}$	$\frac{1}{107}$	$\frac{1}{107}$	$\frac{1}{118}$	$\frac{1}{118}$	$\frac{1}{118}$	$\frac{1}{117}$	$\frac{1}{117}$	$\frac{1}{117}$	$\frac{1}{118}$	$\frac{1}{118}$	$\frac{1}{118}$	$\frac{1}{29}$	$\frac{1}{29}$	$\frac{1}{40}$	$\frac{1}{30}$	$\frac{1}{40}$	$\frac{1}{30}$	$\frac{1}{40}$	$\frac{1}{30}$
·3	1·2¶	12*	8·6	4·3¶	1·9	12·5	6·8¶	1·9	..	11·5¶	..	..	22·4¶	..	..	39·4¶	..	..	..	..	22	12	22·1¶	39·4¶	67·7¶	84·6¶	12·5	19·6
·0	2·6	2·4‖	3·0	2·5	2·0‖	3·5	3·0	2·4‖	3·5	4·0	3·5	3·5	4·0	3·5	3·5	4·0	3·5	..	..	3·5	3·5	4·0	3·0	4·0	4·0	5·0	3·0	3·5
·30	2·30	2·30	2·70	2·70	2·70	3·25	3·25	3·25	5·97	5·97	5·97	7·33	7·33	7·33	8·94	8·94	8·94	11·94	11·94	11·94	7·33	7·33	7·08	8·94	7·08	8·94	7·08	8·94

19·8	119·8	81·385	81·385	44·8175	205·25	275·11	284·51	331·12	340·15	452·9	82·76	91·64	98·92
phero x. Siege nnon.	Sphero hex. Siege Cannon.	Sphero hex. Siege Cannon.	Sphero hex. Siege Cannon.	Sphero hex. Siege Cannon.‡	Brown Pris.	Brown Pris.	Brown Pris.	Brown Pris.	Brown Pris.	Brown Pris.	Brown Pris.	Brown Pris.	Brown Pris.
Siege n and How- tzer.	Siege Gun and How- itzer.	Siege Gun and How- itzer.	Siege Gun and How- itzer.	3·2″ Field Gun, models 1885 and 1890.	8″ B. L. Rifle.	10″ B. L. Rifle.	10″ B. L. Rifle.	12″ B. L. Rifle.	12″ B. L. Rifle.	16″ B. L. Rifle.	10″ Mortar.	12″ Mortar ‡ or Siege Gun and Howitzer.	12″ Mortar ‡ or Siege Gun and Howitzer.
3·0	13·0	10·5	10·5	6·0†	135·0	280·0	280·0	490	490	1,176	63·0†	§75·0†	θ105†
4·25	4·25	3·5	3·5	1·75†	70·0	140·0	140·0	240	240	576	30·0†	§41·5†	θ50†
0·9096	0·9096	0·9177	0·9177	0·9086†	1·0331	1·0886	1·0886	1·1133	1·1133	1·1077	1·1222†	1·0272†	1·0861†
0·2923	0·2923	0·3059	0·3059	0·2105†	0·5354	0·5441	0·5441	0·5452	0·5452	0·5425	0·5344†	0·5684†	0·5172†
1,830	1,830	1,100	1,100	700†	2,025	2,025	2,025	2,025	2,025	2,025	1,020†	§1,020†	θ1,020†
1,830	1,830	1,100	1,100	710†	2,300	2,300	2,300	2,300	2,300	2,300	1,150†	§1,200†	θ1,150†
5,000	35,000	28,000	28,000	20,000†	38,000	38,000	38,000	38,000	38,000	38,000	31,000†	§27,500†	θ31,000†
0,000	30,000	20,000	20,000	17,000†	37,000	37,000	37,000	37,000	37,000	37,000	33,000†	§26,000†	θ33,000†
1,045	1,045	881	881	425†	8,528	16,345	16,345	28,426	28,426	68,255	4,147†	§5,769†	θ7,212†
1,045	1,045	881	881	437†	10,528	21,086	21,086	36,671	36,671	88,050	5,272†	§7,986†	θ9,168†
6·2	6·2	3·8	3·8	2·3†	16·8	21·1	21·1	25·8	25·8	35·3	7·9†	§8·2†	θ9·7†
6·2	6·2	3·8	3·8	2·3†	19·6	25·3	25·3	30·9	30·9	42·3	9·4†	§10·4†	θ11·5†
4·6	4·6	3·3	3·3	..	15·0	19·2	19·2	23·8	23·8	33·4	7·5†	§7·8†	θ9·3†
4·6	4·6	3·3	3·3	..	17·4	23·0	23·0	28·5	28·5	40·0	8·7†	§9·5†	θ10·7†
3·0	3·0	2·7	2·7	..	12·6	16·6	16·6	21·2	21·2	30·6	7·0†	§7·3†	θ8·7†
3·0	3·0	2·7	2·7	..	14·6	20·0	20·0	25·5	25·5	36·7	7·9†	§8·5†	θ9·9†
2·5	2·5	2·5	2·5	..	11·4	15·1	15·1	19·5	19·5	28·8	6·7†	§6·8†	θ8·4†
2·5	2·5	2·5	2·5	..	13·0	18·1	18·1	23·5	23·5	34·6	7·5†	§8·1†	θ9·4†

* Ounces.

† Maximum. The weight of charge varies with the range; for issues in bulk the average charge is assumed to be ¾ the maximum.

‡ The kind of powder varies with the range.

§ For 800-pound shell.

‖ Without fuze.

¶ Gun-cotton.

φ The use of the 16½ lb projectile with this rifle is to be discontinued. The charge for this projectile was 12·87 ozs. smokeless powder, resulting in a velocity of 1450 F.S. with a pressure of 35,000 lb per square inch.

θ For 1000-pound shell; with the 800-pound shell the velocities are 1150 and 1325 F.S. with brown and smokeless powder respectively.

gearing. The gun is elevated and depressed by means of a rack on the chassis rails, connected to the gun by two long arms; any movement of the rack up or down is thus communicated to the gun. While theory requires, in order that the gun shall always return to the same angle for loading whatever may be the firing angle, that the rack and its guide shall be struck with a radius equal to the length of the elevating arms, using the point of attachment to the gun in the loading position as a centre, the expense of manufacture has made it desirable to make them straight. These are so placed, however, as to cause only a slight variation in the loading angle, which is about 4°. Ammunition is served to the gun on ammunition trucks, permitting the projectile to be raised to the proper height for loading and to be given the same inclination that the gun has in the loading position. The gun can be pointed by means of indirect laying, or of a telescope sight placed on the right trunnion or on a sight standard attached to the rear of the carriage at such a height as to look over the interior crest.

In these carriages the centre of gravity of the gun-counterweight system moves some distance to the rear, greatly relieving the firing strains. The character of motion also permits the muzzle to project some distance over the interior crest. From the fact that the lower ends of the gun levers are constrained to move vertically, and their centres nearly horizontally to the rear, the path of the trunnion of the gun is an ellipse. The breech of the gun, being connected by a fixed arm to the elevating rack, travels in the arc of a circle. The combination of these two movements causes the muzzle of the gun to move almost directly to the rear, parallel to the superior slope, until it has passed the interior crest, when it turns suddenly downwards. These carriages are hardly more complicated than barbette carriages, having the same hydraulic cylinders and the same slide rails. There are no valves and no fluid under compression, except during the instants of recoil, and after long standing they can be prepared for immediate use by simply filling the cylinders with oil. The character of motion has other advantages besides that of causing the piece to describe a suitable path in recoil. The top carriage starts with only about one-half the acceleration of the piece, thus diminishing the shocks and strains brought upon it and the gun levers. At the beginning of the motion, when the gun has its greatest velocity, the counter-weight has relatively the least, so that the latter starts from rest very slowly, and the operation brings no sudden or undue strains upon any part of the mechanism.

The barbette and disappearing carriages are manœuvred and loaded by hand power. Electric power may be applied if desired. Guns mounted on the former carriages have not quite the rapidity of fire of corresponding calibres on disappearing carriages. This is due to the fact that guns on the latter carriages always return to the loading position with the proper loading angle, while on

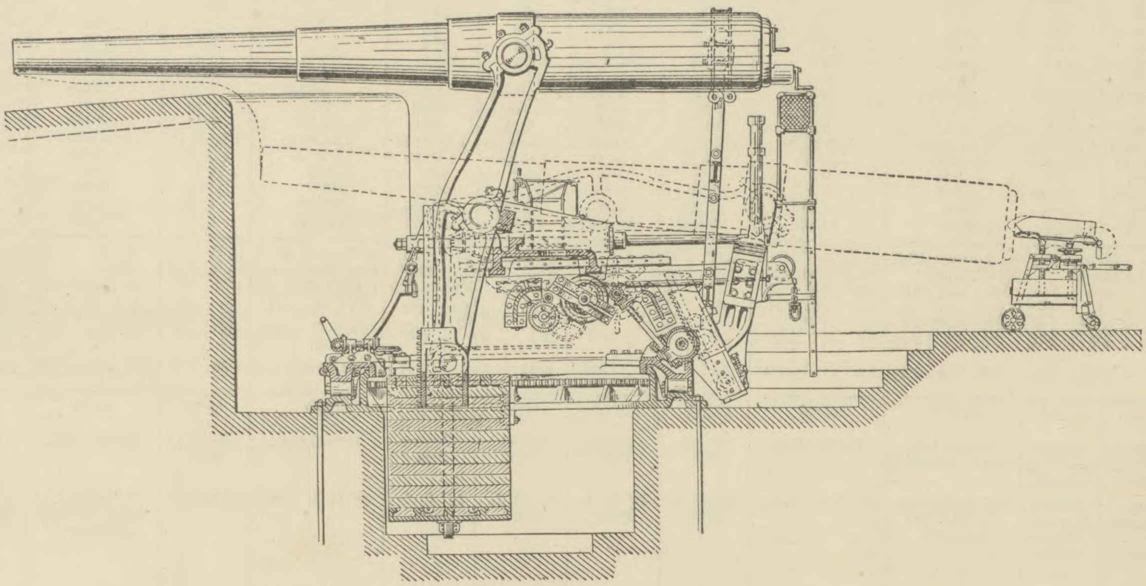


Fig. 4.—Diagram of Disappearing Carriage L.F. for 10-inch B.L. Rifle.

the former they must be brought nearly to a horizontal position for loading, the operations of which are performed on a platform at some distance from the ground, to which the charge and projectile must be raised at each discharge. Recent trials with disappearing carriages indicate that ten rounds can be fired from 8-inch guns in twelve minutes, from 10-inch guns in fourteen minutes, and from 12-inch guns in seventeen minutes, meaning in the latter case that 14,500 pounds of ammunition are handled for the ten rounds.

There are two kinds of mortar carriages, designated respectively as "model of 1891" and "model of 1896." The former is of the "Raskasoff, Easton, and Anderson" type, in which two triangular side frames are mounted on a turn-table, and the mortar recoils downwards and to the rear at an angle of 50° to the horizon, the mortar being held in the firing position by two columns of springs placed in spring cylinders cast in the side frames. The turn-table of the model of 1896 carriage (Fig. 5) is similar to that of the model of 1891. The top carriage or saddle in which the mortar is mounted consists of two arms connected by a heavy web, inclined to the rear and upwards at an angle of 45°. The upper ends of the arms form the trunnion beds, while the lower ends are held by a fulcrum shaft attached to the turn-table. The saddle is supported at a point about one-third of its length from the fulcrum by five columns of double springs arranged in a row side by side. The recoil is checked by two hydraulic cylinders, one on each side, the pistons of which are attached to the cradle near the gun trunnions. The action of the carriage when the piece is fired is as follows: The saddle revolves about its fulcrum to the rear and downwards, carrying the mortar and compressing the spring columns. As the piece moves down the two crank pins force down the crossheads and piston-rods until the resistance of the hydraulic cylinders stops the motion. The springs, acting against the saddle, reverse the motion and raise the piece to the firing position. The mortar must be brought to a horizontal position for loading, and the shot is served to it by means of a truck, passing the shell direct from the truck into the mortar.

Ammunition.—Armour-piercing shot and shell are used with the rifles, the difference between them being as regards penetrative power and interior capacity for high explosive charge. Deck-piercing and torpedo shells, weighing 800 and 1000 pounds, are used with the mortars, depending upon the range. The heavy torpedo shells are $4\frac{1}{2}$ calibres long, and are designed to carry a large bursting charge, so as to have great effect on striking in the vicinity of a battleship. The extreme range of these mortars is about six miles, but they are intended to cover all ranges by variation of charge and projectile and angle of elevation.

Breech Mechanisms.—In all of the guns, except the mountain guns, the breech mechanism belongs to the interrupted screw system, using the plastic pad for obturation, excepting only the 3·6″ mortar, which has the "Freyre" check. In the guns of larger calibre the gas-check cups are replaced by split rings, which are slightly larger than the conical seats, and are sprung together by being forced into their places. In action they are held against the walls of the gun by the plastic pad, thus preventing an escape of gas. In the field and siege guns the block is carried in a ring, which supports it when open. Rotation is given by means of a handle fixed or pivoted near the top, and the block is withdrawn through the carrier ring and swung open by hand. The breech-blocks of the rifles of old model and of the mortars are rotated by means of crank handles, and withdrawn from the piece on to a bronze tray by means of a screw, and are then swung open by hand. In the latest improved mechanism the continuous movement of rotation, translation, and swinging of the block and tray are effected by the operation of a single crank. The newer mechanisms for field and siege material will conform to those for the rapid-fire guns, where the block is opened by the single movement of a lever, of which there are numerous similar types.

Wire Guns.—Several systems of wire guns have been tested in the United States with a view to their adoption. All have failed under test, or have had objections which were not overcome, excepting the Crozier, in accordance with which a 10-inch gun was constructed and exhaustively tested at the Army Proving Ground. The test of this gun was highly successful, but up to 1901 none had been installed in fortifications.

Means of Sighting.—All field, siege, and sea-coast guns, excepting the mortars, are provided with both open and telescopic sights. The mortars are pointed by indirect laying, elevation being given by a quadrant. The telescopic sight is somewhat similar to the Scott, erecting the image and having a larger field. For the rapid-fire guns a bar sight is used, having a peep sight and a telescopic sight side by side. Electric night sights are also provided.

Fuzes.—Three kinds of fuzes are used: the base percussion, the point combination time and percussion, and a detonating fuze for high explosive shells. The first is used with all shells not containing high explosive, and the combination fuze is used with shrapnel alone. There are two sizes of the latter fuze, one burning to 15 seconds and the other to 28 seconds. The former is adapted to high-velocity fire with field and siege guns, and the latter for firings with the field and siege mortars and the siege howitzer. These fuzes are graduated to sixths of seconds. This method has been preferred to one giving the range in yards, since it permits the interchange of fuzes in projectiles for guns of different calibres. The fuzes for the field projectiles and 5-inch shrapnel are issued and transported with the projectiles ready for firing. The remaining fuzes for siege and sea-coast service are packed in tin waterproof cases for separate transportation, to be inserted in the projectile at or near the firing ground.

Powder.—The sphero-hexagonal black powders and brown prismatic powder in store will be used principally for practice until the supply is exhausted, after which smokeless powders will alone be supplied. Many experiments to determine the most suitable smokeless powders have been made since 1890. At present that which appears to meet with most favour is a pure gun-cotton powder made from cotton, of which only about 1 per cent. is insoluble. This has a cylindrical multi-perforated grain, the size depending upon the calibre. All powders are stored in hermetically sealed cases to prevent deterioration.

High Explosives.—Various high explosive charges for shells have been recommended and provisionally adopted, but this matter

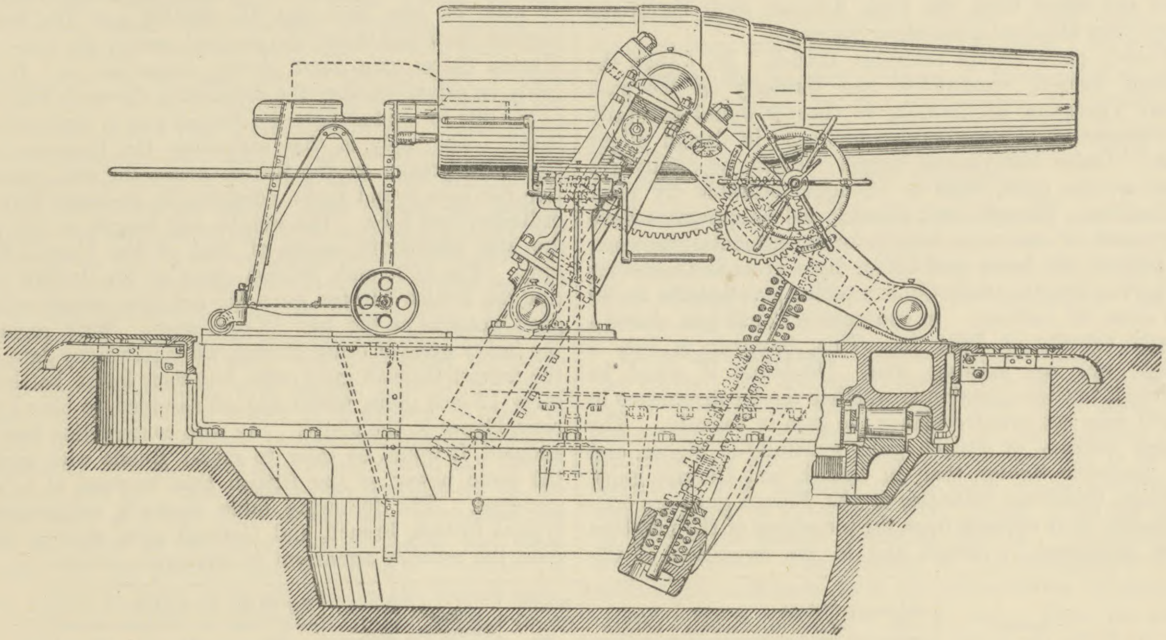


Fig 5.—Diagram of Carriage for 12-inch B.L. Mortar.

cannot as yet be considered settled. The war with Spain caused renewed activity in the field of invention, and recent experiments indicate two or three promising explosives for shells of all calibres to replace gun-cotton, which is now used.

Range-Finders.—The only range-finder thus far issued is the "Lewis Depression Range and Position Finder," of which there are two types. The type "A" is an instrument weighing about 700 pounds, designed for permanent installation on a concrete foundation at a considerable distance from the guns of a battery. A complete automatic replotter is carried on the table of each instrument, by the use of which the observer can instantly convert the range and direction of the target as read from the instrument into the corresponding range and direction from the gun itself. The corrections necessary for effects of curvature and normal refraction are made in the construction of the range scale, and corrections for changes in tide and abnormal refraction are controlled by the observer through mechanical devices. The type "B" instrument is light and portable, and somewhat resembles a transit in the ease and quickness of its adjustment. This type is designed as an emergency instrument, to be used in case of accident to the type "A," or when the lines of communication between the main position-finder and the gun are broken. The accuracy of this instrument is not so great as that of the larger one, but the error in range is said not to exceed 1 per cent. up to 8000 yards.

(C. B. W.)

IV. Other Powers.

The readiest method of presenting information in regard to the ordnance of foreign countries is to take the description of the British ordnance as a basis, and to state the principal differences exhibited in others. It is in a comparison of strength that the interest really lies. The following are the chief elements to note as indicating power in various ways:—

Muzzle Energy.—This is an expression for the actual blow delivered by a projectile leaving the muzzle of the gun. It is written $\frac{WV^2}{2g}$; W, on the British system, being the shot-weight in lb, V^2 the square of velocity in feet per second, and g the force of gravity in feet per second. The result is divided by 2240 to convert pounds into tons, the blow being most conveniently expressed in foot tons, *i.e.*, the number of tons that could be lifted through one foot by the energy of the blow if applied in a suitable shape. A comparison of energies is then a comparison of the blows delivered. The cost of manufacture and the necessary provision for the carriage of a gun mainly depend on its weight, and the simplest estimate of the success of any gun, as an investment, is the blow produced for each ton of metal. This is obtained by dividing the total energy by the weight of the gun in tons. The 12-inch wire-gun, Mark IX., gives 718, and the old 12-inch muzzle-loader only 273 foot tons per ton of gun.

Fire Energy per Minute.—The introduction of quick fire made it imperative to consider speed in any comparison of efficiency. This is done by multiplying the energy of the blow by the number of rounds delivered in a minute, the result being the total hitting or energy per minute. Thus, a 6-inch Q.F. gun, with a muzzle energy of 4840 foot tons, if it fires three times in a minute, has an energy per minute of 14,520 foot tons.

With these remarks the comparison of energies and other data given in tables will be intelligible. As, however, continual progress is made, it may be well to direct attention to certain annual publications giving trustworthy information. The Austrian *Marine Almanack*, published at Pola, is the first authority on Continental armaments. Much of its data is official, but not by any means all, and, in common with all works, it is apt to be specially behindhand in Russian guns. Brassey's *Naval Annual* gives official figures obtained directly concerning British and American guns, as well as Elswick, Krupp, Schneider-Canet, and Vickers Q.F. guns. Its figures on Continental guns are taken from the Pola *Annual*, with occasional corrections obtained from other sources.

French guns closely resemble British. M. Canet, the leading French constructor, was formerly on the staff of Mr Vavasseur of Elswick, so that it would naturally be supposed that considerable similarity in design might exist. Canet has pushed length farther, especially for coast-service guns, than is thought desirable by most authorities. Though both Elswick and Krupp guns have been made of enormous length for experimental purposes, 40 calibres for heavy and 50 for light guns is their limit for service length, while Canet's tables give lengths to 60 and even 80 calibres. In one case a Canet gun shows a muzzle velocity of 3281 f.s. This, however, is only a design, not an existing gun. Doubtless it could be achieved, but the question is whether the inconvenience in length does not counterbalance the gain in velocity. The muzzle velocity of French guns generally is higher, and the projectile lighter, than in British and German guns. In many tables the velocities of the French guns are only estimated, as is obvious from the roundness of the numbers when expressed in metres, and in the repetition of the same exact figures for many guns in tables converted into British units. German heavy guns made by Krupp are of about the same length as British pieces of the same calibre, but generally discharge heavier projectiles, the velocity being lower. The following table gives a comparison of the most powerful guns afloat in British, French, and German battleships, an American piece being added :—

Nation.	Calibre in inches.	Weight of Gun in tons.	Length of Bore in calibre.	Weight of Shot in lb.	Muzzle Velocity in ft. sec.	Muzzle Energy in ft. tons.	Energy per Ton of Gun.
British wire	12	46	35·4	850	2367	33,020	718
French .	12	45·9	40	643·8	2625	30,750	670
German .	11·02	43·4	40	562	2362	20,750	501
U.S.A. .	12	45·2	35·0	850	2100	25,985	575

There is a German 12-inch gun, but of an old type, giving inferior results and not mounted in the newest ships, so that the 11-inch is a fairer representative piece. It may be seen here that the British gun hits far the hardest blow and shows the greatest energy per ton. The United States gun most closely resembles it. It may fairly be asked whether the superiority shown in this table is not due to the fact that the British gun is more severely taxed. The reply is, that supposing the pressure to be somewhat greater in the British piece, the wire construction has been found to be considerably stronger than the ordinary steel tube. The weight and length of the piece are also slightly in excess of that of the United States gun. The 100- and 105-ton guns of the Italian navy, like the British 110-ton guns, are not now considered such good weapons as the last 12-inch guns. With regard to the heavy guns of other Powers, no trustworthy data as to the newest Russian guns exist, but their latest battleships carry 12-inch guns, which may be assumed to bear a close resemblance to the above. As wire construction has been adopted, it would be safer to credit Russia with guns of the same power as the British than to guess at a lower standard. The following table shows a comparison of typical British, French, and German guns such as might form the primary armament of armoured cruisers :—

Nation.	Calibre in inches.	Weight of Gun in tons.	Length of Bore in calibres.	Weight of Shot in lb.	Muzzle Velocity in ft. secs.	Muzzle Energy in ft. tons.	Energy per Ton of Gun. ft. tons.	Perforation wrought-iron in ins.		
								At muzzle.	At 2000 yds.	At 3000 yds.
British wire .	9·2	25	40	380	2347	14,520	581	27·6	20·7	18·0
French . .	9·45	22·4	40	317·5	2625	15,170	677	29·4	20·6	17·2
German . .	9·45	25·4	40	474	2067	14,050	553	26·8	20·0	17·7

The velocity of the French gun (800 metres) is doubtless only estimated, nine guns in the table having the same identical round figures. Practically it might probably prove to be somewhat less than here shown. Taking the figures as they stand, the French piece looks best at the muzzle, where its energy is highest, and its energy per ton of gun is nearly 20 per cent. better than the others. At 2000 yards, however, the British gun has passed it in penetration, and at 3000 yards the German also, owing to the resistance of the air telling more on the light projectile. Italian and Japanese guns, being principally supplied by Elswick and Krupp, closely resemble the British and German armaments. In some cases Elswick supplied to Japan rather longer pieces and Q.F. guns of larger calibre than had at that time been adopted in the British service. In short, the newer Japanese ships are likely to be in the very front in power of armament. Austria, Holland, and Denmark have obtained their most powerful and newest guns from Krupp, although the two latter countries have some Elswick guns. The same is generally true of Sweden and Norway, China, and the South American Governments. The latter are chiefly remarkable for cruisers obtained from Elswick, mounting Q.F. batteries of extraordinary power. The energy of fire per minute of the broadside of these cruisers is enormous.

With regard to heavy guns, then, the state of matters may be summed up thus :—The ordnance of foreign Powers closely resembles that of the United Kingdom, the greater number of guns being furnished by Krupp, Elswick, or Canet. New guns differ but slightly in proportions, and therefore when similarly charged deliver similar blows; but experiments indicate that the wire construction adopted in Great Britain, and to some extent in Russia, increases the strength of the piece. Consequently, such guns are capable of delivering harder blows than others when all are worked to the same limit of safety.

Probably the most important guns at the present time for naval warfare are not the heavy primary guns, but the heavier classes of Q.F. guns mounted on broadside or secondary armaments behind medium armour. The reason for this is that the blows delivered by the heavy primary guns are comparatively few, and the light unprotected guns may be too much exposed for them to be manned in close action, while their small destructive capacity limits their scope to unarmoured structures. In the adoption of this important class, *i.e.*, the more powerful Q.F. guns, Great Britain took the lead, the first pieces made at Elswick having been proposed and designed by Sir Andrew Noble. In 1886 Elswick had 30-pounder Q.F. guns. In 1890 Krupp and Gruson, and doubtless Canet, had perfected light Q.F. guns; but the appearance in 1888 of 4·7-inch Q.F. pieces in the armaments of the *Nile* and *Trafalgar*, and of those of 6-inch, discharging 100-℔ shells, in the *Ramillies* class in 1890, marked a great stride in British naval armaments. The French at that time had only small 65-mm. (2·57-inch) Q.F. pieces, discharging a shell weighing 8½ ℔ in the *Carnot*, and Germany had 10·5-cm. pieces in the *Brandenburg* class. Nor was the advantage limited to priority in time. From an early date Elswick guns were laid by sights on the fixed part of the carriage, so that the eye would be right on the sights, undisturbed by the recoil of the gun. This feature, on which special stress was laid some years afterwards in the French parliamentary discussions, was found in very few Q.F. guns even in the Chicago Exhibition in 1893. Now things are greatly changed: Germany shows the entire armaments of her new turret-ships as Q.F. guns, including the 9·4-inch pieces of the turrets; and France shows 6·4-inch Q.F. guns in her new cruisers and battleships. In the British navy some of the features of quick firing are embodied in the heaviest pieces, including the 12-inch, which probably compares well in speed of loading with foreign guns of the same calibre; but quick-firing proper is considered to cease in England when the projectile becomes too heavy for ready manipulation by hand; and this consideration has caused the 6-inch gun Q.F. armament to be retained up to the present time, although Elswick has long advocated the 8-inch embodied in the armaments of Chilian and other cruisers. At the present time a Q.F. gun of about 7·5 inches calibre is likely to be adopted in the British navy. The important matter is the relation of the power of the Q.F. gun to the armour protecting that of the enemy, and, conversely, of the enemy's fire to British protection. So far the advantage on the side of the British armaments has been so marked that it is hardly too much to say that their Q.F. guns are able easily to attack those on nearly all foreign war-vessels with success, while well protected themselves from counter-attack. The official tables of Schneider-Canet Q.F. guns begin at 37-mm. (1·46-inch), and extend up to 24-cm. (9·45-inch). Those of Krupp begin similarly at 37-mm. (1·46-inch) and extend to 30·5-cm. (12·01-inch). In short, all now apply means for increasing the speed of fire to all guns, but their means gradually cease to be applicable as the calibre increases.

Land-Service Guns.—Siege guns in many cases correspond with the heavier Q.F. guns mentioned above, so that the pieces deserving notice are the field guns, including howitzers. The most important feature is the application of quick fire; and as it is necessary for quick laying that the gun should not recoil or depart far from the direction in which the previous round was laid, field guns which are free to move instead of being on fixed mountings require brakes to check their recoil; so that one necessary element in the power of field artillery is an efficient brake. The gun generally has a measure of recoil and recovery provided by means of a recoil cylinder fixed in the carriage, the latter being checked from running back by a spade, rope, or other brake. France up to 1902 kept its newest field equipment secret, but it is known that Q.F. guns exist in some proportion, and the calibre is said to be 2·95 inches. The gun acts on a recoil cylinder on the carriage, and the latter has a strong spade brake fixed on the trail. Germany has completely introduced Q.F. field guns; the gun breech opens to the side on the wedge system. It seems doubtful if it is nearly as quick as some systems. There is no recoil cylinder on the carriage, which is checked by rope and spade brakes. The gun ordinarily fires shrapnel shell, but high explosive shells with a wide-spreading burst are issued, to search behind cover and act as a substitute for a howitzer shell. In Austria the existing field guns have been improved and modified for temporary need, so as to achieve about five rounds per minute; a spade brake is used. Russia has introduced quick fire into her field equipment. The carriage is checked in recoil by a spade brake. There is also a sliding arrangement, and a system of indiarubber pads in the body of the carriage. The gun is kept secret, but is said to fire from four to five rounds a minute. Italy, Spain, and Belgium have experimented with Q.F. guns. (C. O.-B.)

Ordu, the ancient *Cotyora*, a town on the north coast of Asia Minor, between Samsún and Kerasund, connected with Sivas by a carriage road, and with Constantinople and Trebizond by steamer. Population, 5800 (900 Moslems, 3000 Greeks, 1900 Armenians).

Örebro, an ancient town of Sweden, near the west extremity of Lake Hjelmar, 124 miles west of Stockholm by rail. It has a considerable trade in iron by way of the lakes Hjelmar and Mälar. Population (1880), 11,785; (1890), 14,547; (1900), 22,013.

Ore-dressing.—When the miner hoists his ore to the surface, the contained metal may be either in the native uncombined state, or combined with other substances forming minerals of more or less complex composition. In both cases the valuable mineral is always associated with minerals of no value. The province of the ore-dresser is to separate the "values" from the waste by mechanical means, obtaining thereby "concentrates" and "tailings." The province of the metallurgist is to extract the pure metal from the concentrates by chemical means, with or without the aid of heat. There are also a number of non-metallic minerals which do not have any value, or at best do not reach their highest value until they have been subjected to some form of mechanical preparation; among them are diamonds, graphite, corundum, garnet, asbestos, and coal. Ore-dressing, for the purposes of this article, may be divided into three parts: (1) properties of minerals which render aid in their separation; (2) simple operations; (3) operations combined to form processes or mills.

Properties.

(1) The *specific gravity* of minerals varies greatly, some being heavy, others light. The rate of settling in water is affected by the specific gravity in this way: of two particles of the same size but different specific gravity, the heavier settles more rapidly than the lighter, while of two particles of different specific gravity which settle at the same rate in water, that of higher specific gravity is of smaller diameter than the other. The same statements are true in regard to settling in air, and in regard to momentum in air when the particles are thrown out in a horizontal direction. *Colour, lustre, and fracture* are of especial value in hand-picking, to aid the eye in selecting the mineral sought. Instances are, of colours, the white of quartz, the pale straw colour of feldspar, the dull yellow of limonite, the brass yellow of chalcopyrite, the pale metallic yellow of pyrites; of lustres, the vitreous of quartz, the adamantine of diamond and

cerussite, the resinous of blende, the earthy of limonite, and the metallic of pyrite; and of fractures, the cleavage planes of feldspar and galena, the conchoidal fracture of quartz and pyrite, the granular of some forms of magnetite and blende. *Magnetism* is a most direct and simple method of separating minerals where it is available. The discovery that by the use of electro-magnets of great power, minerals formerly regarded as non-magnetic are attracted, has made it possible to separate several classes of minerals present in an ore; for example, the strongly magnetic mineral may first be taken out, then the mildly magnetic, and last the weakly magnetic, the non-magnetic being left behind. *Adhesion* acts when brightly burnished particles of gold issuing with the sand from the stamp mill come in contact with an amalgamated copper plate, for they are instantly plated with mercury and adhere to the copper, while the sand is carried forward by the water. In this way a very perfect separation of the gold from the sand is effected. In the South African diamond fields it has been found that if the diamond-bearing sand is taken in a stream of water over a smooth surface covered with a suitable coating of grease, the diamonds will adhere to the grease while the sand does not. *Decrepitation* is the property possessed by some minerals of flying to pieces when heated suddenly. If, for example, blende and barite occur together in a product where the grains are about the same size, they cannot be separated by water, being of nearly the same specific gravity, but when dropped upon a heated iron plate, the barite flies into small particles, and can then be separated from the blende by sifting. This principle, however, can only rarely be applied.

Simple operations.

(2) The concentration of ores always proceeds by steps or stages. Thus the ore must be crushed before the minerals can be separated, and certain preliminary steps, such as sizing and classifying, must precede the final operations which produce the finished concentrates. The more important of these simple operations will now be described.

The ore as mined contains the valuable minerals attached to and enclosed in lumps of waste rock. The province of *crushing* or disintegrating is to sever or unlock the values from the waste, so that the methods of separation are then able to part the one from the other. In crushing ores it is found wise to progress by stages, coarse crushing being best done by one class of machine, medium by another, and fine by a third. Coarse crushing is accomplished by *breakers* of the Blake type (Fig. 1) or of the Gates Comet type (Fig. 2). All of these machines break by direct pressure, caused by a movable jaw, *a* (Figs. 1, 2), approaching towards and receding from a fixed jaw, *b*. The largest size ever fed to a breaker is 24 inches in diameter, and the smallest size to which the finest crushing commonly done by these machines brings the ore is about $\frac{3}{4}$-inch diameter. The machine is generally supplied with ore in lumps not larger than 9 inches in diameter, and crushes them to about $1\frac{1}{2}$ inch in diameter. Medium-size crushing is done mostly by rolls or steam stamps. *Rolls* (Fig. 3) crush by direct pressure caused by the ore being drawn between two revolving rolls held closely together. They make the least fine slimes or fines to be lost in the subsequent treatment, and are therefore preferred for all brittle minerals. The *steam stamp* works upon the same principle as a steam hammer, the pestle being forced down by steam pressure acting through piston and cylinder with great crushing force in the mortar. Steam stamps have been very successful with the native copper rock, because they break up the little leaves, flakes, and filaments of copper, and render them susceptible of concentration, which rolls do not. Fine crushing is done by gravity stamps, pneumatic stamps, by centrifugal roller mills, by amalgamating pans, by ball mills, by Chile edgestone mills, and by arrastras. The *gravity stamp* (Fig. 4) is a pestle of 800 lb weight more or less, which is lifted by a revolving cam and falls by the force of gravity to strike a heavy blow in the mortar and do the work of crushing; the frequent revolution of the cam gives a more or less rapid succession of blows. Gravity stamps are especially adapted to the fine crushing of gold ores, which they reduce to $\frac{1}{30}$-inch and sometimes even to $\frac{1}{80}$-inch grains. The blow of the stamp upon the fragments of quartz not only liberates the fine particles of gold, but brightens them so that they are quickly caught upon the amalgamated plates. The *pneumatic stamp* has a heavy pestle, which is moved up and down by direct connexion with a crank; but since the height of the ore in the mortar varies, the pestle must have the means also of varying its movement to avoid breakage. To this end an air cylinder with piston is inserted in the stem, the elasticity of the air within the cylinder not only giving the needed variation of throw, but increasing the force of the blow in the mortar. The *centrifugal roller mills* are suited to fine crushing of middle products, namely, by-products composed of grains containing both values and waste, since they avoid making much fine slimes. They crush by the action of a roller, rolling on the inside of a steel ring, both having vertical axes. The *amalgamating pan* is suitable for grinding silver ores for amalgamation where the finest grinding is sought, together with the chemical action from the contact with iron. It crushes by a true grinding action of one surface sliding upon another. The *Chile edgestone mill* is employed for the finest grinding ever used preparatory to concentration. The *arrastra* or drag-stone mill grinds still finer for amalgamating.

A considerable class of workable minerals, among which are surface ores of iron and surface phosphates, contain worthless clay mixed with the valuable material, the removal of which is accomplished by the *log washer*. This is a disintegrator consisting of a long narrow cylinder revolving in a trough which is nearly horizontal. Upon the cylinder are knives or paddles set at an angle, which serve the double purpose of bruising and disintegrating the clay and of conveying the cleaned lump ore to be discharged at the upper end

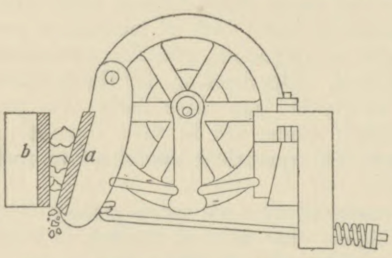


FIG. 1.—Blake Breaker. *a*, Movable jaw; *b*, fixed jaw.

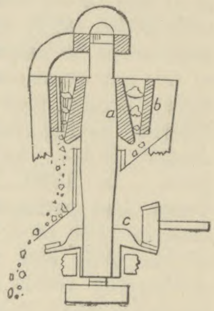


FIG. 2.—Gates Breaker. *a*, Movable jaw; *b*, fixed jaw; *c*, gear with eccentric hub and with loose fit on the spindle.

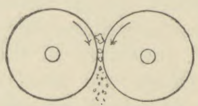


FIG. 3.—Crushing Rolls.

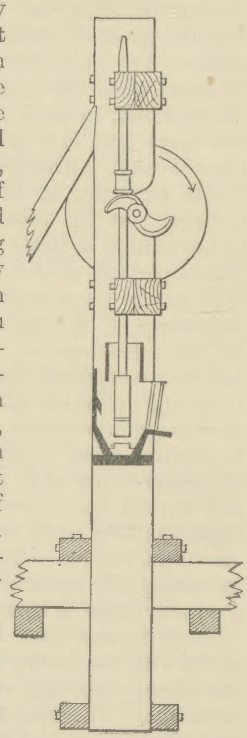


FIG. 4.—Gravity Stamp.

of the trough, the water meanwhile washing away the clay at the lower end.

Roasting for Friability.—When two minerals—for example, pyrites and cassiterite,—one of which is decomposed and rendered porous and friable by heat and oxygen, are roasted in a furnace, the pyrites becomes porous oxide of iron, while the cassiterite is not changed. A gentle crushing and washing operation will then break and float away the lighter iron oxide, leaving the cassiterite behind.

Sizing.—If crushed ore be sifted upon a screen with holes of definite size, two products will result—the oversize which is unable to pass through the screen and the undersize which does pass. If the latter size be sifted upon another screen with smaller holes, it will again make oversize and undersize. Rittinger adopted for close sizing the following diameters in millimetres for the holes in a set of screens: 64, 45·2, 32, 22·6, 16, 11·3, 8, 5·6, 4, 2·8, 2, 1·4, 1. Each of these holes has an area double that of the one next below it; this may be called the screen ratio. A process which does not need such close sizing might use every other screen of the above set, and in extreme cases even every fourth screen. In mills the screen ratio for coarse sizes often differs from that for fine. Sizing is done by cylindrical screens revolving upon their axes (Fig. 5), by flat shaking screens, and by fixed screens with a comparatively steep slope. Wire cloth with square holes and steel plate punched with round holes are both used. To remove the largest lumps in the preliminary sizing fixed-bar screens are preferred, on account of their strength and durability.

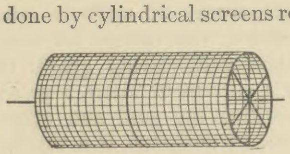


Fig 5.—Trommel or Revolving Screen.

Sizes smaller than can be satisfactorily handled by screens are treated by means of *hydraulic classifiers* and *box classifiers* (*spitzkasten*). The lower limit of screening and therefore the beginning of this work varies from grains of 5 millimetres to grains of 1 millimetre in diameter. A hydraulic classifier (Fig. 6) is a trough-like washer through which the water and sand flow from one end to the other. In the bottom, at regular intervals, are pockets or pits with hydraulic devices which hinder the outflowing discharge of sand, *b*, by an inflowing stream of water, *a*. By regulating the speed of these water currents, the size of the grains in the several discharges can be regulated, the first being the coarsest and the overflow at the end the finest. Box classifiers are similar, except that the pockets are much larger and no inflowing clear water is used; they therefore do their work much less perfectly. Classifiers do not truly size the ore, but merely class together grains which have equal settling power. In any given product, except the first, the grain of high specific gravity will always be smaller than that of low. The box classifiers are suited to treating finer sizes than the hydraulic classifiers, and therefore follow them in the mill treatment.

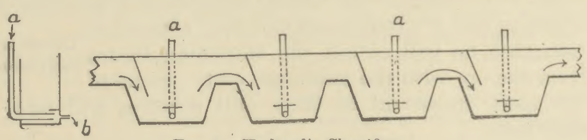


Fig. 6.—Hydraulic Classifier.

Picking floors are areas on which men, boys, or girls pick out valuable mineral which is rich enough to ship at once to the smelter. The picking is often accompanied and aided by breaking with a hammer. *Picking tables* are generally so constructed that the pickers can sit still and have the ore pass before them on a moving surface, such as a revolving circular table or travelling belt. Stationary picking tables require the ore to be wheeled to and dumped in front of the pickers. Picking out the values by hand has the double advantage that it saves the power and time of crushing, and prevents the formation of a good deal of fine slimes which are difficult to save.

Jigs treat ores ranging from $1\frac{1}{2}$ inch in diameter down to $\frac{1}{50}$ inch. If an intermittently pulsating current of water is passed up through a horizontal sieve on which is a bed of ore, the heavy mineral and the quartz quickly form layers, the former beneath the latter. The machine by which this work is done is called a jig (Fig. 7), and the operation is called jigging. The pulsating current is obtained by placing a vertical longitudinal partition, *c*, extending part of the way down to the bottom of the jig box. The sieve *a* is firmly fastened on one side of the partition, and on the other a piston, *d*, is moved rapidly up and down by an eccentric, causing an up-and-down current of water through the sieve *a*. The sieve is fed at one end, *e*, with a constant supply of water and ore, and the quartz overflows at the other. The constantly accumulating bed of concentrates is either discharged through the sieve into the space below, *g*, called the hutch, or by some special device at the side. On jigs where the concentrates pass through the sieve, a bed of heavy mineral grains too large to pass holds back the lighter quartz. The quartz overflow from one sieve, *a*, generally carries too much value to be thrown away, and it is therefore jigged again upon a second sieve, *b*. In jigging difficult ores, three, four, five, and even six sieves are used. A succession of sieves gives a set of products graded both in kind and in richness, the heavier mineral, as galena, coming first, the lighter, as pyrites and blende, coming later. The best jigging is done upon closely sized products using a large amount of hydraulic water added beneath the sieve. Very good jigging may, however, be done upon the products of hydraulic classifiers, where the heavy mineral is in small grains and the quartz is large, by using a bed on the sieve and diminished hydraulic water, which increases the suction or downward pull by the returning plunger.

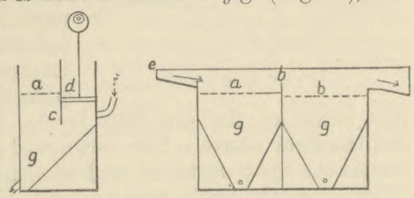


Fig. 7.—Harz Jig.

Bumping Tables.—Rittinger's table is a rectangular gently-sloping plane surface which by a bumping motion throws the heavy particles to one side while the current of water washes down the quartz to another, a wedge-shaped divider separating and guiding the concentrates and tailings into their respective hoppers. The capacity on pulp of $\frac{1}{30}$- to $\frac{1}{50}$-inch size is some 4 tons in twenty-four hours. In the Wilfley table (Fig. 8) and those derived from it a gentler vanning motion is substituted for the harsh bump; they have a greatly increased width and a set of riffle blocks, *b*, at right angles to the direction of flow, *c*, tapering in height towards the side where the concentrates are discharged, *d*. This combination has produced a table of great efficiency and capacity for treating grains from $\frac{1}{8}$ inch in diameter down to $\frac{1}{200}$ inch or even finer. The capacity on $\frac{1}{30}$-inch pulp is from 15 to 25 tons in twenty-four hours.

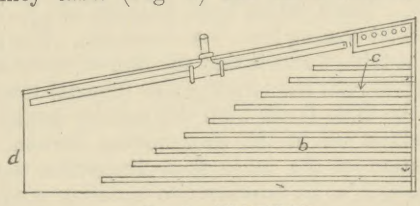


Fig. 8.—Wilfley Table.

Vanners are machines which treat ores on endless belts, generally of rubber with flanges on the two sides. The belt (Fig. 9) travels up a gentle slope, *a*, on horizontal transverse rollers, and is shaken about 200 times a minute, either sidewise or endwise, to the extent of about one inch. The lower 10 feet is called the concentrating plane, *b*, and slopes 2·78 per cent. more or less from the horizontal; the upper 2 feet of length is called the cleaning plane, *c*, and slopes 4·45 per cent. more or less. The ore is fed on with water at the intersection of the two planes, *d*. The vibration separates the ore into layers, the heavy beneath and the light above. The downward flow of the water carries the light waste off and discharges it over the tail roller *e* into the waste launder, while the upward travel of the belt carries up the heavy mineral. On the cleaning plane the latter passes under a row of jets, *f*, of clean water, which remove the last of the waste rock; it clings to the belt while it passes over the head roller, and only leaves it when the belt is forced by the dipping roller to dip in the water of the concentrates tank *g*. The cleaned belt then continues its return journey over the guide roller *h* to the tail roller *e*, which it passes round, and again does concentration duty. Experience proves that for exceedingly fine ores the end shake with steep slope and rapid travel does better work than the side-shake vanner. For ordinary gold stamp-mill pulp, where cleanness of tailings is the most important end, and where to gain it the engineer is willing to throw a little quartz into the heads, the end-shake vanner is again probably a little better than the side shake, but where cleanness of concentrates is sought the side-shake vanner is the most satisfactory.

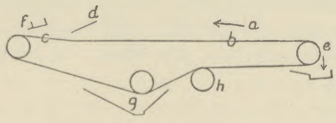


Fig. 9.—Frue Vanner.

Slime-tables are circular revolving tables (Fig. 10) with flattened conical surfaces, and a slope of $1\frac{1}{8}$ inch more or less per foot from centre to circumference; a common size is 17 feet in diameter, and a common speed one revolution per minute. These tables treat material of $\frac{1}{100}$ inch and less in diameter coming from box classifiers. The principle on which the table works is that the film of water upon the smooth surface rolls the larger grains (quartz) towards the margin of the table faster than the smaller grains (heavy mineral) which are in the slow-moving bottom current. The revolution of the table then discharges the quartz earlier at *a*, *a*, *a*, *a*, an intermediate middling product next at *b*, and the heavy mineral last at *c*. Suitable waste-launders and catch-boxes are supplied for the three products. The capacity of such a table is 12 tons or more of pulp, dry weight, in twenty-four hours. *Frames* are rectangular slime-tables which separate the waste from the concentrates on the same principle as the circular tables, though they run intermittently. They treat very fine pulp, and after being fed for a short period (about fifteen minutes) the pulp is shut off, the concentrates are flushed off with a douche of water and caught in a box, and the feed pulp is again turned on. They are much used in the Cornish tin works. *Canvas tables* are rectangular tables with plane surfaces covered with cotton duck (canvas) free from seams; they slope about $1\frac{1}{2}$ inch to the foot. They are fed with stamp-mill pulp, with the tailings of vanners, or, best of all, with very fine pulp overflowing from a fine classifier. The rough surface of the duck is such an efficient catching surface that they can run for an hour before the concentrates are removed—an operation which is effected by shutting off the feed pulp, rinsing the surface with a little clean water, and hosing or brooming off the concentrates into a catch-box. The feed-pulp is then again turned on and the work resumed. They have been more successful than any other machine in treating the finest pulp, especially when their concentrates are finally cleaned on a steep slope end-shake vanner.

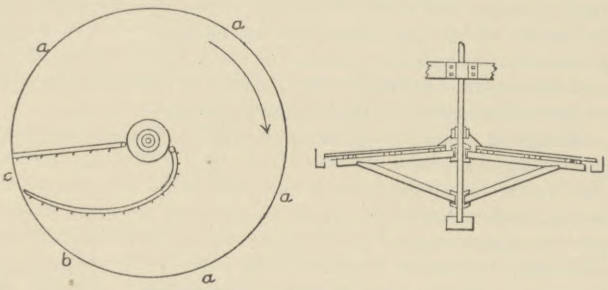


Fig. 10.—Convex Revolving Slime-table.

Buddles act in principle like slime-tables, but they are stationary, and they allow the sand to build itself up upon the conical surface, which is surrounded by a retaining wall. When charged, the tailings are shovelled from the outer part of the circle, the middlings from the intervening annular part, and the concentrates from the inner part. They treat somewhat coarser sizes than the slime-table. When wooden blocks or cobble-stones of uniform size are placed in the bottom of a sluice, the spaces between them are called *riffles*; and when gold-bearing gravel is carried through the sluice by a current of water, a great many eddies are produced, in which the gold and other heavy minerals settle. The *kieve* or *dolly-tub* is a tub as large or larger than an ordinary oil barrel, with sides flaring slightly upwards all the way from the bottom. In the centre is a little vertical shaft, with hand-crank at the top and stirring blades like those of a propeller at the bottom. Fine concentrates from buddles or slime-tables are still further enriched by treatment in the kieve. The kieve is filled perhaps half full of water, and the paddles set in motion; concentrates are now shovelled in until it is nearly full, the rotation is continued a little longer, and then the shaft is quickly withdrawn and the side of the kieve steadily thumped by a bumping-bar as long as settling continues. When this is completed, the water is syphoned off, the top sand skimmed off and sent back to the buddle, and the enriched bottom material shovelled out and sent to the smelter.

Combined operations.

(3) In designing concentration works, the millwright seeks so to combine the various methods of coarse and fine crushing and of preliminary and final concentration that he will obtain the maximum return from the ore with the minimum cost. Some of the more important of these mill schemes will now be described.

The *hand-jig process* used for the *zinc and lead* ores of Missouri is first to clean the ore from adhering clay by raking it back and forth in a sluice with a running stream of water, and then shovel it upon a sloping screen with holes of about one inch, where it yields oversize and undersize. The former is hand-picked into lead ore, zinc ore, and waste, while the latter is jigged upon a hand-jig and yields several layers of minerals removed by a hand-skimmer. The top skimmings are waste, the middle skimmings come back with the next charge to be jigged over, and the bottom skimmings go to a second jig with finer screen. The coarsest of the hutch product goes to the second jig, the finest is sold to a sludge mill. The second jig makes top skimmings which are sent back to the first jig, middle skimmings which are zinc concentrates, and bottom skimmings and hutch, which are both lead concentrates.

In the *Missouri zinc-concentrating mill* the ore carrying blende and calamine with a little galena is in very large crystallizations and contains, when crushed, very little in the way of included grains. It is crushed by Blake breaker and rolls, to pass through a sieve with holes $\frac{3}{4}$ inch in diameter, and is then treated on a jig with six consecutive sieves, yielding discharge and hutch products from each sieve, and tailings to waste. The earlier discharges are finished products, while the later are re-crushed and re-treated on the same jig. The hutch products are treated on a finishing-jig with five sieves, and yield galena from the first discharge and hutch, and zinc ore from the others. The capacity of such jigs is very large, even to 75 or 100 tons per day of ten hours.

In the *diamond washing* of Kimberley, South Africa, the material taken from the mine is weathered by exposure to the air and rain for several months, and the softening and disintegration thus well started are completed by stirring in vats with water. Breaker and rolls were tried in order to hasten the process, but the larger diamonds were broken and ruined thereby. The material from the vats is screened and jigged, and of the jig concentrates containing about 2 per cent. of diamonds the coarser are hand-picked and the finer are treated on a greased surface.

Lead and copper ores contain their values in brittle minerals, and are concentrated in mills which vary somewhat according to local conditions; the one here outlined is typical of the class. The ore is crushed by breaker and rolls, and separated into a series of products diminishing in size by a set of screens, hydraulic classifier, and box classifier. All the products of screens and hydraulic classifiers are jigged on separate jigs yielding concentrates, middlings, and tailings; those of the box classifier are treated on the slime-table, vanner, or Wilfley table, yielding concentrates and tailings and perhaps middlings. The coarser middlings contain values attached to grains of quartz and are therefore sent back to be re-crushed and re-treated. The finer middlings contain values difficult to save from their shape only, and are sent back to the same machine or to another to be finished.

The *native copper rock of Lake Superior* is broken by powerful breakers, sometimes preceded by a heavy drop-hammer weighing nearly a ton. The operation is accompanied by hand-picking, yielding rich nuggets with perhaps 75 per cent. of copper ready for the smelter; at some mines a second grade is also picked out which goes to a steam finishing-hammer and yields cleaned mass copper for the smelter and rich stamp stuff. The run of rock which passes by the hand-pickers is of a size that will pass through bars 3 inches apart, and goes to the steam stamps. The stamps crush the rock to pass through a screen with round holes $\frac{3}{16}$ inch in diameter. This sand is treated in hydraulic classifiers with four pockets, the products from the pockets being jigged by four roughing-jigs yielding finished mineral copper for the smelter, included grains for the grinder, partially concentrated products for the finishing-jigs, and tailings which go to waste. The overflow of the hydraulic classifier runs to a tank of which the overflow is sent to waste in order to diminish the quantity of water, while the discharge from beneath, treated upon slime-tables, yields concentrates, middlings, and tailings. The middlings are re-treated. The stamp mortars are cleaned out periodically, even several times a day, and yield rich nuggets of copper and unfinished material which is sent back to the mill. Putting all the finished concentrates together, they will assay from 60 to 80 per cent. of copper according to circumstances. The extraction from the rock is from 50 to 80 per cent. of the copper contained in it.

Cornwall Tin.—Tinstone in Cornwall occurs associated with sulphides, wolfram, quartz, feldspar, slate, &c., and is broken by spalling-hammers to 3-inch lumps. Hammers make less slimes than the rock-breakers, and they also break the ore more advantageously for the hand-picking. The latter rejects waste, removes as far as possible the hurtful wolfram, and classes the values into groups according to richness. Gravity or pneumatic stamps then crush the ore to $\frac{1}{50}$ inch, and stripes (a species of long rectangular buddle) yield heads, middlings, tailings, and fine slimes: the first three are sent separately to circular buddles, and the last to frames. The buddles yield heads, middlings, and tailings: the middlings are re-treated, the tailings are all waste; the heads are still further enriched by kieves, which yield tops to the buddle again and bottoms shipped to the smelter. The fine slimes are treated on frames, the concentrates of which go to buddles; of these the heads go to kieves.

The *Missouri zinc-lead sludge mill* takes the finest part of the hutch product of the hand-jigs. The treatment begins on revolving screens with two sizes of holes, 25 mm. and 1 mm.: these take out two coarser sizes, of which the coarser is waste and the other is jigged, yielding concentrates and waste. The main treatment begins with the finest size, which is much the largest product. It is fed to a convex circular buddle (first buddle), and yields a coarser product at the outer part of the circle and a finer product in the inner. The finer product is treated by a series of buddlings which vary somewhat, but in general are as follows: fed to a second buddle it yields zinc and lead ore in the centre, next zinc ore, next middlings which come back, and, outside of all, tailings. The zinc-lead ore is set on one side until enough has accumulated to make a buddle run, when it is run upon a third buddle yielding in the central part pure lead concentrates, next lead ore (which is returned to this treatment), next zinc ore, and outside of all a zinc product which is fed to the second buddle. The coarse outside product of the first buddle is treated in much the same way as the fine, but it yields practically no lead zinc product, which simplifies the series of buddlings necessary.

Gold Mill.—Gold ores usually contain their value in two conditions—the free gold, which can be taken out by mercury, and the combined gold, in which the metal is either coated with or combined with compounds of sulphur, tellurium, &c. The usual gold-milling scheme is to crush the ore by rock-breaker to about $1\frac{1}{2}$ inch diameter, and then to crush with water by gravity stamps, a little mercury being added to the mortar from time to time to begin the amalgamation at the first moment the gold is liberated. The pulp leaves the mortar through a screen with holes or slots $\frac{1}{30}$ to $\frac{1}{60}$ inch in width, and is then passed over amalgamated plates of copper or silver-plated copper. The free gold, amalgamated by the mercury, adheres to the mercurial surface on the plate; the rest of the pulp flows on through mercury traps to catch any of the mercury, which drains off the end of the plate. The plates and mortar are periodically cleaned up, the plates being scraped to recover the amalgam and leave them in good condition to do their work: if plates are used inside the mortar, they are cleaned in the same way. The residue of partly crushed ore in the mortar, with amalgam and free mercury scattered through it, is ground for a time in a ball mill, panned to recover the amalgam, and returned to the mortar. The pulp flowing away from the mercury traps flows to a Frue vanner or Wilfley table, on which it yields concentrates for the chlorination plant or smelter, and tailings: these are waste when the heavy mineral is of low grade, but if the vanner concentrates are of high grade, they still contain values in very fine sizes which can and should be saved. Recent improvements in California for saving this material have been made. The vanner tailings are sent to a fine classifier, from which the light overflow only is saved; this is treated upon canvas tables yielding concentrates and tailings, and these concentrates, treated upon a little end-shake vanner with steep slope and rapid travel, give clean, very fine, high-grade concentrates for the chlorination works.

Iron Ores.—The brown ores of iron from surface deposits are contaminated with a considerable amount of clay and some quartz. The crude ore from surface pits or shallow underground workings is treated in a log washer and yields the fine clay, which runs to waste, and the coarse material which is caught upon a screen and hand-picked, to free it from the little quartz, or jigged if it contains too much quartz. The magnetic oxide of iron occurs associated with feldspar and quartz, and can often be separated from them by the magnet. The ore, after being broken by breaker and rolls to a size varying from $\frac{1}{4}$ to $\frac{1}{16}$ of an inch in diameter, goes to a magnetic machine which yields (1) the strongly magnetic, (2) the weakly magnetic, and (3) the non-magnetic portions. The second or middlings product contains grains of magnetite attached to quartz, and is therefore re-crushed and sent back to the magnets; the strongly magnetic portion is shipped to the furnace; and the waste to the dump heap. In concentrating certain zinc sulphides, siderite (carbonate of iron) follows the zinc, and would seriously injure the furnace work. By a carefully adjusted roasting of the product in a furnace the siderite is converted into magnetic oxide of iron, and can then be separated from the zinc ore. A special magnet of very high power has been designed for treating the franklinite of New Jersey, a mineral which is non-magnetic in the usual machines. The ore, crushed by breaker and rolls and hand-picked to remove garnet, is treated upon a belt with a roughing magnet to take out the most magnetic portion, and then very closely sized by screens with 16, 24, 30, and 50 meshes per linear inch. The several products are treated each on its own magnetic machine, yielding the franklinite for the zinc oxide grates, and followed by spiegel furnace; the residue, which is jigged, yields the zinc silicate and oxide for the smelter furnaces, and waste carrying the calcite quartz and mica.

Gold dredging is the method employed for saving the values from gold-bearing sand and gravel in river bottoms. A flat boat is built, provided with guy-ropes or spuds, or both, for holding it still. The spuds are vertical posts or legs which can be forced down by powerful tackles through sockets in the boat, and so lift it as it were upon legs. At one end of the boat is a powerful endless-chain bucket-dredge, which scrapes the gravel from the bottom and elevates it to a revolving screen in the boat. This in turn sifts out the boulders, which are at once elevated to the bank of the river, while the fine material flows over tables covered with cocoa matting which acts like fine riffles, catching the gold in the interstices. The matting is periodically lifted up and thoroughly rinsed off, the rinsings are panned for gold, and the matting returned for another charge. The fine sand and gravel passing over the end of the tables is sent by the elevator to the river bank.

Asbestos, when of good quality, is in compact masses, which by suitable bruising and beating are resolved into fine flexible fibres. The Canadian asbestos is associated with serpentine, and is crushed by breakers to $\frac{3}{4}$ inch, screened on $\frac{1}{16}$-inch screens to reject fines. The values are removed by hand-picking and are crushed by rolls carefully set so as not to break the fibre; this product is then sized by screens and the various sizes are sent to the Cyclone pulverizer, which by beating liberates the individual fibres. It then goes to a screen with eleven holes to the linear inch, and yields a granular undersize and oversize, and a fibrous oversize which is drawn off by a suction fan to a settling-chamber with air outlets covered by fine screen cloth. This fibrous product is the clean mineral for the market. A special treatment separates the fibres of different lengths.

The usual method of dressing *corundum and emery*, after the preliminary breaking, is to treat the material in an edge-stone mill fitted with light wooden rollers. The action is that of grinding one particle against another, whereby the talc, chlorite, mica, &c., are worn off from the harder mineral. A constant current of water carries off the light impurities. This is called the "muller" process. At Corundum Hill, North Carolina, the first step in removing the impurities from "sand" corundum is to subject it to the scouring action of a stream of water while it is being sluiced from the mine to the mill, the action being increased by several vertical drops of 5 to 10 feet in the sluice. After reaching the mill all that will not pass through a 14-mesh screen is crushed by rolls, and the undersize of the screen is treated in a washing trough; this removes part of the light waste, and the "mullers" mentioned above complete the cleaning.

Graphite occurs in schist, but being of less specific gravity than the other minerals which enter into the composition of the schist, it settles later than they do. It also breaks into thin scales, which reduces its settling rate still further. The ore is broken by breakers, and by Chile edge-stone mills or by gravity stamps, to a size varying with the character of the minerals from perhaps $\frac{1}{20}$ to $\frac{1}{80}$ inch diameter. The pulp is then conveyed through a series of settling tanks of which the later are larger than the earlier. The quartz and other waste minerals settle in the earlier tanks, while the graphite settles later: the latest tank gives the best graphite. In the Dixon Company's works in New York some forms of concentrators are believed to have replaced the slower settling tanks.

Gold Hydraulicking.—The gold contained in surface gravel deposits is saved by one of the several schemes included in hydraulicking. A source of water power with very high head furnishes the water to a powerful jet called a "giant"; this washes down the gravel bank and conveys the coarse and fine material first to a head-sluice with riffles, which may be one hundred feet or more long, and then to a tail sluice, also with riffles, which may be several miles long. Periodically, once a month perhaps, the head-sluice is cleaned up, the riffle-blocks being removed and cleaned, and the sand which is washed down and caught in a temporary tank at the foot panned for its gold with hand-pans. The riffle-blocks are then replaced and work proceeds as before. At the end of the season the long tail-sluice also is cleaned up in the same way. Gravel containing 5 cents a cubic yard has in places paid well.

The *phosphates* of Florida are of four kinds: hard rock, soft rock, land pebble, and river pebble. The hard rock is crushed by toothed rolls, and cleaned in log washers. The washed product is screened; the sizes finer than $\frac{1}{16}$ inch are thrown away because too poor; the other sizes are dried and sold, some waste having been picked out of the coarsest. The soft rock is simply dried, ground, and sold. Land pebble is treated by log washers, any clay balls remaining being removed by a screen, and the phosphate dried and sold. In special cases land pebble is treated by hydraulicking, followed by a log washer, and this again by a powerful jet washer, to remove the last of the clay. River pebble is taken from the river by centrifugal pumps, and screened on two screens with 1-inch and $\frac{1}{16}$-inch holes respectively; the oversize of the first sieve and the undersize of the second sieve are thrown away because of too low grade. (R. H. R.)

Oregon, one of the north-western states of the American Union, situated on the Pacific coast, bounded on the N. by the state of Washington, on the E. by the state of Idaho, on the S. by the states of California and Nevada, and on the W. by the Pacific Ocean.

Population.—In 1880 the population was 174,768; in 1890 it had risen to 313,767, and in 1900 to 413,536, giving a density per square mile of 4·4 in 1900, as compared with 3·3 in 1890. The population was classified in 1900 as follows: males, 232,985; females, 180,551; native-born, 347,788; foreign-born, 65,748 (white, 394,582; negro, 1105; Chinese, 10,397; Japanese, 2501). Of the 116 incorporated cities, towns, and villages, twelve had a population of over 2000, but only three had over 5000, namely, Portland, one of the most important towns on the Pacific coast, with 90,426; Astoria, with 8381; and Baker City, with 6663 inhabitants. The urban population was 23·9 per cent. of the total. The school population (from 4 to 20 years) was, in 1890, 99,543; and in 1899, 133,181. The total land surface is approximately 94,560 square miles.

Agriculture.—Of farm products there were raised in 1899 21,949,536 bushels of wheat, of the value of $11,633,254; 1,255,264 tons of hay, of the value of $8,598,555, and 14,400,000 ℔ of hops. Other farm products included barley, corn, rye, buckwheat, and potatoes. The total farm and orchard products for the year amounted to $45,530,737, including 10,999,251 ℔ of butter, of the value of $3,024,508. The wool crop was 18,028,776 ℔. On 1st January 1900 there were in the state 189,427 horses and mules, valued at $5,727,164; 637,433 cattle, valued at $15,776,411; 2,446,695 sheep, valued at $6,532,676; and 87,532 swine, valued at $700,256.

Lumber.—The manufacture of lumber in 1900 amounted to 776,978,000 feet board measure, exclusive of custom sawing, as compared with 470,146,000 feet in 1890. The total number of wage-earners employed in this industry in 1900 was 4084, and the lumber products were valued at $10,352,167. The standing timber in the state, as appears from a survey made by the general Government in 1899, reaches a total of 234,653,000,000 feet board measure, and consists mainly of the Douglas fir, known in the lumber trade as the Oregon pine. The Bull Run national forest reserve, from which the city of Portland obtains its water-supply, consisting of 142,080 acres, and the Cascade national forest reserve, consisting of 4,492,800 acres, are contiguous, and constitute the largest forest reserve in the United States. Besides these there is the Ashland reserve.

Fish Canning and Preserving.—This is one of the most important industries in the state. The methods employed in taking fish tend to exhaust the fisheries and lessen the catch. The product of the Columbia river for 1895, as shown by the report of the United States Fish Commission, exceeded in value that of any other river in the world. The use of refrigerator cars has resulted in large annual shipments of fresh fish from Portland to the Eastern states and Europe, and this has lessened the canned product, the value of which in 1900 was $1,788,809.

Mining.—Gold mining has largely increased, the estimated output for 1900 exceeding $5,000,000 in value. The most productive gold-fields are in the counties of Baker and Grant. There is a constantly growing yield of gold from the mines of southern Oregon, and from the recently developed district in Lane county known as the Bohemia.

Manufacturing.—The following table shows the manufacturing and mechanical industries as returned at the censuses of 1890 and 1900, and the percentage of increase for the decade:—

	1890.	1900.	Percentage of Increase.
Number of establishments	1,523	3,088	102·8
Capital	$32,122,051	$33,422,393	4·0
Wage-earners, average number	16,760	17,236	2·8
Total wages	$9,559,734	$8,333,433	12·8 [1]
Cost of material used	$21,793,578	$26,099,855	19·8
Value of products	$41,432,174	$46,000,587	11·0

Those of most importance are lumber and timber products, flouring and grist mill products, canning and preserving fish, and slaughtering and meat-packing. A beet-sugar factory, in operation in the eastern part of the state, employed in 1899 between 130 and 140 employés. It cut during that season 11,295 tons of beets, and manufactured 2,200,000 ℔ of sugar. The product of the paper and pulp industry of the state for 1900 was of the value of $856,646. There were five manufactories, employing 716 wage-earners, engaged in this industry, and the capital invested was $2,161,186.

Railways and Commerce.—The Oregon Railway and Navigation Company owns and works 1130 miles of railway, including extensions of branch lines into portions of the state of Washington. It is the connecting line for two of the transcontinental railways of the state—the Union Pacific and its allied line, the Oregon Short Line, with which it connects at the eastern boundary of the state, and the Great Northern Railway, with which it connects at Spokane, in the state of Washington. It works river steamers on the Columbia and lower Willamette and Snake rivers, and a line of ocean steamships between Portland and San Francisco. The Southern Pacific Railway works 655·76 miles in the state; the Corvallis and Eastern, 142 miles; and the Astoria and Columbia River, 82½ miles.

In 1899 the foreign commerce was $10,639,068, of which $1,522,095 consisted of imports. Wheat shipments from the port

[1] Decrease.

of Portland were 12,431,807 bushels, of which 8,946,335 were shipped to Europe and Africa.

Banks.—Individual deposits in the national banks of the state during 1899 reached $11,781,130, and the bank clearings for the same year were $91,652,230. There are no statistics of the business done by private banks, of which there is a large number.

State Finances.—The state has no debt. The value of taxable property in 1898 was $133,533,577, and the rate of levy $5\frac{7}{10}$ mills. The revenue raised was $761,141. The lowest rate of levy was 3 mills, in 1894; the highest, 7 mills, in 1892. The average rate for twelve years ending with 1898 was 4·73 mills.

Education.—The cost of public education in 1880 was $339,080; in 1890, $1,062,890; and in 1899, $1,327,781. The average annual expenditure of public funds on this account for ten years ending with 1899 was $1,267,321. The state maintains a university, an agricultural college, and four normal schools. The two former have endowments from the sale of public lands granted to the state for these objects by Congress. The university has a further endowment of $50,000 derived from a private source. All are supported by liberal appropriations of public money by the Legislature. The general faculty of the university, including lecturers in the schools of law and medicine, consists of the president and fifty-three professors, instructors, and assistants. The number of students in 1899–1900 was 320. The agricultural college has, in common with such colleges in all the states, and in addition to the funds derived from the state grant and appropriations, endowments from the general Government of $25,000 annually for the benefit of agriculture and the mechanic arts, and $15,000 annually for an agricultural experiment station in connexion with the college. The object of the college, in its general scope, is "to promote the liberal and practical education of the industrial classes" by teaching such branches as are related to agriculture and the mechanic arts, and including military tactics. The endowments permit scientific and classical studies. The faculty of instructors consists of a president and twenty-eight professors, assistants, and instructors. The enrolment of students for 1888–89 was 151, and for 1899–1900, 405.

Charitable and Penal Institutions.—The state maintains at Salem, the capital, an asylum for the insane, a penitentiary, and a reform school. The insane asylum had 628 inmates in 1891 and 1160 in 1899. The penitentiary had 324 inmates in 1891 and 322 in 1899. The reform school had 99 inmates in 1899. The state also maintains separate schools for deaf mutes and for the blind, and also makes liberal appropriations for various "homes" and societies, organized as private charities.

Religion.—In 1890 the state had 969 religious organizations, with an aggregate of 70,524 members. The total value of church property was $2,829,150. In respect of numbers the principal denominations rank in the following order: Roman Catholic, Methodist, Baptist, Presbyterian, Congregational, Episcopalian.

Constitutional Changes: Politics.—There is a strong conservative tendency in the state. Constitutional amendments submitted to popular vote from time to time, since the admission of the state into the Union in 1859, have uniformly been defeated; among them an amendment repealing an obsolete provision to exclude free negroes from the state. The election of 1900, however, showed a growing sentiment in favour of woman suffrage. When the woman suffrage amendment was first submitted in 1884, it was defeated by a large majority. The vote in 1900 upon the same amendment stood, for the amendment, 26,265, against 28,402. The Republican party is dominant. In 1896, with three opposition candidates for Congress in one district and four in the other, its plurality was 441, while the combined opposition vote was 25,510 greater than the Republican vote. This result was due in large part to the equivocal position of the party in that year on the money question, and the nomination in consequence of a distinctively gold standard candidate for Congress in the largest district. In 1900 the Republican candidates for Congress had a plurality in the state of 12,407 votes, and a majority over the combined vote of three opposition parties of 3670. (C. B. B*.)

Oregon City, a city of Oregon, U.S.A., capital of Clackamas county, on the Willamette river, at the falls, and on the Southern Pacific Railway, 12 miles south of Portland, in the north-western part of the state, at an altitude of 100 feet. Fine water-power is afforded by the falls, 40 feet high, which is utilized in lumber, flour, paper, and pulp mills. The surplus power from the falls is wired to neighbouring cities for manufacturing, transportation, and lighting purposes. Population (1880), 1263; (1890), 3062; (1900), 3494, of whom 535 were foreign-born.

Orel, a government of Middle Russia, bounded by Kaluga and Tula on the N., Voronezh and Tamboff on the E., Kursk on the S., Tchernigoff and Smolensk on the W. Its area covers 18,040 square miles. Beside the Jurassic clays (Oxford and Kellowey), which were known to cover the Devonian deposits, Cretaceous deposits were found to have a wide extension. They consist of marls, white chalk, sandy chalk, phosphorite sands, very rich in fossils, and white and yellow sands and sandstones. Tertiary sands, sandstones, and glauconite clays are found in the south-west. Loess has a wide development.

In January 1897 the population reached 2,054,749, of whom 1,052,765 were women, and 228,618 lived in towns. The area under culture has slightly increased, from 59 per cent. of the total surface to 62 per cent., and the average annual crops of 1894–99 were: rye, 9,623,000 cwts.; wheat, 768,000; oats, 5,912,000; all cereals, 17,753,000 cwts. The eastern black-earth districts grow enough of their own crops for the whole year; to the others grain has to be imported. There were, in 1897, 427,410 horses, 243,370 cattle, 639,880 sheep, and 153,270 swine. Industrial activity is on the increase, and the aggregate return of all the 8537 large and small factories attained £1,569,800. The government is divided into twelve districts, of which the chief towns and their population in 1897 are: Orel, capital of the government (69,858), Bolkhoff (20,703), Bryansk (23,520), Dmitrovsk (5259), Elets (37,455), Karacheff (15,605), Kromy (5429), Livny (20,574), Maloarkhangelsk (7799), Mtsensk (9355), Sevsk (9167), and Trubchevsk (6899).

Orenburg, a province of East Russia, in the southern Urals, bounded by Ufa and Perm on the N., by Tobolsk on the E., by Turgai on the S.E., by Uralsk and Samara on the W. It has an area of 73,816 square miles. Its population has nearly doubled since 1860, and was 1,609,388 in 1897, of whom 149,373 lived in towns. It is rich in various minerals: gold, copper, and iron ore, rock and lake salt, semi-precious stones, sandstones, &c. Traces of coal have been discovered. Gold is extracted chiefly from alluvial deposits, about 116,400 oz. every year; as also some silver, 2160 oz. Nearly one-fifth of all the copper ore extracted in Russia comes from Orenburg (about 16,000 tons annually). Iron ores, including magnetic ore, exist in large quantities, and every year 16,000 to 20,000 tons of cast iron and 11,500 tons of iron are obtained. Coal has also been found on the Mias and near Iletsk. The extremely rich layers of rock salt at Iletsk yield about 24,000 tons of salt every year. Owing to the fertility of the soil, agriculture is carried on on a large scale; in an average year nearly 6,000,000 cwts. of grain—chiefly wheat and oats—are available for export. The annual average of the crops for 1894–99 was: wheat, 7,309,300 cwts.; rye, 1,362,000; oats, 3,117,000; all cereals, 12,999,000 cwts. Kitchen-gardening is carried on on a large scale, and gives occupation to nearly 11,000 persons. Cattle-breeding is conducted on an extensive scale by both Russians and Bashkirs, there being in 1895, 531,000 horses, 509,800 horned cattle, and 730,000 sheep. Various kinds of animal produce are largely exported, and by knitting "Orenburg shawls" of goat's wool the women earn £10,000 every year. The growth of the industries is slow, but trade, especially with the Kirghiz, is prosperous, and the annual returns of the Orenburg and Troitsk markets are estimated at £700,000. The chief towns of the five districts into which the government is divided are: Orenburg, Orsk (14,036), Tchelyabinsk (19,891), Troitsk (23,128), and Verkhneuralsk (11,802).

Orenburg, capital of the above government, on the Ural river, and connected by rail with Samara (262 miles). It is a large city, and had in 1897 a population of 72,740 (34,927 women), of whom about 30 per cent. were Tatars, Jews, Bashkirs, &c. The fortress has lost its former importance. A "Barter House," one mile from the town, has been built in the shape of a fort. The importance of Orenburg as a centre of trade with central Asia has decreased since the opening of the Transcaspian Railway; but, on the other hand, it has become an important centre for the export of horses, cattle, and meat to markets in the interior of Russia. From 20,000 to 100,000 horses, 40,000 to 160,000 cattle, and 450,000 to 750,000 sheep are sold every year at the Barter House. Formerly most of these were sent alive to Russia; now, from 50,000 to 60,000 head of cattle and sheep are killed every year at the municipal slaughter-houses, and 150,000 sheep in private *abattoirs*, the whole being exported in cold-storage waggons. Cattle are also bought by wandering merchants in the Steppe provinces and Turkestan. Every year from 8950 to 23,500 tons of frozen meat, tallow, hams, sausages, butter, cheese, and game are exported by rail to Samara. Besides these, nearly a million of hides and sheep-skins, goat and astrakhan skins, as well as wool, horse hair, bristle, down, horns, bones, &c., are exported. There are gymnasia for boys and for girls, two cadet corps, one theological seminary, seminaries for Russian and Kirghiz teachers, a museum, a theatre, branches of the Russian Geographical Society and the Gardening Society, a military arsenal, and a custom-house.

Orense, an inland province in the north-west of Spain. Its area is 2738 square miles, and it is divided into 11 administrative districts and 97 parishes. Population, 388,835 in 1877, and 402,873 in 1897. The birth-rate is 3·13 per cent., the death-rate 2·93, and the proportion of illegitimate births 6·07 per cent. of the total births. The climate is very varied, mild in some valleys, cold and damp in the highlands, rainy near the northern border, and subject to rapid changes of temperature. The railway from Monforte to Vigo runs through the province, but the means of communication are very crude. The provincial industries are in a backward condition. There are a few iron foundries of a primitive sort, but lack of transport and of cheap coal hinder the growth of mining and manufactures.

Though the soil is fertile and well watered, agricultural products are not so important as arboriculture. The oak, beech, pine, chestnut, walnut, and plane grow in abundance on the hills and mountains; pears, apples, cherries, almonds, figs, roses, olives, and the laurel in the valleys, and even oranges and lemons in sheltered spots like Ribadavia. In 1897 the vine was grown on 29,760 acres, wheat on 3972, and a large area was devoted to pod-fruit, rye, and oats. The live stock included 3716 horses, 2463 mules, 5443 asses, 35,958 cattle, 105,303 sheep, 31,487 goats, and 72,227 pigs.

Orense, the capital of the above province, stands on the left bank of the Miño, and on the railway from Monforte to Juy and Portugal. It has a theatre, primary schools, and an institute, seminary, training schools for teachers of both sexes, and public libraries. In the older streets some residences of the nobility are good specimens of mediæval architecture. Population (1887), 14,168; (1897), 15,250.

Orghyeeff, a district town of Russia, in the province of Bessarabia, 28 miles north of Kishineff railway station. It stands on the seat of an old Dacian fortress, Petrodava, or Orhei, of which the ruins still exist. Population (1897), 13,356, chiefly Russian, but containing also Armenians, Jews, and Germans. It was annexed to Russia in 1812.

Oriente, or LA REGION ORIENTALE, a vast undefined territory belonging to the republic of Ecuador, comprising the whole eastern part of the republic. It was formed in 1884 of the older territories of Napo, Canelos, and Zamora. The boundaries have still to be settled by treaties with the coterminous republics. Its southern boundary is the Marañon river from its source to its mouth. Its eastern boundary runs along the 70° of W. long. Its northern boundary is a conventional line nearly parallel to the course of the Rio Putumayo. The population of El Oriente, nearly entirely composed of wild Indian tribes, was estimated in 1887 to be about 80,000.

Orihuela, a town of Spain, province of Alicante, on the river Segura, which divides the city into two parts, Roig and San Augustus, connected by two bridges. There has been progress in agriculture, and in the manufactures of silk, linen, wool, leather, and starch, and tanning. The streets have been improved and many public buildings restored. Population (1887), 24,364; (1897), 26,951.

Orillia, a town and port of entry of Simcoe county, Ontario, Canada, situated 64 miles north of Toronto, on Lake Couchiching and on the Grand Trunk Railway. It is a favourite summer resort, and has steamboat communication with other ports on Lakes Simcoe and Couchiching. It contains an asylum maintained by the provincial government, also saw and grist mills and iron foundries. Population (1881), 2910; (1891), 4752; (1901), 4907.

Orinoco, The, a river in the north of South America, falling north-east into the Atlantic between 60° 20′ and 62° 30′ W. It is approximately 1500 miles long, but it is several hundred miles longer if measured by its Guaviare branch. Lying south and east of the main river is a vast, densely forested region called Venezuelan Guiana, diversified by ranges of low mountains, irregular broken ridges and granitic masses, which define the courses of many unexplored tributaries of the Orinoco. The upper part of the river was ascended in 1857 by Michelena y Rojas to the Mawaca, a point about 170 miles above the northern entrance to the Casiquiare canal, and then a few miles up the Mawaca. A little knowledge about its sources above these points was given by the savages to de la Fuente in 1759 and to Mendoza in 1764, and we are also indebted to Humboldt for some vague data.

Physical features.

The principal affluent of the Orinoco from the Guiana district is the *Ventuari*, the head-waters of which are also unknown. It is an important stream, which, running south-west, joins the Orinoco about 90 miles above its Guaviare branch. Two other large tributaries of the Orinoco flow north from the interior of this mysterious Guiana region, the Caura and the Caroni. The former has recently been explored by André, who found it greatly obstructed by falls and rapids; the latter is about 800 miles long, 400 of which are more or less navigable.

South of the Guaviare, as far as the *divortium aquarum*, between it and the Rio Negro branch of the Amazon, the country is dry and unswept by moisture-laden winds, so that no streams of moment are found in its southern drainage area; but north of it, as far as 6° 30′ N., the north-east trade winds, which have escaped condensation in the hot lower valley of the Orinoco, beat against the cold eastern slopes of the lofty Colombian Andes, and ceaselessly pour down such vast volumes of water that the almost countless streams which flow across the plains of Colombia and western Venezuela are taxed beyond their capacity to carry it to the Orinoco, and for several months of the year they flood tens of thousands of square miles of the districts they traverse. Among these the Apure, Arauca, Meta, and Guaviare hold the first rank.

The *Apure* is formed by two great rivers, the *Uribante* and *Sarare*. The former, which rises in the Sierra de Merida, which overlooks the Lake of Maracaibo, has 16 large affluents; the latter has its sources near the Colombian city of Pamplona, and they are only separated from the basin of the river Magdalena by the "Oriental" Andean range. From the Uribante–Sarare junction to the Orinoco the length of the Apure is 645 miles, of which Codazzi makes the doubtful claim that 564 are navigable, for there are some troublesome rapids 114 miles above its mouth, where the Apure is three miles wide. The numerous affluents which enter it from the north water the beautiful eastern and southern slopes of the Merida, Caraboso, and Caracas mountain ranges. A few of them are navigable for a short distance; among these the most important is the many-armed Portugueza, on the main route south from the Caribbean coast to the *llanos*. A few large streams enter the lower Apure from the south, but they are frequently entangled in lateral canals, due to the slight elevation of the plains above sea-level, the waters of the Apure, especially during flood time, having opened a great number of *caños* before reaching the Orinoco.

The "Oriental" Andes of Colombia give birth to another great affluent of the Orinoco, the *Arauca*, which soon reaches the plain and parallels the Apure on the south. Perez says that the Sarare branch of the Apure has formed a gigantic dam across its own course by prodigious quantities of trees, brush, vines, and roots, and thus, impounding its own waters, has cut a new channel to the southward across the lowlands and joined the Arauca, from which the Sarare may be reached in small craft and ascended to the vicinity of Pamplona. The Arauca is navigable for large boats and barges up to the Andes, and by sail to its middle course. In floods, unable to carry the additional water contributed by the Sarare, it overflows its banks, and by several *caños* gives its surplus to the Capanaparo, which, about 18 miles farther south, joins the Orinoco.

The *Meta* is known as such from the union of two Andean streams, the Negro and Humadea, which rise near Bogotá. At their junction, 700 feet above sea-level, it is 1000 feet wide and 7 feet deep in the dry season, but in flood the Meta rises 30 feet. It is navigable up to the old "Apostadero," about 150 miles above its mouth, but launches may ascend it, in the wet season, about 500 miles, to the junction of the Negro with the Humadea. In the dry season, however, it is obstructed by reefs, sandbanks, shallows, snags, trees, and floating timber from the "Apostadero" up, so that even canoes find its ascent difficult, while savage hordes along its banks add to the dangers to be encountered.

The *Guaviare* is the next great western tributary of the Orinoco. Eugenio Alvarado, a Spanish commissioner for the boundary delimitation of Colombia with Brazil in 1759, informed the viceroy at Bogotá that the rivers Arivari and Guayabero rise between Neiva and Popayan, and unite to take the composite name of Guaviare. In those times they called it Guaibari, or Guayuare. The Guaviare is about 500 miles long, of which 300 are called navigable, although not free from obstructions. Its upper portion has many rapids and falls. The banks are forested throughout, and the river is infested by numerous alligators, so ferocious that they attack canoes. Two-thirds of the way up, it receives its Ariari tributary from the north-west, which is navigable for large boats. Near its mouth the Guaviare is joined by its great south-western affluent, the *Ynirida*. Above its rapid of Mariapiri, 180 miles up, this stream runs swiftly through a rough country, but for a long distance is a succession of lakes and shallow, overflowed areas. Its head-waters do not reach the Andes.

Between the Guaviare and the Meta the Orinoco is obstructed by the famous *Maipures cataract*, where, in several channels, it breaks through a granite spur of the Guiana highlands for a length of about 4 miles, with a total fall of about 40 feet, and then, after passing two minor reefs, reaches the Atures rapids, where it plunges through a succession of gorges for a distance of about 6 miles, winding among confused masses of granite boulders, and falling about 30 feet. At the mouth of the Meta it is about a mile wide, but as it flows northwards it increases its width until, at the point where it receives its Apure affluent, it is over 2 miles wide in the dry season and about 7 in floods. It rises 32 feet at Cariben, but at the Angostura, or narrows, where the river is but 800 feet wide, the difference between high and low river is 50 feet, and was even 60 in 1892.

The Orinoco finds its way to the ocean through a delta of about 700 square miles area, so little above sea-level that much of it is periodically flooded. The river is navigable for large steamers up to the *raudal* or rapid of Cariben, 700 miles from the sea, and to within 6 miles of the mouth of the Meta. Maintaining its eastern course from the Apure, the main stream finds its way along the southern side of the delta, where it is called the *Corosimi river*, and enters the sea at the Boca Grande; but in front of the Tortola island, at the commencement of the Corosimi and 100 miles from the sea, it throws northwards to the Gulf of Paria another great arm which, about 100 miles long, and known as the *Rio Vagre*, bounds the western side of the delta. *En route* to the gulf the Vagre sends across the delta, east and north, two *caños* or canals of considerable volume, called the *Macareo* and *Cuscuino*. The delta is also cut into many irregular divisions by other canals which derive their flow from its great boundary rivers, the Corosimi and Vagre, and its numerous islands and vast swamps are covered with a dense vegetation. The Boca Grande outlet is the deepest, and is the main navigable entrance to the Orinoco at all seasons, the muddy bar usually maintaining a depth of 16 feet.

The Casiquiare Canal.—A missionary explorer, Padre Roman, in 1743, was the first to report that the upper Orinoco river was connected with the Negro branch of the Amazon by a canal. Little faith was attached to the statement until it was verified, in 1756, by the Spanish boundary-line commission of Yturriaga y Solano. The actual elevation of this "canal" above sea-level is not known, but a knowledge of it is of primary importance to a study of the hydrography of South America. Travellers in general give it as from 400 to 900 feet, but, after considerable study of the question of elevations in South America, the writer believes that the Casiquiare canal does not exceed 300 feet elevation. It is about 300 miles long, with an average depth of 30 feet, and has a violent current towards the Rio Negro. From its own extensive drainage basin it receives several rivers of considerable volume, so that, parting from the Orinoco with a width of only 220 feet, it swells to about five times that before reaching its Negro outlet, thus showing that the quantity of water contributed to it by the Orinoco is small in comparison to what it gathers *en route*. It is not, as is generally supposed, a sluggish canal on a flat tableland, but a great, rapid river, which, if its upper waters had not found contact with the Orinoco, would belong entirely to the Negro affluent of the Amazon. To the west of the Casiquiare there is a much shorter and more facile connexion between the Orinoco and Amazon basins, called the isthmus of Pimichin, which is reached by ascending the Terni branch of the Atabapo affluent of the Orinoco. Although the Terni is somewhat obstructed, it is believed that it could easily be made navigable for small craft. The isthmus is 10 miles across, with undulating ground, nowhere over 50 feet high, with swamps and marshes. It is much used for the transit of large canoes, which are hauled across it from the Terni river, and which reach the Negro by the little stream called the Pimichin.

Population, trade, &c.

The Spanish *conquistador* and his descendants have not been a blessing to the basin of the Orinoco. All they can boast of is the destruction of its population and products, so that the number of inhabitants of one of the richest valleys in the world is less to-day than it was four centuries ago. The entire river trade centres upon *Ciudad Bolivar*, on the right bank of the Orinoco, 373 miles above its mouth. It has a population estimated at 15,000. The only other river port of any importance is *San Fernando* (3000 inhabitants), on the Apure. It is a stopping-point for the incipient steamer traffic of the valley, which is principally confined to the Apure and lower Orinoco. It occupies, however, but a few small steam craft. There is steam connexion between Ciudad Bolivar and the island of Trinidad, which supplies 90 per cent. of the foreign imports of the Orinoco. A French steamer carries cattle from the valley to the neighbouring foreign colonies, and a few local steamers do a coasting trade between the river and the Caribbean ports of Venezuela. A transit trade with Colombia, *viâ* the Meta river, was lately carried on, with promising results, by two small steamers, but was suspended by order of the Venezuelan Government.

According to British consular reports, the tonnage of commerce for Ciudad Bolivar was as follows:—

	1897.	1898.	1900.
Registered tonnage entered	29,549	22,326	22,917
,, ,, cleared	28,818	21,762	23,470
Total movement	58,367	44,088	46,387
Total vessels entered	64	70	73
,, ,, cleared	69	59	74

This table represents the foreign and river trade of the Orinoco river and its branches at the close of the 19th century. (G. E. C.)

Orissa, a province of British India, in Bengal, consisting of four British districts and about sixteen tributary states.

The historical capital is Cuttack; and Puri, with its temple of Jagannath, is world-famous. It differs from the rest of Bengal in being under a temporary settlement of land revenue. A new settlement for a term of thirty years has just been concluded, which will raise the total land revenue from Rs.13,84,000 to Rs.21,05,000, or by more than one half; but the greater part of this increase will be levied gradually during the first eleven years of the term. To obviate destructive inundations and famines, the Orissa system of canals has been constructed, with a capital outlay of Rs.2,64,91,769, or nearly two millions sterling. In 1897–98 the total area irrigated was 200,943 acres, yielding a revenue of Rs.3,14,729. In addition, tolls on navigation yielded Rs.1,62,939. The net profits were Rs.12,005, not including any charge for interest. Embankments were maintained at a further cost in that year of Rs.2,04,797. The province is traversed by the East Coast Railway, which was opened throughout from Calcutta to Madras in 1901.

The division of ORISSA consists of the three British districts of Cuttack, Puri, and Balasore, together with the forfeited state of Angul and the tract known as the Khondmals. Total area, 9853 square miles; population (1881), 3,789,799; (1891), 4,047,352; (1901) 4,350,372, showing an increase of 7 per cent. between both 1881 and 1891 and 1891 and 1901; average density, 442 persons per square mile. According to the census of 1891, the total number of persons in all India speaking Uriya is 9,010,957, showing that the linguistic area (extending into Madras and the Central Provinces) is much larger than the political province.

The tributary states of ORISSA occupy the hills between the British districts and the Central Provinces. The most important are Moharbhanj, Keonjhar, Dhenkanal, Bod, and Nayagarh. Total area, 14,387 square miles; population (1881), 1,410,183; (1891), 1,696,710; (1901), 1,959,556; showing between 1881 and 1891 an apparent increase of 21 per cent., partly due to improved enumeration, and between 1891 and 1901 an increase of 15·5 per cent. In 1897–98 four states under British administration (including Dhenkanal) had a total revenue of Rs.4,80,000. Moharbhanj and Dhenkanal have each an efficient English high school, with a boarding-house attached. In 1897–98 the total number of schools was 1314, attended by 17,658 pupils. The raja of Moharbhanj is distinguished for his intelligent administration. He has declared 1075 square miles, or more than one-fourth of the area of his state, to be reserved forest.

Oristano, a town and archiepiscopal see of the province of Cagliari, Sardinia, Italy, near the west coast, 58 miles by rail north-north-west of Cagliari, in a marshy and unhealthy position, near the mouth of the river Tirso. The cathedral is an 18th-century structure. There are remains of the mediæval walls. Its industries embrace the manufacture of pottery, flour-milling, linen and hemp weaving, and tunny-fishing. Population (1899), 7000.

Orkney, a county of Scotland, formed of a group of islands in the North Sea, the most southerly being separated from Caithness by the Pentland Firth.

Area and Population.—According to the latest official estimate, the area of the islands (foreshore included) is 249,565 acres, or about 300 square miles. Of the 68 islands and islets, 29 are inhabited. The population was in 1881, 32,044; in 1891, 30,453; and in 1901, 28,698, of whom 14,027 were males and 14,671 were females. Taking the land area only (240,476 acres, or 375·7 square miles), the number of persons to the square mile was 81, and the number of acres to the person 7·9. The population decreased between 1881 and 1891 by 4·9 per cent., and between 1891 and 1901 by 5·8 per cent. Between 1881 and 1891 the excess of births over deaths was 2665, and the decrease of the resident population 1591. The following table gives births, deaths, and marriages, with the percentage of illegitimate births:—

Year.	Deaths.	Marriages.	Births.	Percentage of Illegitimate.
1880	466	174	755	6·0
1890	502	126	625	4·96
1899	445	164	553	6 1

The birth-rate, death-rate, and marriage-rate are all below the rates for Scotland. The following table gives the birth-rate, death-rate, and marriage-rate per thousand of the population for a series of years:—

	1886.	1881–90.	1890.	1891–98.	1899.
Birth-rate	23·60	23·08	20·44	20·25	19·00
Death-rate	14·57	14·55	16·42	14·48	15·29
Marriage-rate	5·44	4·81	4·12	4·65	5·63

There were 88 Gaelic-speaking persons in the county in 1891, and 31 foreigners. Valuation in 1889–90, £65,910; 1899–1900, £64,092.

Administration.—Orkney unites with Shetland to send a member to Parliament, and Kirkwall (3660), its county town, and the only royal burgh, is one of the Wick group of parliamentary burghs. There are 21 civil parishes, with a combination poorhouse at Kirkwall; the number of paupers and dependents in September 1899 was 871. Orkney forms a sheriffdom with Shetland and Caithness, and there is a resident sheriff-substitute at Kirkwall. Twenty school boards manage 61 schools, which had in 1898–99 an average attendance of 4327. Kirkwall and Stromness public schools give secondary education.

Agriculture.—In 1898 the percentage of cultivated area was 42·7. In 1895 the average size of the 3267 holdings was 33 acres. The percentage under 5 acres was 14·66, between 5 and 50 acres 70·89, and over 50 acres 14·45. There were 306 farms between 50 and 100 acres, 135 between 100 and 300, and 31 over 300, one being above 1000 acres in extent. Farming is, on the whole, not below the average lowland Scottish standard. The crofters' houses are now superior to those in almost any part of the Highlands, being rebuilt of stone and lime, instead of stones and clay. The following table gives the principal acreages at intervals of five years from 1880:—

Year.	Area under Crops.	Corn Crops.	Green Crops.	Clover.	Permanent Pasture.	Fallow.
1880	104,958	37,278	17,147	30,575	18,656	1,302
1885	113,246	38,516	17,675	32,297	23,689	1,069
1890	110,435	38,498	17,624	33,004	20,406	898
1895	106,188	38,525	17,595	32,283	17,544	241
1899	107,376	38,268	17,606	33,805	17,440	257

The following table gives the live stock during the same years:—

Year.	Total Horses.	Total Cattle.	Cows or Heifers in Milk or Calf.	Sheep.	Pigs.
1880	6,100	25,416	9,101	29,592	3,312
1885	6,094	25,239	9,476	32,178	4,398
1890	5,861	24,040	8,989	32,408	4,587
1895	6,350	26,832	9,390	32,050	3,580
1899	6,839	28,428	9,858	36,836	2,586

There were only 11 acres under wood in 1895. At the census of 1891, 5349 men and 637 women were returned as being connected with agriculture.

Industries and Trade.—The principal industry, apart from agriculture, is fishing. There are 22 stations in the Orkney fishery district, some statistics about which are given in the following table:—

Year.	Boats.			Value of Gear.	Resident Fishermen and Boys.	Total Value of all Fish.
	No.	Tons.	Value.			
1890	656	3816	£17,013	£12,532	2,142	£39,733
1894	692	3265	£11,464	£10,229	1,706	£60,555
1898	501	2789	£10,800	£4,317	1,292	£53,359
1899	502	2876	£10,777	£12,397	1,309	£44,394

Of the total value of fish in 1899, £28,359 was the value of the herring catch, and £7474 the value of shellfish. In 1899, 2050 persons were employed in the district in the various branches of the sea fisheries.

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Orleans, chief town of department Loiret, France, 75 miles south-west of Paris by rail. It is the headquarters of the 5th army corps, the seat of the Court of Appeal for departments Loiret, Indre-et-Loire, and Loir-et-Cher; of the central prison for the same departments, of a Protestant consistory for the departments of Loiret, Loir-et-Cher, and Yonne, and of a school of artillery. The Corn Exchange now serves as a hall for *fêtes.* Amongst modern buildings may be noted the churches of St Marc (1886), St Marceau (1892), in the suburbs of the same names, and in the latter suburb also a church commemorative of Joan of Arc (1895), and St Lawrence in the Madeleine suburb. A large hair-pin factory employs about 100 persons, and turns out 100,000 pins per day. Orleans was the ancient *Cenabum*, not *Genabum*, as has been proved by several ancient inscriptions. It was reduced to ruins by Cæsar in 52 B.C. Population (1891), 54,270; (1901), 59,568.

Orleans.—Since the article in *Ency. Brit.* vol. xvii. on the Orleanist princes was published, some additional names of importance require to be added to the account there given. For a complete list of the Orleans family reference must be made to the *Almanach de Gotha*, but the accompanying genealogical table of the descendants of Louis Philippe will be of assistance.

Reference may be made to the articles PARIS, COMTE DE (with his son, the DUC D'ORLEANS) and JOINVILLE, PRINCE DE, for information concerning those members of the family. It is only necessary here to give further details about two others whose names won distinction in recent years, the duc d'Aumale and Prince Henri d'Orleans.

HENRI-EUGÈNE-PHILIPPE-LOUIS D'ORLÉANS, duc d'Aumale (1822–1897), was the fourth son of King Louis Philippe I. and of his wife Marie Amélie. He was born at Paris, 16th January 1822, and was educated at the College of Henry IV. At seventeen he entered the army, and saw service in Algeria, where he distinguished himself. In May 1843, after the capture of Abd-el-Kader, he was made lieutenant-general. In 1847 he was made governor of the French possessions in Africa, but in 1848, when the February revolution broke out, he handed over his office to General Cavaignac and went to England, where he lived for some years, occupying himself with historical work and contributing to the *Revue des Deux Mondes.* He married in 1844 the Princess Caroline, daughter of the prince of Salerno; she died in 1869. They had two sons, the prince de Condé (d. 1866) and the duc de Guise (d. 1872). In 1869 two volumes of the duke's *Histoire des Princes de Condé* were published. In 1870, when the Franco-German war broke out, his request for employment in the field was refused. In 1871 he was elected a deputy for the department of Oise, and in 1872 was elected a member of the French Academy. He took an important part in the events leading to the downfall of Thiers. In 1873 he presided at the Bazaine court-martial, and was then given the command of the 7th army corps. In 1879 he was made inspector-general of the army corps, and in 1880 a member of the Académie des Beaux Arts. In 1883, however, he was included in the decree against the Orleanist princes, by which they now retired from the army; and in 1886 the duc d'Aumale formally protested to the President of the Republic against

(b. 1773; d. 1850) LOUIS PHILIPPE = Marie Amélie, dau. of Ferdinand IV. of Naples

- Ferdinand of France (duc d'Orléans), Dauphin (b. 1810; d. 1842) = Hélène, duchess of Mecklenburg-Schwerin
  - Philippe (comte de Paris) (b. 1838; d. 1894) = Isabelle d'Orléans, dau. of Antoine, duc de Montpensier
    - Amélie
    - Philip (duc d'Orléans) (b. 1869)
    - Hélène
    - Isabelle
    - Louise
    - Ferdinand (b. 1884)
  - Robert (duc de Chartres) (b. 1840) = Françoise d'Orléans, dau. of prince de Joinville
    - Marie
    - Henri (b. 1867; d. 1901)
    - Marguerite
    - Jean = Isabelle, d. of Philippe, comte de Paris
- Louise = King Leopold I. of Belgium
- Marie = Duke Frederick of Würtemberg
- Louis (duc de Nemours) (b. 1814; d. 1896) = Victoria Louise of Saxe-Coburg-Gotha
  - Gaston (comte d'Eu) = Isabelle of Braganza
    - Pierre
    - Louis
    - Antoine
  - Ferdinand (duc d'Alençon) = Sophie of Bavaria
    - Louise
    - Emmanuel = Henriette of Belgium
  - Blanche
- Clémentine (b. 1817; d. 1881) = August Victor of Saxe-Coburg-Gotha
- François (prince de Joinville) (b. 1818; d. 1900) = Françoise de Braganza
  - Françoise = Robert, duc de Chartres
  - Pierre (duc de Penthièvre)
- Henri (duc d'Aumale) (b. 1822; d. 1897) = Caroline of Bourbon
  - Prince de Condé (b. 1845; d. 1866)
  - Duc de Guise (b. 1854; d. 1872)
- Antoine (duc de Montpensier) (b. 1824; d. 1890) = Louise, Infanta of Spain
  - Isabelle = comte de Paris
  - Antoine = Eulalie, Infanta of Spain
    - Alphonse
    - Louis-Fernando

his treatment by General Boulanger, but the only result was that he was formally exiled from French territory, and retired to Brussels. The duc d'Aumale had an immense fortune, and in 1886 he announced that, after his death, his château of Chantilly with its contents would go to the French Institute. On its request the Government repealed in 1889 his decree of exile, and he returned to France. He died in Sicily on the 7th of May 1897, his death being undoubtedly accelerated by the disaster of the fire at the charity bazaar in Paris, where his niece, the duchesse d'Alençon, lost her life.

Henri, Prince of Orleans (1867–1901), eldest son of Robert, duc de Chartres, was born at Ham, near Richmond, Surrey, on the 16th of October 1867. In 1889, at the instance of his father, who paid the expenses of the tour, he undertook, in company with MM. Bonvalot and Dedecken, a journey through Siberia to Siam. In the course of their travels they crossed the mountain range of Tibet, and the fruits of their observations, submitted to the Geographical Society of Paris (and later incorporated in *De Paris au Tonkin à travers le Tibet inconnu*, published in 1892), brought them conjointly the gold medal of that society. In 1892 the prince made a short journey of exploration in East Africa, and shortly afterwards visited Madagascar, proceeding thence to Tongking. From this point he set out for Assam, and was successful in discovering the sources of the river Irrawaddy, a brilliant geographical achievement which secured the medal of the Geographical Society of Paris and the cross of the Legion of Honour. In 1897 he revisited Abyssinia, and political differences arising from this trip led to a duel with the comte de Turin, in which both combatants were wounded. While on a trip to Assam in 1901 he died at Saigon of dysentery on 9th August. Prince Henri was a somewhat violent Anglophobe, and his diatribes against Great Britain contrasted rather curiously with the cordial reception which his position as a traveller obtained for him in London, where he was given the gold medal of the Royal Geographical Society.

Orléans, Louis Philippe Robert, Duc d' (1869-——), eldest son of the comte de Paris, was born at York House, Twickenham, 6th February 1869. The law of exile against the French princes having been abrogated in 1871, he returned with his parents to France. He was first educated by a private tutor, and then followed the courses of the municipal collège at Eu. In 1882 he entered the College Stanislas, Paris, and took a first prize in a competitive Latin translation. On the death of the comte de Chambord, the comte de Paris became head of the Bourbons; and in 1886 he and his son were exiled from France. Queen Victoria appointed the duke of Orleans a supernumerary cadet at the Royal Military College, Sandhurst. After passing his examinations he received a commission in the 4th battalion of the 60th Rifles, then quartered in India. In January 1888 the duke went out to India, accompanied by Colonel de Parseval as military governor and adviser. At Bombay he was received by the duke of Connaught and Lord Reay, and at Calcutta he became the guest of the Viceroy, the marquis of Dufferin, who organized for the duke and his cousin, Prince Henry of Orleans, a grand tiger-shooting expedition in Nepaul. The duke now reported himself to the commander-in-chief (now Earl Roberts), and joined his regiment at Chakrata. After seeing considerable service, the duke ceased his connexion with the Indian army in February 1889, and returned to England. On attaining his majority, he entered Paris, and proceeding to the *mairie*, expressed his desire, as a Frenchman, to perform his military service. This act caused great excitement, and he was arrested in conformity with the law of 1886, which forbade the soil of France to the direct heirs of the families which had reigned there. He was tried, and sentenced to two years' imprisonment; but he was liberated by President Carnot after a few months' nominal incarceration, and conducted to the Swiss frontier. This escapade won for him the title of "Le Premier Conscrit." After the comte de Paris's funeral, the duke received his adherents in London, and then removed to Brussels, as being nearer France. On 5th November 1890 the duke married the Archduchess Maria Dorothea of Austria, the ceremony taking place at Vienna. It was alleged that some of his followers were implicated in the conspiracies against the French Republic in 1899. A letter which the duke wrote in 1900, approving the artist whose caricatures were grossly insulting to Queen Victoria, excited great indignation both in England and in many French circles, and estranged him from many with whom he had formerly been upon friendly terms; but after Queen Victoria's death it was allowed to become known that this affair had been forgotten and forgiven by the British royal family.

Ormerod, Eleanor A. (1828–1901), English entomologist, was the daughter of George Ormerod, F.R.S., author of *The History of Cheshire*, and was born at Sedbury Park, Gloucestershire, on the 11th of May 1828. From her earliest childhood insects were her delight, and the opportunity afforded for entomological study by the large estate upon which she grew up and the interest she took in agriculture generally soon made her a local authority upon this subject. When, in 1868, the Royal Horticultural Society began forming a collection of insect pests of the farm for practical purposes, Miss Ormerod largely contributed to it, and was awarded the Flora medal of the society. In 1877 she issued a pamphlet, *Notes for Observations on Injurious Insects*, which was distributed among persons interested in this line of inquiry, who readily sent in the results of their researches, and was thus the beginning of the well-known *Annual Series of Reports on Injurious Insects and Farm Pests.* In 1881 Miss Ormerod published a special report upon the "turnip-fly," and in 1882 was appointed consulting entomologist to the Royal Agricultural Society, a post she held until 1892. For several years she was lecturer on scientific entomology at the Royal Agricultural College, Cirencester. Her fame was not confined to England: she received silver and gold medals from the University of Moscow for her models of insects injurious to plants, and her treatise on *The Injurious Insects of South Africa* showed how wide was her range. In 1899 she received the large silver medal from the Société Nationale d'Acclimatation de France. Among others of her works are the *Cobden Journals*, *Manual of Injurious Insects*, and *Handbook of Insects injurious to Orchard and Bush Fruits.* Almost the last honour which fell to her was the honorary degree of LL.D. of Edinburgh University—a unique distinction, for she was the first woman upon whom the university had conferred this degree. The dean of the legal faculty in making the presentation aptly summed up Miss Ormerod's services as follows: "The pre-eminent position which Miss Ormerod holds in the world of science is the reward of patient study and unwearying observation. Her investigations have been chiefly directed towards the discovery of methods for the prevention of the ravages of those insects which are injurious to orchard, field, and forest. Her labours have been crowned with such success that she is entitled to be hailed the protectress of agriculture and the fruits of the earth—a beneficent Demeter of the 19th century." She died at St Albans on the 19th of July 1901.

Ormskirk, a market town and, since 1894, urban district in the Ormskirk parliamentary division of Lancashire, England, 11 miles north-east of Liverpool by rail. In 1896 a corn exchange and news-room were erected. Public pleasure grounds were opened in 1894, and in the same year an isolation hospital. Population (1881), 6651; (1891), 6298; (1901), 6857.

Ornament.—Ornament is in its nature accessory, and implies a thing to be ornamented, which is its active cause and by rights suggests its design. It does not exist apart from its application. Nor is it properly *added* to a thing already in existence (that is but a makeshift for design), but is rather such modification of the thing *in the making* as may be determined by the consideration of beauty. For example, the construction and proportions of a chair are determined by use (by the necessity of combining the maximum of strength with the minimum of weight, and of fitting it to the proportions of the human body, &c.); and any modification of the plan, such as the turning of legs, the shaping of arms and back, carving, inlay, mouldings, &c.—any reconsideration even of the merely utilitarian plan from the point of view of art—has strictly to do with Ornament, which thus, far from being an afterthought, belongs to the very inception of the thing. Ornament is good only in so far as it is an indispensable part of something, helping its effect without hurt to its use. It is begotten of use by the consideration of beauty. The test of ornament is its *fitness.* It must occupy a space, fulfil a purpose, be adapted to the material in which and the process by which it is executed. This implies *treatment.* The treatment befitting a wall space does not equally befit a floor space of the same dimensions. What is suitable to hand-painting is not equally suitable to stencilling; nor what is proper to mosaic proper to carpet-weaving. Neither the purposes of decoration nor the conditions of production allow great scope for naturalism in ornament. Its forms are derived from nature, more or less; but repose is best secured by some removedness from nature—necessitated also by the due treatment of material after its kind and according to its fashioning. In the case of recurring ornament it is inept to multiply natural flowers, &c., which at every repetition lose something of their natural attraction. The artist in ornament does not imitate natural forms. Such as he may employ he transfigures. He does not necessarily set out with any idea of natural form (this comes to him by the way); his first thought is to solve a given problem in design, and he solves it perhaps most surely by means of abstract ornament—witness the work of the Greeks and of the Arabs. The extremity of tasteless naturalism, reached towards the beginning of the Victorian era, was the opportunity of English reformers, prominent amongst whom was Owen Jones, whose fault was in insisting upon a form of ornament too abstract to suit English ideas. William Morris and others led the way back to nature, but to nature trained in the way of ornament. The Styles of ornament, so-called, mark the evolution of design, being the direct outcome of Greek, Roman, Byzantine, Gothic, or other conditions, in days when fashion moved slowly. Post-Renaissance ornament goes by the name of the reigning king; but the character of the historic periods was not sought by artists; it came of their working in the way natural to them and doing their best. "Style," as distinguished from "the Styles," comes of an artist's intelligent and sympathetic treatment of his material, and of his personal sincerity and strength. International traffic has gone far to do away with national characteristics in ornament, which becomes yearly more and more alike all the world over. The subsidiary nature of ornament and its subjection to conditions lead to its frequent repetition, which results in *pattern,* repeated forms falling inevitably into lines, always self-asserting, and liable to annoy in proportion as they were not foreseen by the designer. He cannot, therefore, safely disregard them. Indeed, his first business is to build pattern upon lines, if not intrinsically beautiful, at least helpful to the scheme of decoration. He may disguise them; but capable designers are generally quite frank about the construction of their pattern, and not afraid of pronounced lines. Of course, adaptation being all-essential to pattern, an artist must be versed in the technique of any manufacture for which he designs. His art is in being equal to the occasion. (L. F. D.)

Orne, a department of the north-west of France, watered by the Orne.

Area, 2372 square miles. The population decreased from 376,126 in 1881 to 325,445 in 1901. Births in 1899, 5961, of which 315 were illegitimate; deaths, 7554; marriages, 2311. Out of 1,414,780 acres of land cultivated in 1896, 773,110 acres were arable, and nearly 494,000 acres were green crop and grass lands. In 1899 the wheat crop was valued at £682,000; barley, £206,000; oats, £402,000; potatoes, £336,000; green crop (trefoil, lucern, and sainfoin), £278,000; natural pastures, £448,000; grass lands, £496,000; cider-apples, £480,000. The live stock in 1899 included 62,000 horses, 216,100 cattle, 70,460 sheep, and 37,000 pigs. Though without metallic ores, Orne possesses industries in metals—pin factories at Laigle, &c. The textile industry is especially developed around Flers and Alençon, where cotton stuffs are manufactured. Alençon, the capital, had 14,886 inhabitants in 1901.

Orosháza, a market town of Hungary, in the county of Békés, 33 miles north-east of Szegedin. The inhabitants are mainly agriculturists and artisans, and carry on a brisk trade in swine. There are five steam mills and many financial institutions. Population (1891), 19,956; (1901), 21,385.

Orsha, a district town of Russia, government of Moghileff, and 112 miles by rail west-south-west of Smolensk on the Moscow–Brest railway, on the Dnieper. Its industries are insignificant, but it is an important entrepôt for grain, seeds, and timber, which are shipped both by rail and on the Dnieper. Population (1897), 13,161.

It is a very old town, mentioned in the annals under the name of Rsha in 1067. In the 13th century it was taken by the Lithuanians, who fortified it. In 1604 the Poles founded there a Jesuit college. The Russians besieged Orsha more than once in the 16th and 17th centuries, and finally annexed it in 1772.

Orsk, a district town of Russia, government and 150 miles south-east of Orenburg, on the right bank of the Ural river. Being situated on the prairies, cattle-breeding prospers. It has tanneries and tallow-melting establishments, and is a centre for trade in cattle and various animal produce imported from central Asia. Population (1897), 14,036.

Orsova, a market town of Hungary, in the county of Krassó-Szörény, near the pass of Vaskapú (Iron-Gates), on the Danube. As an important railway station on the frontiers of Hungary, Servia, and Rumania, it has a thriving trade. It has numerous financial institutions, a saw-mill, and several Government edifices. The private walls of the old Roman city of Tierna have been demolished. Near the railway station stands a handsome chapel, called the Crown Chapel, which was erected in 1855 on the spot where Louis Kossuth concealed the crown at the close of the Hungarian war of liberty. The islet of Ada-Kaleh, opposite to the town, was ceded in 1878 by the Turkish Government to Hungary. Population (1891), 3564; (1901), 4610.

Orta, a lake of Italy, lying west from Lago Maggiore, and due north of Vercelli. It has an area of 7 square miles, and is 8 miles long and from $\frac{1}{4}$ to $4\frac{3}{4}$ miles wide. A subaqueous ridge divides it into two basins, of which the north is the deeper, descending to a maximum depth of 469 feet. The altitude of the lake is 951 feet above sea-level. The area of the drainage basin is 39 square miles. The temperature of the bottom never falls below 39·2° F. This lake seems to owe its origin to glacial action. By means of the Strona, which flows out of its northern extremity, it communicates with the Toce, which flows into Lago Maggiore.

Orthodox Eastern Church.—The object of this article is to enumerate all the Christian Churches of the East, and to sketch shortly their present condition; *i.e.*, both those which together constitute the Orthodox Eastern Church and also those which have a common origin with it, but which, for one reason or another, have separated from communion with it. (See *Ency. Brit.*, ninth edition, art. GREEK CHURCH.)

I. The ORTHODOX EASTERN CHURCH, which is frequently spoken of as "the Greek Church," and which has for its full official title "The Holy Orthodox Catholic Apostolic Eastern Church" (ἡ ἁγία ὀρθόδοξος καθολικὴ ἀνατολικὴ ἐκκλησία), is the historical representative of the churches of the ancient East. It consists of (*a*) those churches which have accepted all the decrees of the successive general councils and have remained in full communion with one another, (*b*) such churches as have derived their origin from these by missionary activity, or by abscission without loss of communion. In the Eastern churches, unlike the Western, there has never been any pronounced tendency towards an organized unity under a single head, of the kind which in the Roman world gave rise to the Papacy. Their bishops preserve, indeed, their ancient dignities and precedence, but are equals in their inherent power; and the authority of patriarchs and metropolitans is recognized as being committed to them by the synodical voice of their brethren. Again, not only is it the fact that the ancient patriarchs and other heads of local churches have independent authority within their own spheres, but it has been fully recognized, from the end of the 16th century at any rate, that a separate and independent organization is the natural corollary of complete political separation. On the other hand, the Orthodox Eastern Church has always laid especial stress upon the unchanging tradition of the faith, and has claimed orthodoxy as its especial characteristic. The "Feast of Orthodoxy" (ἡ κυριακὴ τῆς ὀρθοδοξίας), celebrated annually on the first Sunday of the Greek Lent, was founded in honour of the restoration of the Holy Images to the churches after the downfall of Iconoclasm (19th February 842); but it has gradually assumed a wider significance as the celebration of victory over all heresies, and is now one of the most characteristic festivals of the Eastern Church. In addition to the ancient churches which have separated themselves from the orthodox faith, many have ceased to have an independent existence, owing either to the conquests of Islam or to their absorption by other churches. For example, the church of Mount Sinai may be regarded as all that survives of the ancient church of northern Arabia; the autocephalous Slavonic churches of Ipek and Okhrida, which derived their ultimate origin from the missions of Cyril and Methodius, were absorbed in the patriarchate of Constantinople in 1766 and 1767 respectively; and the Church of Georgia has been part of the Russian Church since 1801. At the present day, then, the Orthodox Eastern Church consists of twelve mutually independent churches (or thirteen if we reckon the Bulgarian Church) using their own language in divine service (or some ancient form of it, as in Russia) and varying not a little in points of detail, but standing in full communion with one another, and united as equals in what has been described as one great ecclesiastical federation. However, in using such language it must be remembered that we are not dealing with bodies which were originally separated from one another and have now entered into fellowship, but with bodies which have grown naturally from a single origin and have not become estranged. These bodies are the following:—

1. *The Patriarchate of Constantinople* or *New Rome.*—The Ecumenical Patriarch, as he has been called since early in the 6th century, is the most exalted ecclesiastic of the Eastern churches, and his influence reaches far outside the lands of the patriarchate. His jurisdiction extends over the dominions of the Sultan in Turkey, together with Asia Minor and the Turkish islands of the Aegean; there are eighty-two metropolitans under him, and the "monastic republic" of Mount Athos. He has great privileges and responsibilities as the recognized head of the Greek community in Turkey, and enjoys also many personal honours which have survived from the days of the Byzantine emperors.

The Patriarch has his own court at Phanar, and his own prison, with a large civil jurisdiction over, and responsibility for, the Greek community. In ecclesiastical affairs he acts with two governing bodies—(*a*) a permanent Holy Synod (Ἱερὰ Σύνοδος τῆς Ἐκκλησίας Κωνσταντινουπόλεως), consisting of twelve metropolitans, six of whom are re-elected every year from the whole number of metropolitans, arranged in three classes according to a fixed cycle; (*b*) the Permanent National Mixed Council (Διαρκὲς Ἐθνικὸν Μικτὸν Συμβούλιον), a remarkable assembly, which is at once the source of great power by introducing a strong lay element into the administration, and of a certain amount of weakness by its liability to sudden changes of popular feeling. It consists of four metropolitans, members of the Holy Synod, and eight laymen. All of these are chosen by an electoral body, consisting of all the members of the Holy Synod and the National Mixed Council, and twenty-five representatives of the parishes of Constantinople. The election of the Patriarch is also, to a considerable extent, popular. An electoral assembly is formed for the purpose, consisting[1] of the twelve members of the Holy Synod, the eight lay members of the National Mixed Council, twenty-eight representatives of as many dioceses (the remaining dioceses having only the right to nominate a candidate by letter), ten representatives of the parishes of Constantinople, ten representatives of all persons who possess political rank, ten representatives of the Christian trades of Constantinople, the two representatives of the secretariat of the patriarchate, and such metropolitans, to the number of ten but no more, as happen to be in Constantinople at the time for some canonical reason (παρεπιδημοῦντες). On the death or deposition of the Patriarch, the Holy Synod and the National Mixed Council at once meet and elect a temporary substitute for the Patriarch (Τοποτηρητής). Forty days afterwards the electoral assembly meets, under his presidency, and proceeds to make a list of twenty candidates (at the present day they must be metropolitans), who may be proposed either by the members of the electoral assembly or by any of the metropolitans of the patriarchate by letter. This list is sent to the Sultan, who has by prescription the right to strike out five names. From the fifteen which remain the electoral assembly chooses three. These names are then submitted to the clerical members of the assembly, *i.e.*, to the members of the Holy Synod and the παρεπιδημοῦντες, who meet in church, and, after the usual service, make the final selection. The Patriarch-elect is presented to the Porte, which thereupon grants the berat or diploma of investiture and several customary presents; after which the new ruler is enthroned. The Patriarch has the assistance and support of a large household, a survival from Byzantine times. Amongst them, actually or potentially, are the Grand Steward (μέγας οἰκόνομος), who serves him as deacon in the liturgy and presents candidates for orders; the Grand Visitor (μέγας σακελλάριος), who superintends the monasteries; the Sacristan (σκευοφύλαξ); the Chancellor (χαρτοφύλαξ), who superintends ecclesiastical causes; the deputy-Visitor (ὁ τοῦ σακελλίου), who visits the nunneries; the Protonotary (πρωτονοτάριος); the Logothete (λογοθέτης), a most important lay officer, who represents the Patriarch at the Porte and elsewhere outside; the Censer-bearer, who seems to be also a kind of captain of the guard (καντρίσιος or κανστρήνσιος); the Referendary (ῥεφερενδάριος); the Secretary (ὑπομνημογράφων); the Chief Syndic (πρωτέκδικος), who is a judge of lesser causes; the Recorder (ἱερομνήμων); and so on, down to the cleaners of the lamps

[1] The numbers have varied from time to time.

(λαμπαδάριοι), the attendant of the lights (περιεισερχόμενος), and the bearer of the images (βασταγάριος) and of the holy ointment (μυροδότης).

2. The *Patriarchate of Alexandria*, consisting of Egypt and its dependencies, was at one time the most powerful of all, and the Patriarch still preserves his ancient titles of "pope" and "father of fathers, pastor of pastors, archpriest of archpriests, thirteenth apostle, and œcumenical judge." But the secession of the greater part of his church to Monophysitism [COPTIC CHURCH], and the Mahommedan conquest of Egypt, have left him but the shadow of his former greatness; and at the present time he has only the bishop of Libya under him, and rules over some 20,000 people at the outside, most of whom are settlers from elsewhere. 3. The *Patriarchate of Antioch*, including Cilicia, Syria (all but Palestine), and Mesopotamia, with fourteen metropolitans. The Patriarch is "father of fathers and pastor of pastors," but retains little of his ancient importance. 4. The *Patriarchate of Jerusalem*, which comprises Palestine only, and derives its chief influence from the position of Jerusalem as a place of pilgrimage. The Patriarch has under him five archbishops and five bishops. 5. The ancient *Church of Cyprus*. 6. The *Church of Mount Sinai*, consisting of little more than the famous monastery of St Catherine, under an archbishop who frequently resides in Egypt. It has, however, a few branch houses (μετόχια) in Turkey and Greece. The archbishop is chosen, from a list of candidates submitted by the monks of St Catherine, by the Patriarch of Jerusalem and his Synod; and the Patriarch consecrates him. 7. The *Hellenic Church*, *i.e.*, the church of the kingdom of Greece, which declared itself independent in 1833, though the claim was not admitted by the Patriarch of Constantinople till 1850. By the Greek constitution of 16th/28th November 1864 "the Orthodox Church of Greece remains indissolubly united, as regards dogmas, to the great Church of Constantinople, and to every other church professing the same doctrines, and, like these churches, it preserves in their integrity the apostolical constitutions and those of the councils of the Church, together with the holy traditions; it is αὐτοκέφαλος, it exercises its sovereign rights independently of every other church, and it is governed by a synod of bishops." 8. *The Servian Church.*—After the suppression of the Church of Ipek in 1766, Servia became ecclesiastically subject to Constantinople; but in 1830 the Sultan permitted the Serbs to elect a Patriarch (as a matter of fact he is merely styled Metropolitan), subject to the confirmation of the Patriarch of Constantinople. Eight years later the seat of ecclesiastical government was fixed at Belgrade; and when Servia gained its independence its church became autocephalous. 9. *The Rumanian Church.*—The fall of the church of Okhrida in 1767 had made Moldavia and Wallachia ecclesiastically subject to Constantinople. On the union of the two principalities under Alexander Couza (December 1861) the Church was declared autocephalous under a Metropolitan at Bucharest; and the fact was recognized by the patriarchs, as it was in the case of Servia, after the Treaty of Berlin had guaranteed their independence. 10. The *Church of Montenegro* has from early times been independent under its bishops, who from 1516 to 1851 were also the temporal rulers, under the title of Vladikas, or prince-bishops. 11. The *Orthodox Church in Austria-Hungary*, which, however, really consists of three independent sections: the Servians of Hungary and Croatia, under the Patriarch of Carlowitz; the Rumanians of Transylvania, under the Archbishop of Hermannstadt; and the Ruthenians of Bukovina, under the Metropolitan of Czernowitz. 12. The *Russian Church*, with which is incorporated the ancient Church of Georgia, now under a Russian Exarch who is a member *ex officio* of the Holy Synod of Moscow.

13. The *Bulgarian Church*, unless indeed it be classed with the separated churches. It differs from the national churches already mentioned in that it had its origin in a revolt of Turkish subjects against the patriarchal authority. From the earliest times the Bulgarians had occupied an anomalous position on the borders of Eastern and Western Christendom, but they had ultimately become subject to Constantinople. The revival of Bulgarian national feeling near the middle of the 19th century led to a movement for religious independence, the leaders of which were the archimandrite Neophit Bozveli and the bishop Ilarion Mikhailovsky. The Porte espoused the cause of the Bulgarians, partly to pacify them, but still more to strengthen its hold on all the Christians of Turkey by fostering their differences. Ultimately, on 28th February 1870, the Sultan issued a firman constituting a new church, including all Bulgarians who desired to join it within the vilayet of the Danube (*i.e.*, the subsequently-formed principality of Bulgaria), and those of Adrianople, Salonica, Kossovo, and Monastir (*i.e.*, part of Macedonia, Eastern Rumelia, and a tract farther south). The members of this Church were to constitute a *millet* or community, enjoying equal rights with the Greeks and Armenians; and its head, the Bulgarian Exarch, was to reside at Constantinople. Naturally, this was resented by the Patriarch Anthimus, who stigmatized the racial basis of the Bulgarian Church under the name of Phyletism. A local synod at Constantinople, in August 1872, pronounced it schismatical; Antioch, Alexandria, and Greece followed suit; Jerusalem pronounced a modified condemnation; and the Servian and Rumanian churches avoided any definite expression of opinion. Russia was more favourable. It never actually acknowledged the Bulgarian Church, and Bulgarian prelates may not officiate publicly in Russian churches; on the other hand, the Holy Synod of Moscow refused to recognize the Patriarch's condemnation, and Russian ecclesiastics have secretly supplied the Bulgarians with the holy oil. Above all, when Prince Boris, the heir-apparent of the principality, was received into the Bulgarian Church on 14th February 1896, the Tsar was his godfather. The future of the Church remains doubtful. On the one hand, on accepted orthodox principles every believer ought to wish to see it once more under the Patriarch, since even the principality is still under Turkish suzerainty; on the other hand, its independence has a high value to the Bulgarians as the expression of their national hopes. If Bulgaria were to be constituted a kingdom, this would naturally affect the status of the Bulgarian Church in that kingdom, so far as the Patriarch is concerned; and the regulation of the Church in the principality (as apart from the Turkish provinces) by statute of 1883, into eleven eparchies or metropolitan dioceses, may be regarded as a step in this direction. But this could of course do nothing to validate the sections of the Bulgarian Church in Macedonia and other Turkish provinces. The position is further complicated by the fact that many Bulgarians, both within and without the principality, still remain subject to the Patriarch. Nevertheless, owing to its schools and other activities, the Bulgarian Church undoubtedly makes headway both in the principality and in Macedonia.

At the present day, although the signs of weakness which have characterized the past are still present, the condition of the Greek orthodox churches is on the whole satisfactory, and signs of improvement are not wanting. The encyclical on unity of Pope Leo XIII. (1895) called forth a reply from the Patriarch Anthimus V. of

Constantinople and his Synod, which is eminently learned, dignified, and charitable. The theological school of the patriarchate, at Halkē, is not undistinguished, and the University of Athens has an excellent record. Whilst the parochial clergy are still as unlearned as ever, there are not a few amongst the higher clergy who are distinguished for their learning beyond the limits of their own communion: for example, the metropolitan Ph. Bryennios, who discovered and edited the Didachē; the archbishop N. Kalogeras, who discovered and edited the second part of the commentary of Euthymius Zigabenus on the New Testament; the archimandrite D. Latas, author of a valuable work on Christian archæology (Athens, 1883); and the Logothete S. d'Aristarchi, who has published a valuable collection of the recently discovered homilies of the Patriarch Photius. This latter work is published at the Phanar press, erected as a memorial to Theodore of Tarsus, archbishop of Canterbury, by Greek and English churchmen, which was set up by the Patriarch Constantine V. in 1899, and at which is being prepared also an authorized version of the Scriptures in ancient Greek. (On the other hand, an attempt made in 1901 by the Holy Synod at Athens, with the co-operation of the Queen of Greece, to circulate a modern Greek version of the New Testament led to an ebullition of popular feeling which could only be pacified by the withdrawal of the obnoxious version and the abdication of the Metropolitan of Athens.) The Patriarch Constantine V. was deposed 12th April 1901, and was succeeded on 28th May by Joachim III. (and V.), who had previously occupied the patriarchal throne from October 1873 to April 1884, when he was deposed through the ill-will of the Porte and banished to Mount Athos. His re-election has therefore no little importance. He is a strong man and a resolute reformer, inclined to look favourably upon the plans for reorganization and reconstruction which find no little support amongst the laity and the younger monastic clergy. Like his predecessor, and in this resembling also many of the leading Russian clergy, he is very well disposed towards the English Church; and not a little has been done in the way of establishing friendly communication between the Orthodox and the Anglican Churches, as, for example, in providing for spiritual ministrations to the sick, the dying, and the dead of either communion when their own clergy are out of reach. But undoubtedly the question of the most pressing importance with regard to the future of Eastern Christendom is the relation between Russia and Constantinople. The Œcumenical Patriarch is, of course, officially the superior; but the Russian Church is numerically by far the greatest, and the tendency to regard Russia as the head, not only of the Slav races, but of all orthodox nations, inevitably reacts upon the Church, in the form of what has been called pan-orthodoxy. The Russian Church is the only one which is in a position to display any missionary activity. It has been a powerful factor in the development of several of the churches already spoken of, especially those of Servia and Montenegro, which are usually very much subject to Russian influences (Ῥωσσόφρονες or Ῥωσσώφιλοι). It has taken great interest in non-orthodox churches, such as those of Assyria, Abyssinia, and Egypt. Above all, it has shown an increasing tendency to intervene in the affairs of the three lesser patriarchates, the ultimate result of which it is not easy to foresee.

II. The Separated Churches of the East.—These are the various churches which have severed themselves or drifted into separation from the Orthodox Eastern Church for reasons either doctrinal or practical, mostly through their dissent from the decrees of councils of the 5th century. (1) The *Church of Armenia* (see *Ency. Brit.*, ninth edition, vol. ii. p. 548), a national church dating from the earliest days, was hindered by persecution from taking any part in the council of Chalcedon, A.D. 451, and subsequently repudiated it. But although it undoubtedly accepted the Henoticon of the Emperor Zeno (an abortive attempt to bring together the two parties), at the synod of Varalschapad, in 491, the Patriarch Narses definitely repudiated the Eutychian heresy in 1166. The writings of Armenian theologians have certain "aphthartodocetic" tendencies (*e.g.*, the human body of the Lord is spoken of as being by nature incorruptible), but they appear to show no signs of Eutychianism properly so called. At the present day the relations between the Armenian Church and the Œcumenical Patriarch are decidedly friendly, and in certain circumstances single Armenians may be admitted to communion in Greek churches. The head of the Church is the Patriarch of Etchmiadzin, in the Russian province of Erivan, who bears the title of Catholicos (*Katoghikos*) of Armenia. There are also Patriarchs of Sis, Aghtamar, Constantinople, and Jerusalem. The two last-named are only bishops with the honorary rank of patriarch, their importance springing from their relations with the Turkish Government. Owing, however, to the Turkish practice of organizing and governing its peoples by their religion, the Armenian Patriarch of Constantinople has become the official representative of the Armenian community in Turkey, and is thus of little less practical importance than the Catholicos himself. (2) The *West Syrian* or *Jacobite Church*, which is definitely Monophysite, under a head who bears the title of patriarch of Antioch and is always called (since the 14th century) *Mar* (= Lord) *Ignatius* (see *Ency. Brit.*, ninth edition, vol. xiii. p. 538). (3) The *Coptic Church* of Egypt, which is also Monophysite. (4) The *Abyssinian Church*, also Monophysite, and dependent upon that of Egypt. (5) The *East Syrian*, *Assyrian*, or *Chaldee Church*, which is scattered over Kurdistan, and is Nestorian in doctrine [Nestorians]. (6) A few more or less independent communities, such as the so-called *Christians of St Thomas* in South India, who were Nestorian in origin, but have become Jacobite in modern days (see *Ency. Brit.*, ninth edition, vol. xxiii. p. 308). In addition to these separated churches, there are a number of "Uniat" bodies, *i.e.*, bodies which have been incorporated in the Roman communion without giving up their ancient rites and customs (see *Ency. Brit.*, ninth edition, vol. xx. p. 630); and there are also certain isolated dissenting bodies.

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(W. E. Co.)

Oruro, a department of Bolivia, bounded on the N. by the department of La Paz, on the E. and S. by Cochabamba and Potosi, on the W. by Peru. Area, 21,350 square miles. Population (in 1893), 189,840; in 1898, estimated at 112,300, of whom 85,000 were Indians. Capital, Oruro (16,000). The department is divided into three provinces. In 1898 it had 29 schools and 1280 pupils.

Orvieto, a town and bishop's see of the province of Perugia, Umbria, Italy, on the Paglia, 78 miles by rail north by west of Rome. It crowns an isolated eminence (1165 feet), and is approached on the east by a funicular railway. In addition to the cathedral may be mentioned the church of San Andrea, with 11th-century tower; the church of San Giovenale, of the 11th century; the palace of the Popes, which since 1898 has sheltered the municipal museum, the latter rich in ancient Etruscan remains and mediæval sculptures, cathedral plans, &c.; and the communal offices, dating from the 12th century, but rebuilt in the 14th, the façade in 1585. The citadel, planned in 1364 by Cardinal Albornoz, is now laid out as a public garden. A noteworthy Etruscan necropolis, discovered in 1874, has yielded numerous Greek and Etruscan funereal urns, &c. Good wine is made. Population (1899), 7500.

Oscar II., King of Sweden and Norway (1829–——), was born at Stockholm on the 21st of January 1829, and succeeded his brother, Carl XV., upon the throne of Sweden and Norway on the 18th of September 1872. He was the third son of Oscar I. and Josephine, the daughter of Eugène de Beauharnais, Prince of Leuchtenberg, the son of the Empress Josephine. His elder brother Gustav had died young. His younger brother Auguste died in 1873. In 1857 he married Princess Sophia, youngest daughter of Duke Wilhelm of Nassau and Princess Pauline of Würtemberg, by whom he had issue Gustaf, the crown prince, born at Drottningholm on the 16th of June 1858; Oscar, who took the title of Prince Bernadotte, and renounced his royal rights on his marriage with Miss Ebba Munck (afterwards Countess Wisborg) at Bournemouth; Carl, duke of Westergötland, who married Princess Ingeborg of Denmark; and Eugène, duke of Nerike, who has devoted the greater portion of his time to painting in his studio at Stockholm. It was not only as monarch of the double Scandinavian throne, or as grandson of the famous Marshal Bernadotte, that King Oscar II. won a reputation in far wider circles than those which are influenced by considerations of dynasty or descent, for his chief title to the recognition of posterity is to be found in the tact with which he has handled delicate and difficult international problems, and the artistic and literary work by which he has been distinguished. Tall and dark, with flashing eyes, and well-moulded head upon a pair of massive shoulders, Oscar II. could never have been mistaken for anything but a true Bernadotte. Faced by the constant preoccupations of a domestic struggle whenever he turned to the politics of the two nations, it was only natural that the king should seek what solace was possible, in the scanty leisure of a throne, in those artistic and literary pursuits which had almost wholly claimed his interest as duke of Östergötland. The list of his published works, which contains poetry, history, research, translations, speeches, criticisms, would not disgrace the reputation of an author whose life had been entirely subordinated to the labours of his pen. In 1881 an exhaustive bibliography of the writings of Oscar II. was issued by "C. M. C.," who asserts that the king's first appearance in print was made in 1849, when he contributed an article on the battle of Eckernförde to the *Journal of Army Veterinary Science.* In 1858, as an anonymous competitor, Oscar II. won the second prize of the Swedish Academy with a collection of lyrical and narrative poems called *Memorials of the Swedish Fleet*, which contained some touching lines on the death of the captain of the frigate *Eugénie*, the ship on which he paid his first of many visits to British shores. Between 1859 and 1872 he published five pamphlets of occasional verse, which he collected in the latter year under the general title of *New and Old by O* * * *. In 1859 he published, in the *Annals of the Swedish Academy*, "Contributions to the Military History of Sweden in the years 1711, 1712, 1713," and these he brought out as a separate volume in 1865. In the same year appeared his translation of Herder's *Cid*, which he always considered one of his best literary efforts; and in 1861 he published a poetical version of Goethe's *Torquato Tasso*, with a charming dedication to his wife. In recognition of these scholarly labours he was elected a corresponding member of the Frankfort Academy of Sciences. The king published his *Collected Works* in two volumes in 1875–76, three years after he came to the throne. His poems have since been translated into French, German, Danish, Italian, and Magyar. The lines entitled *In My Home* have especially appealed to his own subjects, for they were written in that castle by the Sound of Helsingborg called after his Queen Sophia; and, besides the tender picture of family happiness and love which they reveal, they recall a number of those old sagas which are so dear to the heart of every Scandinavian. His first drama, *Castle Cronberg*, was also written under the same gentle influences, within a year of his marriage. It was originally composed in French, and is still a favourite piece in Swedish theatres. An English version of his *Memoirs of Charles XII.* was brought out in 1879, and while it astonished foreign readers by the skill with which it treated a subject already handled by the masterly eloquence of Voltaire, it also impressed them with far deeper evidences of accuracy and research. In 1885 King Oscar's *Address to the Academy of Music* was published with annotations. His majesty's fine collection of old printed and manuscript music, ever at the service of the intelligent amateur, is but one sign of his enthusiasm for the subject. The first English version of the most celebrated of these musical essays appeared, with the king's approval, in *Literature* for 19th May 1900. Whether in the case of his poetry, his prose, his military and naval knowledge, or the scholarship which made him worthy to be the only Swedish king who ever fairly earned his degree of Doctor of Philosophy at Lund—King Oscar II. conscientiously tried to lay all his varied talents, in their highest sense, at the service of his subjects. Nor was his wide culture limited by its merely personal expression. He welcomed many International Congresses to Sweden. He encouraged the universities and the cause of general education throughout Scandinavia, a movement in which he had already become deeply interested before his accession.

The progress of parliamentary and of party government in Sweden and Norway has led to many contentions. But whether the pressing problems for the moment were the question of separate foreign ministries, of separate flags, or of separate consulates, unity under his royal standard was the invariable policy of the monarch. In questions of international arbitration he was always deeply interested, and on several occasions took a prominent part. In 1889 he appointed the chief justice of Samoa, at the request of Great Britain, Germany, and the United States. In 1897 he was given the power to appoint a fifth arbitrator in certain circumstances in the dispute between Great Britain and Venezuela. In the same year he accepted the position of decisive umpire in the Anglo-American Arbitration Treaty which was signed at Washington, but did not secure a sufficient majority of votes in the Senate. In 1899 he again accepted the office of arbitrator in the matter of certain claims in Samoa affecting Great Britain, Germany, and the United States. His peculiar position among the sovereigns of Europe, outside their dynastic complications, yet essential to the balance of their powers, especially fitted him for these international services, to which he brought an acute and scholarly intelligence. But his well-known impartiality did not prevent him from occasionally asserting his opinions with no uncertain sound. In an outspoken declaration published in the columns of *The Times* of 2nd May 1900, he asserted his full sympathy with the United Kingdom in the course which had been thrust upon her in South Africa. The courage with which such sentiments were uttered, at a time when European opinion was almost universally hostile, was only less admired than the evident sincerity of which they were as graceful an expression.

The king's eldest son married in 1881 at Carlsruhe (being then in his twenty-third year) the Princess Victoria, daughter of Frederick William Louis, grand duke of Baden, by his wife Louise, princess of Prussia. This lady was therefore first cousin to the German Emperor William II. through her grandfather, the Kaiser Wilhelm I.; and through her grandmother Sophia, princess of Sweden, she was descended from the old royal Scandinavian stock of Gustavus Vasa. This interesting alliance connects the Bernadottes with one of the great ruling houses of Europe, and in years to come promises to set upon the throne of Sweden and Norway a sovereign who will unite in his veins the blood of Napoleon's famous marshal and of Sweden's warrior-king. The sons living (1902) by this marriage are Gustavus Adolphus, duke of Scania, born at Stockholm in November 1882; William, born in 1884; and Eric, born in 1889.

Oschatz, a town of Germany, on the Döllnitz, 18 miles by rail north-west of Meissen, in the circle of Leipzig, kingdom of Saxony. There are burgher, *real*, and commercial schools, and a seminary for teachers, as also the making of sugar, felt, weighing machines, woollens, and leather. Population (1890), 9392; (1900), 10,652.

Oschersleben, a town of Prussia, province of Saxony, 24 miles by rail west-south-west of Magdeburg. It has lignite mines, sugar refining, iron foundries, machine shops, breweries, brick-kilns, &c. The place is first mentioned in 803. Population (1885), 9671; (1900), 13,413.

Osh, a district town of Russian Turkestan, government of Fergana, 31 miles east-south-east of Andijan railway terminus, on the Akbura, altitude 3300 feet. It consists of two parts, native and Russian, of which the latter is quite new and has its streets planted with trees. Its population in 1897 was 36,474, of whom only about 400 were Russians. It has a Russian and a Russian and Sart school, four Mussulman schools, and a small hospital. Its trade with China is considerable.

O'Shanassy, Sir John (1818–1883), British colonial statesman, was born in 1818 at Holycross Abbey, near Thurles, Tipperary, his father being a land surveyor. He married in 1839, and the same year emigrated to the Port Phillip district of New South Wales, where he was for some time engaged in farming, and subsequently commenced business in Melbourne. His remarkable abilities attracted the attention of Dr Geoghegan, who afterwards became Roman Catholic bishop of Adelaide, by whom he was induced to take part in public affairs. He was one of the founders, and later the president, of the St Patrick's Society of Melbourne, represented the Roman Catholic body on the denominational board of education, and was a member of the Melbourne corporation. When Port Phillip was separated from New South Wales in 1851 and became the colony of Victoria, Mr O'Shanassy was returned to the Legislative Council as one of the members for Melbourne. A few weeks after the new colony began its independent existence gold was discovered, and the local government had to solve a number of difficult problems. The only member of the first executive who possessed any great talent for administration was the Attorney-General, Mr (afterwards Sir) W. F. Stawell. The Legislature was composed partly of elected representatives, and partly of nominees, official and non-official, appointed by the governor in council. The great natural ability of Mr O'Shanassy forced him to the front, and for some time the policy of the country was virtually shaped by him and Mr Stawell. It was very much owing to the strong position taken by Mr O'Shanassy that the powers of the Legislative Council were enlarged by the duke of Newcastle, who was at that date Secretary of State for the Colonies, and that it was allowed to control not only the ordinary revenue raised by taxation, but also the territorial, which was derived from the proceeds of the sale and occupation of Crown lands. From that date the Legislative Council, led by Mr O'Shanassy, became virtually supreme, and was enabled to expend the large sums which came into the exchequer of the colony, directly or indirectly through the discovery of gold, upon public works and the various services of the Government. After the Ballarat riots in 1854, Mr O'Shanassy was one of the members of a commission appointed to inquire into the condition of the gold-fields, and his report and that of his colleagues was the foundation of the mining legislation which, initiated in Victoria, was gradually followed by all the Australasian colonies. Mr O'Shanassy, together with Sir Andrew Clarke, was one of the framers of the constitution under which not only was the whole of the Legislature elected by the people, but the ministry became responsible to the local parliament. Under this constitution Mr O'Shanassy was returned in 1856 to the Legislative Assembly for Melbourne and Kilmore, but took his seat for the latter constituency. Early in 1857 the Haines Government, the first formed after the concession of responsible government, from among the members of the old Executive Council, was defeated, and Mr O'Shanassy having been sent for by the governor, Sir Henry Barkly, formed a ministry of which he became the premier. But he encountered strong opposition as soon as he met Parliament, and was defeated after holding office for little more than six weeks. He returned to power in 1858 as chief secretary and premier, on the defeat of the Haines Government through the rejection of the schedule to their increase of members Bill, and was again elected for Kilmore. One of the first duties of the new ministry was to inaugurate the system of railways, and to raise the necessary funds for their construction. Several propositions were made to the Government of Victoria by the great finance houses of the United Kingdom, and the propositions of Baring Brothers were brought to the colony by Mr Childers. Mr O'Shanassy decided to float a loan of eight millions sterling through the instrumentality of six of the Melbourne banks, and he commenced the series of borrowings by the Australian governments which subsequently attained such large proportions. In 1859 the second O'Shanassy ministry had to resign after a vote of want of confidence, and its leader remained in opposition till August 1861, when he defeated the Heales ministry on their budget, and formed his third administration. During the two years that it held office the Government passed an Education, a Local Government, a Civil Service, and a Land Act. The object of this last was to abolish the old system of selling the Crown lands by auction, and to substitute another which insisted rather upon residence and cultivation than upon obtaining the highest possible price. The Act did not carry out all the intentions of its framers, but it was a step in the right direction. The O'Shanassy Government was defeated in June 1863, and its chief never again succeeded in regaining office. He remained in opposition, and as leader of the Conservative or, as it was termed, the Constitutional party, was a steady opponent of the measures introduced by Mr M'Culloch and advocated by Mr Higinbotham. In 1864 he was re-elected for Kilmore, but he did not stand at the general election of 1866, and paid a visit to Europe. In that year he was created by Pope Pius IX., in recognition of his services in the cause of Roman Catholic education, a Knight of the Order of St Gregory the Great. In 1867 he returned to Victoria, and was elected a member for the central province in the Legislative Council. In 1870 he was created C.M.G., and in 1874 K.C.M.G. In the latter year he resigned his seat in the Council, and did not re-enter public life until 1877, when he was returned to the Assembly for Belfast. His strongly expressed Conservative opinions and his devotion to the interests of the Roman Catholic Church impaired his influence in the Legislature, which had become extremely democratic during the eleven years that he had been absent from it; and although Sir John was a fearless critic of the policy of the Government, he never succeeded in defeating it. He had a singularly comprehensive grasp of all constitutional questions, was an eloquent speaker, and an ardent free-trader. He retired from Parliament in 1880, and died in 1883. (G. C. L.)

O'Shaughnessy, Arthur William Edgar (1844–1881), English poet, was born in London on 14th March 1844, and at the age of seventeen obtained through the first Lord Lytton, who took a peculiar interest in him, the post of transcriber in the library of the British Museum. Two years later he was promoted to be an assistant in the natural history department, and took up the ichthyological branch of the work; for this he had probably little natural aptitude, but he so carefully qualified himself as to become in time an authority. He published his *Epic of Women* in 1870, *Lays of France* in 1872, and *Music and Moonlight* in 1874. In his thirtieth year he married a daughter of John Westland Marston, and during the last seven years of his life printed no volume of poetry. *Songs of a Worker* was published posthumously in 1881, O'Shaughnessy dying on the 30th of January in that year from the effects of a chill upon a delicate constitution. The qualities of O'Shaughnessy's poetry are those of the true singer; its defect the lack of importance in theme and dignity in thought. His melodies are often magnificent; and, as in *The Fountain of Tears*, the richness of his imagery conceals a certain vagueness and indecision of the creative faculty. He was also very felicitous in bold uses of repetition and echo, by which he secured effects which for haunting melody are almost inimitable. His spirit is that of a mild melancholy, drifting helplessly through the realities of life and spending itself in song. Where the inspiration of the moment fails him, and nothing but the music is left, the insubstantiality of his talent becomes clear. By some critics he has been occasionally disparaged, but reparation was done to his memory by Francis Turner Palgrave, who, in the second series of the *Golden Treasury*, said with some exaggeration that his metrical gift was the finest, after Tennyson, of any of the later poets, and that he had "a haunting music all his own." (A. WA.)

Oshima, a group of three small islands belonging to Japan, lying southwards of Kiushiu, in 30° 50′ N. and 130° E. Their names, from west to east, are Kuro-shima, Iwo-jima and Taka-shima. Kuro-shima rises to a height of 2475 feet, and Iwo-jima has an active volcano 2480 feet high. These islands are not to be confounded with Oshima, the most northerly island of the Izu-no-shichito, or with the northern group of the Luchu Islands. There are several other islands of the same name in Japan, the term Oshima signifying merely "big island." One of the best known lies off the Kii promontory, and has been the scene of many maritime disasters.

Oshkosh, a city of Wisconsin, U.S.A., capital of Winnebago county, on the Fox river, at its mouth in Winnebago Lake, in the eastern part of the state, at an altitude of 756 feet. The city is divided into thirteen wards; its streets are paved with wood or are gravelled, and it has a water-supply by the Holly system. The schools are excellent, and there is a public library. It is on three railways, the Chicago and North-Western, the Chicago, Milwaukee, and St Paul, and the Wisconsin Central. It has extensive manufactures. In 1900 the number of establishments reported was 285, with a total capital of $8,018,038, employés numbering 4587, and a product valued at $8,781,248. The largest item was lumber, valued at $2,449,430. Besides this, carriages and waggons, furniture, flour, and iron and steel goods were produced, and other minor articles. The city contains the state normal school and an insane asylum. The assessed valuation of real and personal property was, in 1898, $9,279,993; the net debt of the city was $375,316; and the rate of taxation was $26.50 per $1000. Population (1890), 22,836; (1900), 28,284, of whom 7356 were foreign-born. There were 9490 persons of school age (five to twenty years). Of 7513 males, twenty-one years of age and over, 252 were illiterate (unable to write).

Osimo, a town and episcopal see of the province of Ancona, the Marches, Italy, 10 miles south of Ancona. It still retains a portion of its ancient town wall (2nd cent. B.C.), and possesses a cathedral, and a town hall with antiquities. Silk-spinning and the raising of cocoons are carried on. It is the ancient Picenian town of *Auximum*. Population (1899), about 5000.

Oskaloosa, a city of Iowa, U.S.A., capital of Mahaska county, between the Des Moines and Skunk rivers, on the Chicago, Burlington, and Quincy, the Iowa Central, and the Chicago, Rock Island, and Pacific railways, south-east of the centre of the state, at an altitude of 833 feet. It is in an agricultural and coal-mining region. Penn College, situated here, had, in 1899, 14 instructors and 300 students. Population (1890), 6558; (1900), 9212, of whom 649 were foreign-born and 344 negroes.

Oskarshamn, a seaport town of Sweden, county of Calmar, on a bay of the east coast, opposite the north end of the island of Öland, 40 miles north of Calmar. It was called Döderhultsvik down to 1856. It exports timber ($3\frac{1}{2}$ to $4\frac{1}{4}$ million cubic feet annually) and granite; and imports coal, petroleum, salt, and groceries. The port is often closed for a couple of months in the depth of winter. The industries embrace iron-works, match factories, &c. There are two dry docks. Population (1880), 5382; (1890), 5853; (1900), 7077.

Osman (1832–1900), Turkish mushir (field-marshal), was born at Tokat, in Asia Minor, in 1832. Educated at the military academy at Constantinople, he entered the cavalry in 1855, and served under Omar Pasha in the Russian war of 1853–56, in Wallachia and the Crimea. Appointed a captain in the Imperial Guard, he went through the campaigns of the Lebanon in 1860 and of Crete in 1867 to 1869, under Mustapha Pasha, when he distinguished himself at the capture of the convent of Hagia Georgia, and was promoted lieutenant-colonel. He served under Redif Pasha in suppressing an insurrection in Yemen in 1871, was promoted major-general in 1874, and general of division in 1875. Appointed to command the army corps at Widin in 1876 on the declaration of war by Servia, he defeated Tchnernaieff at Saitschar and again at Yavor in July, invaded Servia and captured Alexinatz and Deligrad in October, when the war ended. Osman was promoted to be mushir, and continued in the command of the army corps at Widin. When the Russians crossed the Danube in July 1877, Osman moved his force to Plevna, and, with the assistance of his engineer, Tewfik Pasha, entrenched himself there on the right flank of the Russian line of communication, and gradually made the position a most formidable one. He repulsed the three general assaults of the Russians on the 20th and 30th July and the 11th September, inflicting on them great loss —some 30,000 men in the three battles. He held the position, after being closely invested, until the 9th December, when, compelled by want to cut his way out, he was severely wounded and forced to capitulate. This famous improvised defence of a position delayed the Russians for five months, and entailed their crossing the Balkan range in the depth of winter after the third battle of Plevna. The Sultan conferred on Osman the Grand Cross of the Osmanie in brilliants and the title of "Ghazi" (victorious), and, when he returned from imprisonment in Russia, made him commandant of the Imperial Guard, grand-master of the artillery, and marshal of the palace. In December 1878 he became War Minister, and held the post, with a small break, until 1885. He died at Constantinople, in the palace built for him by the Sultan near Yildiz Kiosk, on 4th April 1900, and his body was buried with great pomp in the Sultan Muhammad Mosque. (R. H. V.)

Osman Digna. See EGYPT: *Military Operations.*

Osnabrück, a town and episcopal see of Prussia, province of Hanover, 31 miles by rail north-east of Münster, in a valley on the north side of the Teutoburger Forest. The town is adorned with a bronze equestrian statue of the Emperor William I. (1899), a monument of the war of 1870–71 (1880), and statues of Justus Möser (1836) and the Hanoverian minister Stüve (1882). The cathedral is undergoing extensive alteration. Osnabrück is a place of considerable industry, possessing iron and coal mines, iron foundries, machine shops, stone quarries, and various iron manufactures. Population (1885), 35,899; (1900), 51,574.

Ossett, with GAWTHORPE, a municipal borough (incorporated 1890), railway station, and parish in the Morley parliamentary division of Yorkshire, England, 3 miles west-north-west of Wakefield. It has baths similar in their properties to those of Cheltenham. New technical school buildings were erected in 1890, and a public library has been opened. Population (1891), 11,123; (1901), 12,886.

Ossining, a village of Westchester county, New York, U.S.A., known as Sing-Sing previous to 1901. It is situated on the east bank of the Hudson river, where it widens into Tappan Bay, 31 miles north of New York City, and on the New York Central Railroad. Its situation is on a steep slope descending from a height of from 200 to 300 feet to the river, on which it is laid out irregularly. Sing-Sing prison is located here, and several excellent schools for boys and girls. Population (1900), 7939, of whom 1642 were foreign-born and 308 negroes.

Ostashkoff, a district town of Russia, government and 162 miles west-north-west of Tver, on Lake Seliger, situated in a damp and insalubrious climate. Its population grows, nevertheless, by immigration, and was 10,457 in 1897. It has several tanneries, and is a great centre for the making of boots and shoes as a domestic trade (400,000 pairs per annum), agricultural implements, fishing-nets, and building of boats. It has good fishing, and steamers ply on the lake.

Ostend, or OSTENDE, a seaport of Belgium, in the province of West Flanders, 14 miles by rail west of Bruges. It is the seaward terminus of important Continental main lines of railway, *e.g.*, from the north of France, from Switzerland, *viâ* Strasburg, and from Cologne and central Germany, and a landing-place in one of the principal express routes (Dover–Ostend) between England and the Continent. The mail service between Dover and Ostend was started on 3rd March 1846, and between then and the end of that year 4525 passengers were carried between the two ports; but by 1899 the number of passengers so carried had increased to 124,724 annually. The growth of the general traffic of the port is shown by the following statistics: in 1860, 704 vessels of 66,950 tons entered; in 1880, 1308 vessels of 244,831 tons; and in 1899, 2000 vessels of 1,156,907 tons (of which 1927, of 1,124,026 tons, were steam vessels). In 1898 what was virtually an additional new harbour was planned and begun, the cost of the necessary works being borne partly by the State, partly by the municipality of Ostend. The excavations extend inland as far as the hamlet of Slykens, a distance of three-quarters of a mile; and the works embrace a basin for the royal mail steamers (Dover–Ostend boats) and other Government vessels, with a depth of 26¼ to 32¾ feet beside the quays; another basin for shipping generally, 3300 feet long, 295 feet to 820 feet wide, and 23 feet deep during the height of the tide; two dry docks; and a new harbour railway station. The approach to the old harbour, as well as the anchorage outside, has been improved by cutting three gaps, each 16½ feet minimum depth, and 1640 feet, 1150 feet, and 2620 feet wide respectively, through the Strombank sand-bar, which stretches 12 miles parallel to the shore at a distance of 1¼ miles from it. Ostend is also one of the principal fishing ports of the kingdom, the deep-sea fishing being carried on by about 300 men in sailing smacks and 1300 men in steam trawlers. Oysters and lobsters are preserved and fattened on a large scale, being brought in the first instance from the east of England, France, and Norway. Ostend is even more celebrated as a seaside resort than as a seaport. In the height of the season, which lasts from 1st May to 15th October, it is visited by some 40,000 persons, attracted partly by the excellent sea-bathing, partly by the fashionable social life and the amusements which minister to it, and partly by the licensed gambling which takes place in the *kursaal.* Along the sea-front of the town extends for a distance of 2½ miles, that is, as far west as Mariakerke (which was incorporated with Ostend in 1899), a magnificent promenade, 100 feet broad, constructed entirely of hardened bricks, and backed by handsome villas with open fronts; by a crowd of hotels, some of them built on a palatial scale; by the *kursaal,* which has a concert hall capable of seating 5000 persons; and by the villa of the king of the Belgians. Out of the season almost all the hotels on the sea-front are closed. The licence for public gaming in Ostend was extended, to the lessees who then held it, for the space of two years from the autumn of 1901. The two principal churches are both quite new—St Peter and St Paul's, originally founded in 1072, has been rebuilt, after being burnt down in 1896; and St Catherine's was built in 1883, on the model of a Ghent church of the 13th century. There is also a third church, St Joseph's (1901). The pleasure-resorts embrace the large Leopold Park, the Marie Henriette Park, the casino or ball-rooms in the Hôtel de Ville, and the restaurant at the pier-head (*estacade*). Ostend vies with Scheveningen in Holland for priority as the most expensive seaside resort on the Continental shores of the North Sea. It is connected by steam tramway with the quieter sea-bathing resorts of Blankenberghe (13 miles), to the north-east, and Middelkerke, Westende, and Nieuport (11 miles), to the south-west. By the Canal de Bruges, Ostend has water communication with the city of Bruges, and thence by other canals with Ghent, Eecloo, Sluis, and other towns of Belgium. Population (1880), 19,307; (1890), 24,688; (1900), 39,484.

Osterode, a town of Prussia, province of Hanover, at the south foot of the Harz Mountains, 34 miles north-west of Nordhausen by rail. It is the seat of various industries—woollens, cottons, white lead, copper and puddling works, tanning, gypsum quarries, dyeworks, &c. The church of St Ægidius contains tombs of the dukes of Grubenhagen. Population (1885), 6435; (1900), 7099.

Osterode, a town of Prussia, province of East Prussia, 75 miles by rail north-east of Thorn, on Lake Drewenz. It has three churches, a synagogue, a castle built by the Teutonic knights in 1270, and a normal school (males). The place has a trade in agricultural products and timber, and such industries as saw-milling, tar production, dyeing, brewing, and manufacture of paper and machinery. Population (1885), 7123; (1900), 13,163.

Östersund, a town of Sweden, capital of the county of Jämtland, situated on the east shore of Stor (Great) Lake, 364 miles north by west of Stockholm by rail. Immediately facing the town is the lofty island of Frös, with which it is connected by a bridge 1418 feet long. It was founded in 1786. Population (1880), 2854; (1890), 5333; (1900), 6866.

Ostia, the ancient port of Rome, Italy, situated at the mouth of the Tiber. The principal survivals of the place are graves, from which numerous remains have been taken; baths, excavated in 1891; the headquarters of the fire-cohort; the forum, excavated in 1880–81, with the basement of a temple, 82 feet long by 39 feet broad; theatre; sanctuary of Mithras; three tiny temples, one dedicated to Venus; the sanctuary of Cybele; and another large temple. The modern village of Ostia, which gives name to one of the most important episcopal sees of the Church of Rome, was founded by Pope Gregory IV. in 830. At Porto the chief edifices are the cathedral of Santa Rufina, dating from the 10th century, but modernized; the bishop's palace; and the villa of Prince Torlonia. At Fiumicino, a port since 1825, there is sea-bathing. Population of all three places, about 1200. In 1884 a beginning was made with the draining of the Agro Romano, that is, the marshes of Ostia, the Isola Sacra, and Maccarese, by constructing banks and canals, and lifting out the water from the enclosed marshes by turbines.

Ostrau, the name of two Austrian towns in the Ostrau-Karwin coal-mining district. 1. Mährisch-Ostrau (Moravian Ostrau), situated on the right bank of the Ostrawitza, near its confluence with the Oder. It has a station on the Austrian Northern Railway, between Vienna and Cracow. It derives its importance from the extensive neighbouring coal-mines, and the blast furnaces and iron-works which they have called into existence. The manufactures comprise sheet-iron, boilers, zinc, brick and tiles, paraffin, petroleum, soap, rum, liqueurs, &c. The Rothschild iron-works at Witkowitz are in the vicinity. Population (1890), 19,243; (1900), 30,125. 2. Polnisch-Ostrau (Polish Ostrau), a mining town in the government district of Freistadt in Austrian Silesia, opposite Mährisch-Ostrau. It has large coal-mines, which form the south-western portion of the extensive Upper Silesian coal-fields, the largest Austrian deposit. Population (1890), 13,176; (1900), 18,761.

Ostrofsky, Alexander Nikolaivich (1823–1886), Russian dramatic author, was born on the 12th of April 1823 in Moscow, where his father was an official of the Senate. After passing through the gymnasium, he studied law in the university, which he quitted without having submitted to the final examination. He was then employed as a clerk in the office of the "Court of Conscience," and subsequently in that of the Commercial Court at Moscow. Both tribunals were called upon to settle disputes chiefly among the Russian merchant class, from which Ostrofsky was thus enabled to draw the chief characters for his earliest comedies. Among these are *Byednaya Nivesta* ("The Poor Bride"), *Byednost ne Porok* ("Poverty not a Vice"), and *Ne v'svoi sani ne sadis* (literally "Don't put yourself in another's sledge," but really meaning "Don't put yourself in a position for which you are not suited"). Of this last Nicholas I. said, "it was not a play, but a lesson." The uncultured, self-satisfied Moscow merchants are strikingly portrayed in *Grozá* ("The Tempest") and *Svoyi lyudi sochtyomsya* ("Between near relatives no accounts are needed"), which was originally called "The Bankrupt." The last-mentioned comedy was prohibited for ten years, until the accession of Alexander II., and Ostrofsky was dismissed the Government service and placed under the supervision of the police. The Liberal tendencies of the new reign, however, soon brought relief, and with a view to the great reforms of the 'sixties, then under consideration, Ostrofsky was one of several well-known literary men who were sent into the provinces to report on the condition of the people. Ostrofsky's field of inquiry lay along the upper Volga, a part of the country memorable for some of the most important events in Russian history. This mission induced him to write several historical dramas of great merit, such as *Kuzma Zakharich Minin Soukhorouk* (the full name of the famous butcher who saved Moscow from the Poles); "The False Demetrius" and "Vassily Shuisky"; *Vassilisa Melentieva* (the name of a favourite Court lady of Ivan the Terrible), and the comedy, *Voivoda eeli Son na Volge* ("The Military Commander," or "A Dream on the Volga"). Many of his later works treat of the Russian nobility, and include *Byeshani Dengi* (literally "Mad Money"), *Vospeetinitsa* ("A Girl brought up in a Stranger's Family"), and *Volki e Ovtsi* ("Wolves and Sheep"); others relate to the world of actors, such as *Liess* ("Forest"), *Bez vini vinovatiya* ("Guiltlessly guilty"), and *Talenti e Pokloniki* ("Talents and their Admirers"). Ostrofsky enjoyed the patronage of Alexander III., and received a pension of 3000 roubles a year. With the help of Moscow capitalists he established in that city a model theatre and school of dramatic art, of which he became the first director. He also founded the Society of Russian Dramatic Art and Opera Composers. His death took place on 24th June 1886, while travelling to his estate in Kostroma. (G. D.)

Ostrog, a district town of Russia, government of Volhynia, 90 miles west of Zhitomir and near the Zdolbunovo railway junction, at the confluence of the Wilia with the Goryn. It has, besides the usual primary schools, gymnasia for boys and for girls, and a brotherhood of Cyril and Methodius, which also maintains schools of its own. The tanning of lighter leather is a widely-spread domestic trade. Population (1897), 14,530.

Ostrogozhsk, a district town of Russia, government and 86 miles by rail south of Voronezh (*viâ* Liski), on the Tikhaya Sosna. It was founded by Little Russians in 1652. It is a centre for wholesale trade in horses, cattle, and tallow, and has several tanneries. Population (1897), 21,891.

Ostrów (Russian, *Ostrov*), a town of Russian Poland, government of Łomża, 53 miles north-east of Warsaw, 10 miles north of the railway to St Petersburg. It has agricultural machinery works. Population (1897), 11,264. Another town of the same name is in the government of Siedlce, district of Włodawa. Population, 4410. A third town of the same name is the Russian district town Ostrov, in the government of and 33 miles by rail south-south-west of Pskoff, on Velikaya river. It is a centre for trade in flax and linseed. Population, 6252.

Oswego, a city of New York, U.S.A., capital of Oswego county, on the southern shore of Lake Ontario, at an altitude of 300 feet. It is regularly laid out on a level site, with broad, mainly unpaved streets, is divided into eight wards, and its water-supply is pumped from the Oswego river, the works being owned by private parties. Oswego is on the Delaware, Lackawanna, and Western, the New York Central and Hudson River, and the New York, Ontario, and Western railways, and these, with boats on the lake, give it a large commerce, principally in coal, grain, and lumber. The ample water-power furnished by the Oswego river has caused a great development in manufactures. In 1900 the city contained 207 manufacturing establishments, with a total capital of $7,322,907. They employed 3845 hands, and the product was valued at $8,137,950. Chief among these products are those of foundry and machine shops, hosiery and knitted goods, and malt. Population (1890), 21,842; (1900), 22,199, of whom 3989 were foreign-born and 57 negroes.

Oswestry, a municipal borough and market town in the Oswestry parliamentary division of Shropshire, England, 18 miles north-west of Shrewsbury, on the Great Western and Cambrian railways. The old town hall has been demolished and new municipal buildings have been opened. The Cambrian Railway Company employ some 300 men at their carriage and engine works here. The castle grounds, laid out by public subscription, were opened in 1890. Population (1891), 8496; (1901), 9579.

Otago. See New Zealand.

Otaheite. See Tahiti.

Otley, a market town and railway station in the Otley parliamentary division of Yorkshire, England, 10 miles north of Bradford. A recreation hall was opened in 1895. In 1897 premises for art and science schools were erected. One of the chief industries is the making of printing machines. The neighbouring range of hills, known as the Chevin, abounds in good stone for building purposes, which was used for the foundations of the Houses of Parliament, and is despatched to all parts of England. Population (1891), 7838; (1901), 9230.

Ottawa, a river of Canada and the largest tributary of the St Lawrence. It rises in northern Quebec, in 75° 35′ W. and 47° 53′ N., and flows westwards 330 miles to Lake Temiscaming; from the outlet of the latter it flows in a south-easterly direction for 250 miles, and then easterly to its confluence with the St Lawrence at the island of Montreal. It drains an area of 56,470 square miles, and is 730 miles long. The principal tributaries from the left bank are the Rouge (120 miles long), North Nation, Petite Nation, Lievre (215 miles), Gatineau (245 miles), Coulonge, Black, Dumoine, and Keepawa; from the right bank, the South Nation, Mississippi, Madawaska, Petewawa, Mattawa, Montreal, and Blanche. Canals at St Anne, Carillon, and Grenville permit the passage of vessels, drawing 9 feet, up to Ottawa city; thence the Ottawa and Georgian Bay canal is projected, by way of the Ottawa, Mattawa, and French rivers, to Lake Huron. This canal, if constructed, will form the shortest route from Chicago, Duluth, &c., to the sea-board.

Ottawa (formerly Bytown), a city of Carleton county, Ontario, and the capital of the Dominion of Canada, situated on the right bank of the river of the same name, 101 miles west of Montreal. The main tower of the parliament buildings is in 75° 42′ 03″ W. and 45° 25′ 28″ N. The city stands on ground elevated from 60 to 155 feet above the river—185 to 280 feet above the sea—and is underlain by rocks of the Trenton and Utica groups, the former outcropping in precipitous bluffs on the river front. It is on the main line of the Canadian Pacific Railway and is the terminus of the Canada Atlantic, Ottawa and Parry Sound, Ottawa and New York, and Ottawa and Gatineau railways, and of the Montreal and Ottawa, Prescott and Brockville branches of the first-named railway. Electric railways afford rapid and easy communication with all parts of the city and with the neighbouring towns of Aylmer and Britannia, and during the summer months steamers ply to Montreal and ports on the Ottawa river and Rideau canal. A railway bridge and a road bridge—the latter a new structure replacing the famous Chaudière suspension bridge—connect Ottawa with the city of Hull on the opposite or Quebec bank of the river, and a third for railway and vehicular traffic gives the Pontiac Pacific Junction and Ottawa and Gatineau railways access to the centre of the city. Ottawa is the seat of the Dominion Government, the supreme and exchequer courts, and residence of the Governor-General. The parliament and departmental buildings are beautifully situated on Parliament Hill, a park of about 25 acres in extent, elevated 150 feet above the river and with precipitous limestone bluffs facing the river and canal. The parliament and eastern and western departmental buildings are in Italian Gothic of the 13th century, and form three sides of a great quadrangle, the fourth side being occupied by the Langevin departmental building. The latter, a fine massive structure, built of brown sandstone from New Brunswick, stands just outside the parliament grounds proper and on the opposite side of Wellington Street. The University of Ottawa—the Roman Catholic university of Ontario—occupies an advantageous situation on Wilbrod Street. It grants degrees in arts and sciences, and has about 475 students, drawn from all parts of Canada and the United States. Other prominent buildings are the post office, city hall, normal school, collegiate institute, printing bureau, court-house, Christ Church Cathedral, and the Basilica. The city charities are numerous, and include eight hospitals (three general hospitals and five others), nine homes for children and the aged and infirm, and two training schools for nurses. There are eighteen public schools, with 109 teachers and 6145 pupils, including kindergartens; twenty-four Roman Catholic separate schools, with 96 teachers and 4140 pupils; also a collegiate institute, the normal school for eastern Ontario, model school, ladies' college, six convents, and two monasteries. Ottawa contains many flourishing industries, including large saw, flour, and planing mills, foundries and manufactories of calcium carbide, street cars, waggons, and porcelain and carbon for electrical purposes. It is the seat of the head office of the Bank of Ottawa, and contains eleven branches of other banks. Incorporated as a city in 1854, the population in 1881 numbered 27,412; in 1887 New Edinburgh was annexed, and in 1889 three other suburbs, Stewarton, Rochesterville and Mount Sherwood, were brought in. In 1891 the population had increased to 44,154, and in 1901 to 59,928. The total assessment in 1885, exclusive of corporation and Government property, was $11,545,735; in 1895, $21,247,220; and in 1902, $27,420,740; exemptions in 1902, $16,337,150; assessed value of real estate, $24,738,690. The value of the exports for the year ending 30th June 1901 was $464,587; imports, $3,356,791; customs duty, $592,445. The city returns two members to the Dominion House of Commons, and two to the provincial legislature. A mayor and twenty-four aldermen — the latter representing the eight wards into which the city is divided—constitute the municipal government. It is the seat of a Roman Catholic archbishop and an Anglican bishop. (J. WH*.)

Ottawa, a city of Illinois, U.S.A., capital of Lasalle county, on the Illinois river, at the mouth of the Fox, on the Illinois and Michigan canal, and on the Chicago, Burlington, and Quincy, and the Chicago, Rock Island, and Pacific railways, north of the centre of the state, at an altitude of 484 feet. The city is on a level site on the first terrace above the river, and its plan is regular. Its water-supply is derived from artesian wells, and it has a good sewer system. In 1900 it contained 120 manufacturing establishments having a capital of $2,783,357, 1233 wage-earners, and a product valued at $2,042,148. Population (1890), 9985; (1900), 10,588, of whom 1804 were foreign-born.

Ottawa, a city of Kansas, U.S.A., capital of Franklin county, on the Osage river, which here is not navigable, and on the Atchison, Topeka, and Santa Fé and the Missouri Pacific railways, in the eastern part of the state, at an altitude of 891 feet. The site of the city is level and its plan regular. Its manufacturing establishments consist in part of railway works, flour mills, and beet-sugar factories. Population (1880), 4032; (1890), 6248; (1900), 6934, of whom 333 were foreign-born and 550 negroes.

Ottensen, formerly a town of Prussia, province of Schleswig-Holstein. It has since 1889 been united with Altona.

Ottumwa, a city of Iowa, U.S.A., capital of Wapello county, on the Des Moines river, in the south-eastern part of the state, at an altitude of 649 feet. The city spreads back from the river over a succession of terraces, rising one above another, and is well laid out, with good water-supply and sewerage systems and a steam heating plant. It is on the Chicago, Burlington, and Quincy, the Chicago, Fort Madison, and Des Moines, the Chicago, Milwaukee, and St Paul, the Chicago, Rock Island, and Pacific, and the Wabash railways, which give it a large trade. This is mainly in coal, since the city is in the midst of the great Iowa coal-field. In 1900 it had 160 manufacturing establishments with $3,403,321 capital, 2095 wage-earners, and products valued at $9,129,862. Population (1890), 14,001; (1900), 18,197, of whom 1759 were foreign-born and 598 negroes.

Oudh, or AWADH (*Ajodhya*), a historic tract in northern India, and still a separate administration not completely amalgamated with the North-Western Provinces. Area, 23,965 square miles; population (1891), 12,650,831; (1901), 12,884,150, showing an increase of 2 per cent. The capital is Lucknow. Oudh is a "non-regulation" province, with an independent judicial system; and the existence of the *talukdars* will always preserve an interesting distinction.

The statistics of Oudh are for the most part included under the North-Western Provinces (*q.v.*). Between 1881 and 1891 the population increased by 11 per cent., or more than twice as fast as in the North-West, owing to the extension of cultivation in the submontane tract. Excluding the two cities of Lucknow and Fyzabad, the average density ranged from 305 persons per square mile in the northern district of Kheri to 649 persons in the central district of Bara Banki. Classified according to religion, Hindus numbered 11,016,209, or 87 per cent. of the total population; Mahommedans, 1,620,930, or nearly 13 per cent.; Christians, 9312, of whom 5493 were Europeans and 1545 Eurasians, leaving 2274 for native converts; "others" (chiefly Sikhs and Jains), 4380. Out of a total area of 15,337,846 acres, the amount permanently settled with *talukdars* on privileged terms is 1,112,921, chiefly in the two districts of Gonda and Bahraich. The incidence of assessment is R.1 : 1 : 9 on the temporarily settled and Rs.0 : 14 : 7 on the permanently settled land. In 1896–97 the total cultivated area was 8,072,586 acres, of which 2,398,200 acres were cropped more than once. The irrigated area was 2,266,346 acres, entirely from wells and tanks, for there are no Government canals in Oudh. The principal crops are rice, wheat, barley, pulse, millet, sugar-cane, and opium. The area under indigo was 22,877 acres. Oudh has no manufactures or mines. The only large factory is one for making paper at Lucknow. The chief railway system is that of the Oudh and Rohilkhand, which crosses the Ganges opposite Cawnpore and Benares, and is now connected with northern Bengal.

Ougrée, a town of Belgium, in the province and four miles south-west of the town of Liége by rail. It has five blast-furnaces and large industrial establishments, and is situated in the Liége coalfield district. Population (1880), 7978; (1890), 10,241; (1900), 13,020.

Ouseley, Sir Frederick Arthur Gore (1825–1889), English composer, was the son of Sir Gore Ouseley, ambassador to Persia, and nephew to Sir William Ouseley, the eminent Oriental scholar. He was born 12th August 1825 in London, and very soon manifested an extraordinary precocity in music, composing an opera at the age of eight years. In 1844, having succeeded to the baronetcy, he entered at Christ Church, and graduated B.A. in 1846 and M.A. in 1849. He was ordained in the latter year, and, as curate of St Paul's, Knightsbridge, served the parish of St Barnabas, Pimlico, until 1851. In 1850 he took the degree of Mus.B. at Oxford, and four years afterwards that of Mus.D., his exercise being the oratorio *St Polycarp*. In 1855 he succeeded Sir Henry Bishop as professor of music in the University of Oxford, was ordained priest, and appointed precentor of Hereford. In 1856 he became vicar of St Michael's, Tenbury, and warden of St Michael's College, which under him became an important educational institution both in music and general subjects. His works include a second oratorio, *Hagar* (Hereford, 1873), a great number of services and anthems, chamber music, songs, &c., and theoretical works of great importance, such as *Harmony* (1868) and *Counterpoint* (1869), and *Musical Form* (1875). One of his most useful works is a series of chapters on English music added to the translation of Emil Naumann's *History of Music*, the subject having been practically ignored in the German treatise. A profoundly learned musician, and a man of great general culture, Ouseley's influence on younger men was wholly for good, and he helped forward the cause of musical progress in England perhaps more effectually than if he himself had been among the more enthusiastic supporters of "advanced" music. The work by which he is best known, *St Polycarp*, shows, like most compositions of its date, the strong influence of Mendelssohn, at least in its plan and scope; but if Ouseley had little individuality of expression, his models in other works were the English church writers of the noblest school. He died at Hereford, 6th April 1889. (J. A. F. M.)

Ovar, a town of Portugal, district Aveiro, situated at the north extremity of the lagoon (*ria*) of Aveiro, and 21 miles south of Oporto. Millet, wheat, and vegetables (especially onions) are the chief products. The people are principally engaged in the fisheries. Population, about 12,000.

Overbury, Sir Thomas (1581–1613), English poet and essayist, and the victim of one of the most sensational crimes in English history, was the son of Nicholas Overbury, of Bourton-on-the-Hill, and was born in 1581 at Compton Scorfen, near Wilmington, in Warwickshire. In the autumn of 1595 he became a gentleman commoner of Queen's College, Oxford, took his degree of B.A. in 1598, and came to London to study law in the Middle Temple. He found favour with Sir Robert Cecil, travelled on the Continent, and began to enjoy a reputation for an accomplished mind and free manners. About the year 1601, being in Edinburgh on a holiday, he met Robert Carr, then an obscure page to the earl of Dunbar; and so great a friendship was struck up between the two youths that they came up to London together. The early history of Carr remains obscure, and it is probable that Overbury secured an introduction to Court before his young associate contrived to do so. At all events, when Carr attracted the attention of James I., in 1606, by breaking his leg in the tilt-yard, Overbury had for some time been servitor-in-ordinary to the king. He was knighted in June 1608, and in 1609 he travelled in France and the Low Countries. He seems to have followed the fortunes of Carr very closely, and "such was the warmth of the friendship, that they were inseparable, . . . nor could Overbury enjoy any felicity but in the company of him he loved [Carr]." When the latter was made Lord Rochester in 1610, the intimacy seems to have been sustained. But it was now destroyed by a new element. Early in 1611 the Court became aware of the mutual attraction between Rochester and the infamous and youthful countess of Essex, who seemed to have bewitched the handsome Scots adventurer. To this intrigue Overbury was from the first violently opposed, pointing out to Rochester that an indulgence in it would be hurtful to his preferment, and that the woman, even at this early stage in her career, was already "noted for her injury and immodesty." He went so far as to use, in describing her, a word which was not more just than scandalous. But Rochester was now infatuated, and he repeated to the countess what Overbury had said. It was at this time, too, that Overbury wrote, and circulated widely in MS., the poem called "His Wife," which was a picture of the virtues which a young man should demand in a woman before he has the rashness to marry her. It was represented to Lady Essex that Overbury's object in writing this poem was to open the eyes of Rochester to her defects. The situation now resolved itself into a deadly duel for the person of Rochester between the mistress and the friend. The countess contrived to lead Overbury into such a trap as to make him seem disrespectful to the king, and she succeeded so completely that he was thrown into the Tower on the 22nd of April 1613. It was not known at the time, and it is not certain now, how far Rochester participated in this first crime, or whether he was ignorant of it. But the queen, by a foolish phrase, had sown discord between the friends; she had called Overbury Rochester's "governor." It is, indeed, apparent that Overbury had become arrogant with success, and was no longer a favourite at Court. Lady Essex, however, was not satisfied with having had him shut up; she was determined that "he should return no more to this stage." She had Sir William Wade, the honest Governor of the Tower, removed to make way for a creature of her own, Sir Gervaise Elvis (or Helwys); and a gaoler, of whom it was ominously said that he was "a man well acquainted with the power of drugs," was set to attend on Overbury. This fellow, afterwards aided by Mrs Turner, the widow of a physician, and by an apothecary called Franklin, plied the miserable poet with sulphuric acid in the form of copper vitriol. But his constitution long withstood the timid doses they gave him, and he lingered in exquisite sufferings until the 15th of September 1613, when more violent measures put an end to his existence. Two months later Rochester, now earl of Somerset, married the chief murderess, Lady Essex. More than a year passed before suspicion was roused, and when it was, the king showed a hateful disinclination to bring the offenders to justice. In the celebrated trial which followed, however, the wicked plot was all discovered. The four accomplices were hanged; the countess of Somerset pleaded guilty but was spared, and Somerset himself was disgraced. Meanwhile, Overbury's poem, *The Wife*, was published in 1614, and ran through six editions within a year, the scandal connected with the murder of the author greatly aiding its success. It was abundantly reprinted within the next sixty years, and it continued to be one of the most widely popular books of the 17th century. Combined with later editions of *The Wife*, and gradually adding to its bulk, were "Characters" (first printed in the second of the 1614 editions), "The Remedy of Love" (1620), and "Observations in Foreign Travels" (1626). Later, much that must be spurious was added to the gathering snow-ball of Overbury's *Works*. Posterity has found the praise of his contemporaries for the sententious and graceful moral verse of Overbury extravagantly expressed. *The Wife* is smooth and elegant, but uninspired. There is no question that the horrible death of the writer, and the extraordinary way in which his murderers were brought to justice, gave an extraneous charm to his writings. Nor can we be quite sure that Overbury was in fact such a "glorious constellation" of all the religious virtues as the 17th century believed. He certainly kept very bad company, and positive evidence of his goodness is wanting. But no one was ever more transcendently canonized by becoming the victim of conspirators whose crimes were equally detestable and unpopular. (E. G.)

Overyssel, a Dutch province east of the Yssel, bordering on the Zuider Zee. Five basins are to be distinguished: (1) the Almelo, which communicates with (2) the Regge. These two are divided by a range of hills to the west of them from the basins of (3) the Salland, which discharges its waters into (4) the Vecht, which again has its outfall in (5) the Zwarte Water, which communicates by the Zwollsche Diep with the Zuider Zee and by the Willemsvaart with the Yssel. Meppeler Diep from Drenthe and Dedemsvaart from the north-east of Overyssel both discharge into the Zwarte Water. Most of the uncultivated land lies in the east of the province, the cultivated land in the west and on the banks of the small rivers. About 18 per cent. of the surface consists of ploughland, 32 per cent. of natural pastures and grasslands, and fully 30 per cent. of uncultivated land. Population (1879), 247,136; (1900), 338,408.

Oviedo, a maritime province of northern Spain. It has an area of 4091 miles, and is divided into 16 administrative districts and 79 parishes. Population, 595,420 in 1887, and 612,663 in 1897. The birth-rate is 2·85 per cent., the death-rate 2·49 per cent., and the proportion of illegitimate births 4·01 per cent. of the total births. That section of the Cantabrian mountains which forms its southern border includes about a dozen peaks ranging from 3800 to 8000 feet. There are picturesque lakes among the mountains, and the principal rivers that descend to the coast are the Nalon, Narcea, Navia, Pilona, Sella, and Eo, which wind through well-wooded and frequently fertile, well-cultivated vales. The climate is generally mild and temperate, with abundant rains, though bitterly cold during some months in the higher mountains. The means of communication have been much improved. A railway has been constructed through some of the most difficult parts of the Cantabrian chain, the construction of the line affording remarkable evidence of engineering skill. A branch runs from Oviedo to Trubia, where the Government arms factory and foundries occupy more than a thousand hands. There are also several other railways, including numerous narrow-gauge lines built by mining companies and metallurgic establishments. Oviedo is rich in forests, coal mines, streams and waterfalls that have materially contributed to the development of its manufacturing and metallurgical industries, especially the latter, there being an abundant supply of ores in the province. There are flourishing copper works in Aviles; manufactures of fine textiles, coarse cloth, and ribbons in Salas, Pilona, Casas, and Aviles; of paper in Pianton; of porcelain and glass in Gijon, Aviles, and Pola de Surro; of arms in Oviedo and Trubia; while foundries and works for the manufacture of agricultural implements, rails, and pig-iron are numerous. One company uses annually 35,000 tons of coal, 25,000 tons of coke, 33,000 tons of iron ore, and employs 2300 hands to turn out over 30,000 tons of iron; another consumes 100,000 tons of coal, 46,000 tons of ore, and turns out nearly 50,000 tons of iron, mostly for consumption in Spain. The fisheries and the salting of tunny and sardines are important, and much butter and cheese is made in the province for the interior of Spain. The principal exports are fruit, preserved meats and fruit, cheese, butter, fish, wheat, flour, cider, oil, soap, coal, glass, and iron.

Agriculture is not very important in Oviedo. In 1897 wheat was grown on 18,855 acres; rye, oats, barley, maize, on 6662 acres; pod-fruit on 14,712 acres; and vines on 57,370 acres. The live stock included 8494 horses, 2018 mules, 3619 asses, 363,977 cattle, 116,402 sheep, 31,122 goats, and 134,955 pigs. It is the mines that furnish the real wealth. There are 19 quicksilver, 3 zinc, 3 copper, 55 iron, 453 coal, and 2 manganese mines actually worked, giving employment in 1899 to 12,050 hands, of whom 11,279 worked in the coal-mines alone. The output was 10,907 tons of quicksilver ore, 360 of zinc, 886 of copper, 63,965 of iron, 1,397,152 of coal, and 340 of manganese. The mining industries further employed 4874 hands, of whom 3853 were engaged in the ironworks. The output for 1898 was 92 tons of quicksilver, 6031 tons of zinc in bars or sheet, 14,925 tons of steel, 2900 of wire, 38,216 of iron in different shapes, 138,643 tons of coke, 120,176 tons of coal agglomerate. (A. E. H.)

Oviedo, the capital of the above province, on the river Nalon, 16 miles from the coast, in a broad and picturesque valley. Its population was 42,716 in 1887 and 46,376 in 1897. The town has grown chiefly in the suburb near the station and in the modern suburb of Uria, near the great hospital and fine promenade close to the convent of San Francisco. Few towns in Spain have better schools for primary and higher education, and there are an institute, a meteorological observatory, schools for teachers and fine arts, adult classes for the working classes, an archæological museum, several public libraries, and a university (with a fine library). The markets are the centre of a thriving trade in agricultural products, and the principal industries are manufactures of arms, textiles of cotton and wool, iron goods, marble, leather, and matches.

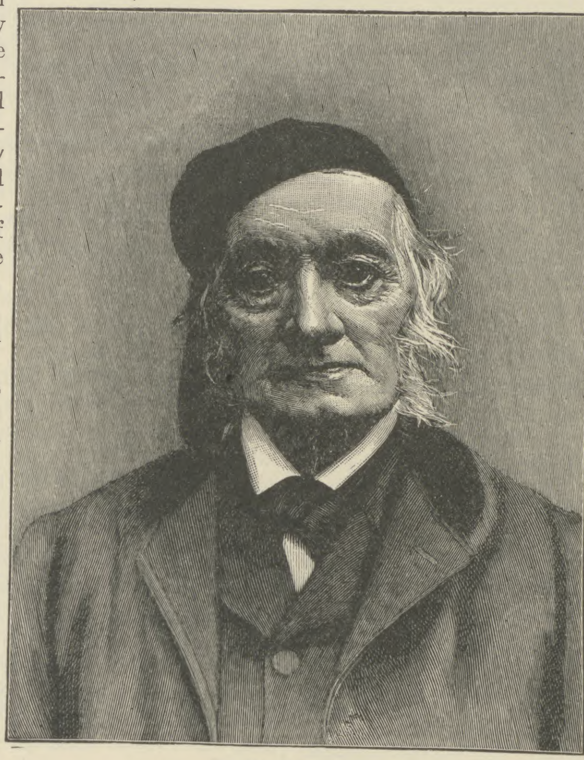
Owatonna, a city of Minnesota, U.S.A., capital of Steele county, in the south-eastern part of the state, at the intersection of lines of the Chicago and North-Western, the Chicago, Milwaukee, and St Paul, and the Burlington, Cedar Rapids, and Northern railways, in a rich farming country. Population (1890), 3849; (1900), 5561, of whom 1160 were foreign-born.

Owego, a village of New York, U.S.A., capital of Tioga county, on the north branch of the Susquehanna river, at the mouth of Owego creek, in the southern part of the state, at an altitude of 822 feet. It is on three railways, the Erie, the Delaware, Lackawanna, and Western, and the Lehigh Valley. It is in a rich agricultural region, and has manufactures of flour, lumber, and woollen goods. Population (1890), 5141; (1900), 5039, of whom 301 were foreign-born and 214 negroes.

Owen, Sir Richard (1804–1892), English biologist, was born at Lancaster on 20th July 1804, and received his early education at the grammar school of that town. In 1820 he was apprenticed to a local surgeon and apothecary, and in 1824 he proceeded as a medical student to the University of Edinburgh. He left the university in the following year, and completed his medical course in St Bartholomew's Hospital, London, where he came under the influence of the eminent surgeon, John Abernethy. He then contemplated the usual professional career; but his bent was evidently in the direction of anatomical research, and he was induced by Abernethy to accept the position of assistant to William Clift, conservator of the museum of the Royal College of Surgeons. This congenial occupation soon led him to abandon his intention of medical practice, and his life henceforth was devoted to purely scientific labours. He prepared an important series of catalogues of the Hunterian collection in the Royal College of Surgeons; and in the course of this work he acquired the unrivalled knowledge of comparative anatomy which enabled him to enrich all departments of the science, and specially facilitated his researches on the remains of extinct animals. In 1837 he was appointed Hunterian professor in the Royal College of Surgeons, and in 1849 he succeeded Clift as conservator. He held the latter office until 1856, when he became superintendent of the natural history department of the British Museum. He then devoted much of his energies to a great scheme for a National Museum of Natural History, which eventually resulted in the removal of the natural history collections of the British Museum to a new building at South Kensington, the British Museum (Natural History). He retained office until the completion of this work in 1884, when he received the distinction of K.C.B. Sir Richard Owen lived quietly in retirement at Sheen Lodge, Richmond Park, until his death on 18th December 1892.

While occupied with the cataloguing of the Hunterian collection, Owen did not confine his attention to the preparations before him, but also seized every opportunity of dissecting fresh subjects. He was especially favoured with the privilege of investigating the animals which died in the Zoological Society's gardens; and when that society began to publish scientific proceedings in 1831, he was the most voluminous contributor of anatomical papers. His first notable publication, however, was his *Memoir on the Pearly Nautilus* (London, 1832), which was soon recognized as a classic. Henceforth he continued to make important contributions to every department of comparative anatomy and zoology for a period of over fifty years. In the sponges Owen was the first to describe the now well-known "Venus's flower basket" or *Euplectella* (1841, 1857). Among Entozoa his most noteworthy discovery was that of *Trichina spiralis* (1835), the parasite infesting the muscles of man in the disease now termed trichinosis (see also Paget, Sir James). Of Brachiopoda he made very special studies, which much advanced knowledge and settled the classification which has long been adopted. Among Mollusca, he not only described the pearly nautilus, but also *Spirula* (1850) and other Cephalopoda, both living and extinct; and it was he who proposed the universally-accepted subdivision of this class into the two orders of Dibranchiata and Tetrabranchiata (1832). The problematical crustacean *Limulus* was also the subject of a special memoir by him in 1873.

Owen's technical descriptions of the Vertebrata were still more numerous and extensive than those of the invertebrate animals. His *Comparative Anatomy and Physiology of Vertebrates* (3 vols., London, 1866–68) was indeed the result of more personal research than any similar work since Cuvier's *Leçons d'Anatomie Comparée.* He not only studied existing forms, but also devoted great attention to the remains of extinct groups, and immediately followed Cuvier as a pioneer in vertebrate palæontology. Early in his career he made exhaustive studies of teeth, both of existing and extinct animals, and published his profusely illustrated work on *Odontography* (1840–45). He discovered and described the remarkably complex structure of the teeth of the extinct animals which he named Labyrinthodonts. Among his writings on fishes, his memoir on the African mud-fish, which he named *Protopterus*, laid the foundations for the recognition of the Dipnoi by Müller. He also pointed out later the serial connexion between the teleostean and ganoid fishes, grouping them in one sub-class, the Teleostomi. Most of his work on reptiles related to the skeletons of extinct forms, and his chief memoirs on British specimens were reprinted in a connected series in his *History of British Fossil Reptiles* (4 vols., London, 1849–84). He published the first important general account of the great group of Mesozoic land-reptiles, to which he gave the now familiar name of Dinosauria. He also first recognized the curious early Mesozoic land-reptiles, with affinities both to amphibians and mammals, which he termed Anomodontia. Most of these were obtained from South Africa, beginning in 1845 (*Dicynodon*), and eventually furnished materials for his *Catalogue of the Fossil Reptilia of South Africa*, issued by the British Museum in 1876. Among his writings on birds, his classical memoir on the *Apteryx* (1840–46), a long series of papers on the extinct Dinornithidæ of New Zealand, other memoirs on *Aptornis*, *Notornis*, the dodo, and the great auk, may be specially mentioned. His monograph on *Archæopteryx* (1863), the long-tailed, toothed bird from the Bavarian Lithographic Stone, is also an epoch-making work. With regard to living mammals, the more striking of Owen's contributions relate to the monotremes, marsupials, and the anthropoid apes. He was also the first to recognize and name the two natural groups of typical Ungulata, the odd-toed (Perissodactyla) and the even-toed (Artiodactyla), while describing some fossil remains in 1848. Most of his writings on mammals, however, deal with extinct forms, to which his attention seems to have been first directed by the remarkable fossils collected by Darwin in South America. *Toxodon*, from the pampas, was then described, and gave the earliest clear evidence of an extinct generalized hoofed animal, a "pachyderm with affinities to the Rodentia, Edentata, and Herbivorous Cetacea." Owen's interest in South American extinct mammals then led to the recognition of the giant armadillo, which he named *Glyptodon* (1839), and to classic memoirs on the giant ground-sloths, *Mylodon* (1842) and *Megatherium* (1860), besides other important contributions. At the same time Sir Thomas Mitchell's discovery of fossil bones in New South Wales provided material for the first of Owen's long series of papers on the extinct mammals of Australia, which were eventually reprinted in book-form in 1877. He discovered *Diprotodon* and *Thylacoleo*, besides extinct kangaroos and wombats of gigantic size. While occupied with so much material from abroad, Owen was also busily collecting facts for an exhaustive work on similar fossils from the British Isles, and in 1844–46 he published his *History of British Fossil Mammals and Birds*, which was followed by many later memoirs, notably his *Monograph of the Fossil Mammalia of the Mesozoic Formations* (Palæont. Soc., 1871). One of his latest publications was a little work entitled *Antiquity of Man as deduced from the Discovery of a Human Skeleton during Excavations of the Docks at Tilbury* (London, 1884).



Sir Richard Owen.
(From a photograph by Elliott and Fry, London.)

Owen's detailed memoirs and descriptions require laborious attention in reading, on account of their nomenclature and ambiguous modes of expression; and the circumstance that very little of his terminology has found universal favour causes them to be more generally neglected than they otherwise would be. At the same time it must be remembered that he was a pioneer in concise anatomical nomenclature; and, so far at least as the vertebrate skeleton is concerned, his terms were based on a carefully reasoned philosophical scheme, which first clearly distinguished between the now familiar phenomena of "analogy" and "homology." Owen's theory of the *Archetype and Homologies of the Vertebrate Skeleton* (1848), subsequently illustrated also by his little work *On the Nature of Limbs* (1849), regarded the vertebrate frame as consisting of a series of fundamentally identical segments, each modified according to its position and functions. Much of it was fanciful, and failed when tested by the facts of embryology, which Owen systematically ignored throughout his work. However, though an imperfect and distorted view of certain great truths, it possessed a distinct value at the time of its conception. To the discussion of the deeper problems of biological philosophy he made scarcely any direct and definite contributions. His generalities rarely extended beyond strict comparative anatomy, the phenomena of adaptation to function, and the facts of geographical or geological distribution. His lecture on "virgin reproduction" or Parthenogenesis, however, published in 1849, contained the essence of the theory of the germ-plasm elaborated several years afterwards by Weismann; and he made several vague statements concerning the geological succession of genera and species of animals and their possible derivation one from another. He referred especially to the changes exhibited by the successive forerunners of the crocodiles (1884) and horses (1868); but it has never become clear how much of the modern doctrines of organic evolution he admitted. He contented himself with the bare remark that "the inductive demonstration of the nature and mode of operation" of the laws governing life would "henceforth be the great aim of the philosophical naturalist."

See *The Life of Richard Owen*. By his grandson, Rev. RICHARD OWEN. 2 vols. London, 1894. (A. S. WO.)

Owensboro, a city of Kentucky, U.S.A., capital of Daviess county, on the south bank of the Ohio river in the north-western part of the state, at an altitude of 386 feet. It has three railways, the Illinois Central, the Louisville, Henderson, and St Louis, and the Louisville and Nashville, and through these and boats on the river it has a large trade. It is in the Indiana–Kentucky coal field, and some coal is mined in its vicinity. Its industries consist largely in the manufacture of tobacco and distilling of whisky. Population (1890), 9837; (1900), 13,189, of whom 308 were foreign-born and 3061 negroes.

Owen Sound, a town and port of entry in Ontario, Canada, and capital of Grey county, situated 99 miles north-west of Toronto, on Georgian Bay. It is the terminus of branches of the Canadian Pacific and Grand Trunk railways, and of the Canadian Pacific and other steamship lines plying to ports on Lakes Huron and Superior. Its harbour is one of the best on Lake Huron, and navigable by lake vessels of the largest size. It contains manufactories of mill machinery, agricultural implements, furniture, and sewing-machines, flour-mills, saw-mills, and large grain elevators. Population (1881), 4426; (1891), 7497; (1901), 8776.

Owosso, a city of Shiawassee county, Michigan, U.S.A., on the Shiawassee river, and on the Ann Arbor, the Grand Trunk, and the Michigan Central railways, east of the centre of the Lower Peninsula, at an altitude of 744 feet. It has a regular plan, is divided into five wards, and has a good water-supply. The river furnishes power for its manufactures, which consist in large part of lumber and furniture. Population (1880), 2501; (1890), 6564; (1900), 8696, of whom 1396 were foreign-born.

Oxford, a midland county of England, bounded on the S. by the Thames, on the W. by Gloucester, on the N. by Warwick, on the N.E. by Northampton, and on the E. by Buckingham.

Area and Population.—The area of the ancient county is 483,614 acres, or 756 square miles, with a population in 1881 of 179,551, and in 1891 of 185,669, of whom 89,649 were males and 96,020 females; and in 1901, 182,768, the number of persons per square mile being 242, and of acres to a person 2·6. The area of the administrative county as given in the census returns was 480,608 acres, with a population in 1891 of 145,449, or including the county borough of Oxford, 485,322 acres, with a population in 1891 of 191,193; but certain changes in the administrative area have since taken place. In 1895 there were transferred to Buckingham the part of the parish of Ibstone in Oxford and the parish of Stokenchurch; and in the same year there were transferred to Oxford the parish of Kingsey in Buckingham, and the parish of Mollington in Warwick. The area of the registration county is 490,146 acres, with a population in 1891 of 188,220, of whom 83,862 were urban and 104,358 rural; and in 1901, 186,767, of whom 88,558 were males and 98,209 females. Within the registration area the percentage of increase between 1881 and 1891 was 3·49, but between 1891 and 1901 there was a decrease of ·7 per cent. Between 1881 and 1891 the excess of births over deaths was 23,710, and the actual increase of population was 6353. The following table gives the numbers of marriages, births, and deaths, with the number of illegitimate births, for 1880, 1890, and 1898:—

Year.	Marriages.	Births.	Deaths.	Illegitimate Births.	
				Males.	Females.
1880	1063	5725	3266	145	146
1890	1184	5182	3203	111	113
1898	1287	4635	2710	126	131

The number of marriages in 1899 was 1315, of births 4543, and of deaths 2899. The following table shows the marriage-, birth-, and death-rate, with the percentage of illegitimate births, for a series of years:—

	1870–79.	1880.	1880–89.	1890.	1888–97.	1898.
Marriage-rate . .	13·4	11·1	12·6	12·6	12·8	13·4
Birth-rate . .	31·7	31·5	30·0	27·6	27·0	24·1
Death-rate . .	19·3	18·0	16·9	17·1	16·1	14·1
Percentage of illegitimacy . .	6·0	5·1	5·4	4·3	5·1	5·4

In 1891 there were in the county 649 natives of Scotland, 584 natives of Ireland, and 359 foreigners.

Constitution and Government.—The ancient county is divided into three parliamentary divisions, and it also includes part of the parliamentary borough of Oxford, returning one member, in addition to which the University of Oxford returns two members. The administrative county contains five municipal boroughs—Banbury (12,967), Chipping Norton (3780), Henley-on-Thames (5984), Oxford (49,413), and Woodstock (1684). Oxford is a county borough. The following are urban districts: Bicester (3023), Caversham (6580), Thame (2911), Wheatley (872), and Witney (3574). Oxfordshire is in the Oxford circuit, and assizes are held at Oxford. The boroughs of Banbury, Henley-on-Thames, and Oxford have separate commissions of the peace, and Banbury and Oxford have in addition separate courts of quarter sessions. The ancient county, which is mostly in the diocese of Oxford, contains 234 ecclesiastical parishes or districts, and parts of 10 others.

Education.—On account of the famous university in the borough of Oxford and other educational institutions there, the county as regards education holds perhaps the premier position in England. In connexion with the university there is a day training college for schoolmasters, and there is also in Oxford a residential training college for schoolmistresses (diocesan), which takes day students. The total number of elementary schools in the county on 31st August 1899 was 266, of which 28 were board and 238 voluntary schools, the latter including 219 National Church of England schools, 3 Wesleyan, 6 Roman Catholic, and 10 "British and other." The total school board receipts for the year ended 29th September 1899 were over £20,138. The income under the Agricultural Rates Act was over £663.

Communications.—An important addition to the railway facilities of the county has been made by a branch line of the Great Central running from Princes Risborough in Bucks to the Great Western at Banbury.

Agriculture.—Nearly seven-eighths of the area of the county is under cultivation, and of this area about three-tenths is under corn crops and nine-twentieths in permanent pasture. Over 2000 acres are under orchards and about 26,000 under woods. Although with the diminution of the acreage under corn crops the acreage under wheat has somewhat diminished, it and barley still occupy each about a third of the corn crop area, while oats occupy about a fourth, and there is also a considerable acreage under beans. More than half the total acreage under green crops is occupied by turnips, and vetches and tares are also largely grown. The following table gives the larger main divisions of the cultivated area at intervals from 1880:—

Year.	Total Area under Cultivation.	Corn Crops.	Green Crops.	Clover.	Permanent Pasture.	Fallow.
1880	418,311	158,404	54,201	46,297	146,929	12,478
1885	417,822	147,349	53,524	49,735	158,593	8,610
1890	414,966	136,700	46,684	48,161	176,113	7,192
1895	415,616	123,419	45,663	50,201	187,668	8,345
1900	411,682	120,898	43 215	50,111	193,716	3,522

The following table gives particulars regarding the principal live stock for the same years:—

Year.	Total Horses.	Total Cattle.	Cows or Heifers in Milk or in Calf.	Sheep.	Pigs.
1880	17,276	51,204	17,286	279,159	31,559
1885	18,193	60,124	20,185	299,172	38,536
1890	17,739	56,443	20,353	266,594	44,110
1895	17,798	53,434	19,165	241,742	44,737
1900	17,276	61,851	20,653	230,325	31,032

Manufactures and Minerals.—According to the report for 1898 of the chief inspector of factories (1900), the total number of persons employed in factories and workshops in 1897 was 6774, as compared with 6721 in 1896. Of the 4432 persons employed in non-textile factories, 1354 were employed in the manufacture of paper. Workshops employed 1608 persons, of whom 1048 were employed in clothing industries. Banbury is famed for its cakes; there is some decline in the glove trade at Woodstock. In 1899 from quarries under 20 feet deep 166,163 tons of iron ore, valued at about £18,000, were raised. The other minerals include clay (30,002 tons).

Authorities. — *The Natural History of Oxfordshire.* Oxford, 1677; 2nd edition, 1705.—Shelton. *Engraved Illustrations of the Principal Antiquities of Oxfordshire from drawings by T. Mackenzie.* Oxford, 1823.—Sir T. Phillips. *Oxfordshire Pedigrees.* Evesham, 1825.—Walker. *The Flora of Oxfordshire.* Oxford, 1833.—Davenport. *Lords Lieutenant and High Sheriffs of Oxford, 1086.* Oxford, 1868; and *Oxfordshire Annals.* Oxford, 1869.—Graves. *The Way about Oxfordshire.* London, 1896.—Murray. *Handbook for Oxfordshire.*—And the *Transactions of the North Oxford Archæological Society.*

Oxford.—The county town of Oxfordshire lies at the junction of the Thames (locally known as the Isis) and the Cherwell, 55 miles from London by road and 63½ by rail. Population (1881), 35,264; (1891), 45,742; (1901), 49,413. The rateable value is £387,609. It is represented in Parliament by one member, having lost its second by the redistribution of 1885, before which date it had been disfranchised entirely for a year owing to the bribery practised at the election of 1881. The number of voters on the register at the election of 1885 was 6983; at that of 1892, 7476; at that of 1895, 7637; in 1901, 8310. Since 1889 the government has been in the hands of a city council, appointed under the Local Government Act of 1888, and consisting of 45 councillors (36 from the city and 9 from the University) and 15 aldermen (12 from the city and 3 from the University). In this joint body are vested the powers of the former municipality and of the local board; to it also has been transferred the share in the control of the police once exercised by the proctors of the University. At the time of the formation of the city council the outlying districts of Summertown on the north, Cowley St John on the east, and Grandpont and New Hincksey on the south were incorporated. The growth of the city has been rapid since 1880. Although no new manufactures of importance have been introduced, Oxford has become to a very large extent a "residential" town, owing partly to its proximity to London, but chiefly to the opening up of University society through the abolition of compulsory celibacy by the statutes of the University Commission (1882). The most important new buildings are the theatre (1886), the Corn Exchange (1896), both in George Street, and the municipal buildings, designed by Mr Hare, and opened by the prince of Wales in May 1897. As a result of this development the city has in some respects lost its picturesqueness; old houses have disappeared everywhere. The most important piece of destruction has been the removal of Carfax church (1896). The tower, however, remains, and is now used for an illuminated clock (1898). Magdalen bridge was widened in 1885 to accommodate the increased traffic. Electric light was introduced in 1892. The water-supply has been greatly improved by a new pumping station above the King's Weir (1887), and by new filter beds (1884). A hospital for infectious diseases has been opened at Cold Harbour (1886), the Oxford Eye Hospital has obtained a permanent home in Walton Street (1894), and the Radcliffe Infirmary has been considerably enlarged (1894); so too has the Acland Nursing Home (1897), which is now in the Banbury Road. Outside cemeteries at Rose Hill, at Summertown, and near Botley were opened in 1893. As a result of improved water and drainage the death-rate of Oxford has fallen. In 1885 it was 16·8; in 1890, 17; in 1895, 15·66; in 1901, 13·85.

Magdalen College opened the new buildings (designed by Sir A. Blomfield) for its school in 1894, and technical schools have been started in St Ebbe's (1894) and St Clement's. The progress in the numbers of the University has been comparatively slow, as the following table will show:—

	Matriculations.	B.A.'s.	Honours in the Final Schools.
1880	758	483	315
1885	749	522	366
1890	771	584	376
1895	863	608	413
1900	839	558	429
1901	837	594	444

The average of matriculations in the last decade of the 19th century was about 60 above that in the previous decade (829 as against 770), while the increase in graduations, especially in honours, has been much larger. In one other department of the University — its revenue — there has been no appreciable progress; but in every other respect there has been rapid development. The Bodleian Library steadily increases, and the basement of the Ashmolean has been fitted up to receive books. The collections once housed there have been transferred to a New Ashmolean Museum, in close proximity to the University Galleries in Beaumont Street; these have been twice extended (1888 and 1894). The Science Museum is ever growing. Apart from minor developments, the Physiological Laboratory was opened in 1885, and the department of Human Anatomy in 1893; the new Library (the gift of the Drapers' Company) was begun in 1898, and a Morphological and a Pathological Laboratory was opened in 1901. The block of the New Schools has also been completed by the addition of the Non-Collegiate Delegacy at its north-east corner (1888). In 1887 the Pitt Rivers anthropological collection found a home in a new annexe on the north-east side of the Science Museum. The Picture Gallery has received the Combe bequest of the works of Pre-Raphaelite painters, especially of Holman Hunt; and the Art Museum has been enormously increased by the gifts of Mr Drury Fortnum (d. 1899). The Indian Institute, too, has been completed (1896). Of a different kind has been the work at St Mary's church, where the spire was rebuilt in 1895, after being sheathed in scaffolding for three years. During the last twenty years of the 19th century there was a greater amount of college building than in any similar period in the history of the University. St Swithun's quad at Magdalen (finished 1884) and the President's house (1888) (the work of Messrs Bodley and Garnier), the new quad (1887) and the President's house (1888) at Trinity (the work of Mr. T. G. Jackson, R.A.), and the new quad at Brasenose College, with its front to the High Street (also Mr Jackson's work), are only the most conspicuous amongst many instances. The religious life of the University has been enriched by a number of new foundations. The Pusey House (1884) led the way, and its example has been followed by such Nonconformist institutions as Mansfield College (1889) and Manchester New College (1893). All three of these are centres of theological study, but not residences for undergraduates. Private halls for Jesuit (1896), Benedictine (1900), and Unitarian (1900) students have also now been opened; the first of these is called Campion Hall. Hannington Hall (1897) has been founded as a centre of missionary interest, on the site of the old New Inn Hall. New Final Schools have been founded in Oriental languages (first held 1887), and in English language and literature (1897). New degrees for the encouragement of research, the B.Lit. and B.Sc. (founded in 1895, and completed in 1900 by the institution of research doctorates), have attracted graduates from the universities of other countries. In 1899 a geographical department was opened, which is jointly supported by the University and by the Royal Geographical Society. Of more bearing on practical life are the Day Training College Delegacy (1892) and the diploma in education (1896). Under the former elementary school teachers are enabled to take their training course at Oxford, and do so in growing numbers; the latter is under the supervision of the Locals Delegacy, and is increasingly taken by secondary teachers every year. To the two original foundations for the education of women, Somerville College and Lady Margaret Hall (which have both largely increased their buildings), are now added two more women's halls—St Hugh's (1886) and St Hilda's (1893). The number of women students is over 200. An attempt to obtain their admission to the degrees of the University (as well as to its examinations) was very decisively defeated in 1896.

There has, too, been a great increase in the work done by Oxford in the world outside. The number of candidates examined by the Delegacy for Local Examinations has increased from 2301 in 1885 to 10,337 in 1901. The University Extension movement has become as important as at Cambridge, where it originated. Started in Oxford in 1877, it had at first little success; since 1885, however, it has rapidly advanced, and has been under a special Delegacy since 1892. In 1900–01, 177 courses of lectures were given to nearly 18,000 students (aggregate average attendance). Special features of the Oxford work have been the "summer meetings" and the foundation of the Extension College at Reading (1892). The former were begun in August 1888. There were nearly 1200 students from all parts of the world at that (the tenth) of August 1901. Similarly, Oxford has become a great centre for educational conferences of all kinds. The Headmasters' Conference met there in 1890, the National Union of Teachers in 1894, and the British Association in the same year. There have been countless others, great and small, for which the New Examination Schools furnish an admirable meeting-place. But with all its developments the life of the University itself has changed but little. "Town and Gown rows" have practically disappeared, though there may probably be some of the old feeling under the surface. At all events, the privileges of the University in jurisdiction and other departments are still attacked, and a suggested compromise as to them was rejected by the city in 1893.

AUTHORITIES.—The Oxford Historical Society has continued its series of publications. The early history of the University has been admirably treated by H. RASHDALL, *Universities of Europe in Middle Ages*, 3 vols. Oxford, 1895 (Oxford is dealt with in the third volume). The various colleges are described by members of their foundations in the *College History Series*, published by Robinson. (J. WE*.)

Oxus.—Prior to the meeting of the commissions appointed for the determination of the Russo-Afghan boundary in 1885, no very accurate geographical knowledge of the upper Oxus regions existed, and the course of the river itself was but roughly mapped. Russian explorers and natives of India trained for geographical reconnaissance, and employed in connexion with the great trigonometrical survey of India, had done so much towards clearing away the mists which enveloped the actual bounds of the river, that all the primary affluents were known, although their relative value was misunderstood, but the nature of the districts which bordered the river in Afghan Turkestan was so imperfectly mapped as to give rise to considerable political complication in framing the boundary agreement between Great Britain and Russia. From Lake Victoria, in the Pamirs, which was originally reckoned as the true source of the river, to Khamiab, on the edge of the Andkhui district of Afghan Turkestan, for a distance of about 680 miles, the Oxus forms the boundary between Afghanistan and Russia. For another 550 miles below Khamiab it follows an open and sluggish course till it is lost in the Sea of Aral, being spanned at Charjui, 150 miles below Khamiab, by the wooden bridge which carries the Russian railway from Merv to Samarkand. The level of Lake Victoria is 13,400 feet above sea. At Khamiab the river is probably rather less than 500 feet.

Sources.—For many years a lively geographical controversy circled about the sources, and the discussion derived some political significance from the fact that the true source, wherever it might be found, was claimed as a point in the Russo-Afghan boundary. The final survey of the Pamir region (the Bam-i-dunya, or "the Roof of the World"), wherein the heads of all the chief tributaries of the river lay hidden, by the Pamir Boundary Commission of 1895 established the following topographical facts in connexion with this question. The elevated mountain chain which is now called the Nicolas range, which divides the Great from the Little Pamir, is a region of vast glaciers and snow-fields, from which the lakes lying immediately north and south derive the greater part of their water-supply. On the north the principal glacial tributary of Lake Victoria forms, within the folds of the gigantic spurs of the Nicolas mountains, a series of smaller lakes, or lakelets, before joining the great lake itself. On the south a similar stream starting farther east, called Burgutai, denoting the position of a difficult and dangerous pass across the range, sweeps downwards towards Lake Chakmaktin, the lake of the Little Pamir, which is some 400 feet lower than Victoria. But at the foot of the mountain this stream bifurcates in the swamps which lie to the west of Chakmaktin, and part of its waters find their way eastwards into the lake, and part flow away westwards into the Ab-i-Panja, which joins the Pamir river from Lake Victoria at Kala Panja. This at least is the action of the Burgutai stream during certain seasons of the year, so that the glaciers and snow-fields of the Nicolas range may be regarded as the chief fountain-head of at least two of the upper tributaries of the Oxus, namely, the Aksu (or Murghab) and the Pamir river, and as contributing largely to a third, the Ab-i-Panja. Neither Lake Victoria nor Lake Chakmaktin derives any very large contributions from glacial sources other than those of the Nicolas range. It is possible that there may be warm springs on the bed of Lake Victoria, as such springs are of frequent occurrence in the Pamirs; but there is no indication of them in the Chakmaktin basin, and the latter lake must be regarded rather as an incident in the course of the Aksu—a widening of the river channel in the midst of this high-level, glacier-formed valley—than as the fountain-head of the infant stream. There are indications that the bed of Lake Victoria, as well as that of Chakmaktin, is rapidly silting, and that the shores of the latter are gradually receding farther from the foot of the hills. The glacial origin of the Pamir valleys is everywhere apparent in their terrace formations and the erratic blocks and boulders that lie scattered about their surface. It is probable that the lakes themselves are evidence of (geologically) a comparatively recent deliverance from the thraldom of the ice covering, which has worn and rounded the lower ridges into the smooth outlines of undulating downs.

The Ab-i-Wakhan Source.—Another important source of the river (considered by Curzon to be the chief source) is to be found in the enormous glaciers which lie about the upper or main branch of the Ab-i-Panja (called the Ab-i-Wakhan), which rises under the mountains enclosing the head of the Taghdumbash Pamirs. Although the superficial area of glacial ice from which the Ab-i-Wakhan derives the greater part of its volume is not equal to that found on the Nicolas range, it is quite impossible to frame any estimate of comparative depth or bulk, or to separate the volume of its contributions at any time from those which, combined, derive their origin from the Nicolas range. If the Aksu, or Murghab, and the Pamir river from Lake Victoria are to be considered in the light of independent tributaries, it is probable that the Ab-i-Panja contributes as large a volume of glacial flood to the Oxus as either of them.

Surveys.—From the point where the rivers of the Great and Little Pamirs join their forces at Kala Panja to Ishkashim, at the elbow of the great bend of the Oxus northwards, the river valley has been surveyed by Woodthorpe; and the northern slopes of the Hindu Kush, which near Ishkashim extend in slopes of barely 10 miles in length from the main watershed to the river banks, have been carefully mapped. These slopes represent the extent of Afghan territory which exists north of the Hindu Kush between Kala Panja and Ishkashim. From Ishkashim northwards the river passes through the narrow rock-bound valleys of Shignan and Roshan ere it sweeps north and west through the mountains and defiles of Darwaz. By the terms of the boundary agreement with Russia this part of the river now parts Badakshan and Darwaz from the districts of Roshan, Shignan, and Bokhara, which formerly maintained an uncertain claim over a part of the territory on the left bank of the river. All this part of the Oxus, until the river once again emerges from the Bokhara hills into the open plains bordering Badakshan on the north, falls within the area of Russian surveys, with which a junction from India has been effected both on the Pamirs and in Turkestan.

Russian Posts on the Oxus.—At Langar Kisht, a little to the east of the Oxus bend, there is a small Russian post of observation. About 50 miles north of the bend, where the Suchan or Ghund joins the Oxus from the Alichur Pamir, there is another and larger post called Charog. Here there are four officers with a guard of fifty Cossacks and two Maxims, according to Cobbold, who visited this part of the Oxus valley in 1900. On the left bank of the river the Afghans maintain a frontier post at the fort of Kala dar Panja. A road will connect Charog with the Alichur Pamir, following the general course of the Ghund stream, a road which will form a valuable link in the chain of communications between Bokhara and Sarikol. Eighty-five miles north of Ishkashim, at Kala Wamar, the river which rises in the Little Pamir, and which is called Aksu, Murghab, or Bartang, joins the Oxus from the east. It is on this river that the Russian outpost, Murghabi (or Pamirski), is situated, at an elevation of 12,150 feet above the sea. Fort Murghabi is connected by a good military road with Osh. At this point the measurement of the comparative lengths of the chief Pamir tributaries of the Oxus is as follows:—

To the head of the Aksu at Lake Chakmaktin .	260 miles.
To the head of the most easterly tributary of Lake Victoria, in the Great Pamir, about . . .	230 ,,
To the glacial sources of the Ab-i-Wakhan, about .	230 ,,

For 120 miles the two latter are united in the main stream of the Oxus, the volume of which has been further increased by the united forces of the Ghund and Shakhdara draining the Alichur Pamir and the heights of Shignan.

Nature of the Oxus Valley.—The narrow cramped valley of the river between Ishkashim and Kala Wamar is hedged in on the west by a long ridge flanking the highlands of Badakshan; on the east the buttresses and spurs of the Shignan mountains (of which the strike is transverse to the direction of the river and more or less parallel to that of the main Hindu Kush watershed) overhang its channel like a wall, and afford but little room either for cultivation or for the maintenance of a practicable road. Yet the lower elevation (for this part of the Oxus stream is not more than about 7000 feet above sea-level) and comparatively mild climate give opportunities to the industrious Tajik population for successful agriculture, of which they are not slow to avail themselves, and a track exists on the left bank of the river to Kala dar Panja opposite the Ghund (or Suchan) debouchment, which is practicable for mules. There are no bridges, and the transit of the river from bank to bank can only be effected by the use of inflated skins. Beyond the Bartang (or Murghab) confluence the valley narrows, and the difficulties of the river route increase. Between Kala Wamar (6580 feet) and Kila Khum (4400 feet), where the Oxus again bends southwards, its course to the north-west is almost at right angles to the general strike of the Darwaz mountains, which is from north-east to south-west, following the usual conformation of all this part of high Asia. Thus its chief affluents from the north-east, the Wanj and the Yaz Ghulam, drain valleys which are comparatively open, and which are said to be splendidly fertile. At Kila Khum the river is 480 feet wide, narrowing to 350 feet in the narrowest gorge. Its level varies with the obstructions formed by ice, falling as much as 28 feet when its upper channels are blocked.

Climate and Productions.—The climate of eastern Bokhara and Darwaz is delightful in summer, and Dr Regel writes of its Alpine scenery and flora in terms of enthusiastic admiration. In the valleys of the Waksh and the Surkhab to the north of Darwaz, which form an important part of the province of Karategin, maple, ash, hawthorn, pistachio, and juniper grow freely in the mountain forests, and beetroot, kohl rabi, and other vegetables are widely cultivated. About the cliffs and precipices of the Panja valley near Kila Khum the wild vine, cerasus, and pomegranate are to be found, and the plane tree and mulberry flourish in groups near the villages. Here also, amongst other plants, the sunflower decorates village gardens. The houses are built of stone and mortar, and above the thatched straw roof which surmounts the double-storeyed buildings the square watch-tower rises gracefully. Every house possesses its staircase, its well, and cisterns for irrigation; and on the whole the Aryan Tajiks of this northern section of the Oxus valley seem to be well provided with most of the comforts, if not the luxuries, of life. Their language is the language of Bokhara and Samarkand. Bokharan supremacy was re-established in 1878, when Kila Khum was occupied by Bokharan troops. Since then the right bank of the river has been politically divided from the left, and the latter now belongs to Afghanistan.

Between the Mountains and the Plains.—From Kila Khum, which fort about marks the most northerly point of the great bend of the Oxus round Badakshan, the river follows a south-westerly course for another 50 miles through a close mountainous region ere it widens into the more open valley to the south of Kolab. It now becomes a river of the plains from which the mountains on either side stand back.

Darwaz Affluents.—The topography of Darwaz south of the river is not accurately known, but at least one considerable stream of some 60 miles in length drains to the north-east, parallel to the general strike of the mountain system into the transverse course of the Oxus, which it joins nearly opposite to the lateral valleys of Yaz Ghulam and Wanj. This stream is called Pangi-Shiwa, or Shiwa, but not much is known about it. Another of about equal length, starting from the same central water-parting of this mountain block, and included within the Oxus bend, follows a transverse direction at almost right angles to the Shiwa, and joins the Oxus valley near its debouchment into the more open Kolab plains, where the course of the Oxus has again assumed a direction parallel to the mountain strike. All that we know about this river (which is called the Ragh or Sadda) is that towards its junction with the Oxus it cuts through successive mountain ridges, which renders its course impracticable as a roadway. It is necessary to avoid the river, and to pass by mountain tracks which surmount a series of local spurs or offshoots from the central plateau, in order to reach the Oxus. The existence of this route, which traverses the Darwaz mountains from east to west, cutting off the northern bend of the Oxus, and connecting those easterly routes which intersect the Pamirs by means of the Ghund and Shakhdara (and which concentrate about Lake Shiwa) with Kolab in eastern Bokhara, is important. (See BADAKSHAN.)

Karategin Affluents.—From about the point where the Oxus commences to separate the Bokharan province of Kolab from the comparatively open Afghan districts of Rustak and Kataghan, the channel of the river is no longer confined within walls of mountains of volcanic and schistose formation. The Kolab and the Surkhab (or Waksh) flow into it in broad muddy streams from the highlands of Karategin, and the river at once commences to adopt an uncertain channel wherever the outstretched arms of the hills fail to confine it within definite limits. It divides its waters, splitting into many channels, leaving broad central islands; and as the width increases, and the depth during dry seasons diminishes, opportunities for fords become comparatively frequent. Between Kolab and Pata Kesar, immediately north of the Turkestan capital of Mazar-i-Sharif, there are at least three well-known "guzars" or fords, and there are probably more. Besides the great muddy affluents from Karategin on the north, the Kabadian, the Surkhan, and the Darbant are all of them very considerable tributaries from Bokhara. The last of the three is the river on which the well-known trade centre of Shirabad is built, some 20 miles north of the river. Near the junction of the Surkhan with the Oxus are the ruins of the ancient city of Tarmez, on the northern or Bokharan bank, and the ferry at Pata Kesar (not far from the ruins of an old bridge) is the connecting link between Bokhara and Mazar hereabouts.

Badakshan Affluents.—From the south two very remarkable affluents of the Oxus join their streams to the main river between Kolab and the Mazar crossings. The Kokcha and the Khanabad (or Kunduz) are the two great rivers of Badakshan. The valley of the Kokchà leads directly from the Oxus to Faizabad, the capital of Badakshan, and its head is close above Ishkashim at the southern elbow of the great Oxus bend, a low pass of only 9500 feet dividing its waters from those of the main river. This undoubtedly was a section of the great central trade route of Asia, which once connected Fergana and Herat with Kashgar and China. (See BADAKSHAN.) Both these rivers tap the northern slopes of the Hindu Kush, and claim their sources in the unmapped mountain wilderness of Kafiristan. The Khanabad, or Kunduz, is also called locally the Aksarai. All the rivers of Central Asia are known by several names. To the west of the Kunduz no rivers find their way through the southern banks of the Oxus. Throughout the plains of Afghan Turkestan the drainage from the southern hills is arrested and lost in the desert sands.

Island.—The only island of any size in the bed of the river is the island of Paighambar, a little below the ruins of Tarmez. The inhabitants of this island, and of a smaller one in the neighbourhood called Zarshoi, wash for gold in the bed of the river.

Ruins.—At Airatan, a little above the Pata Kesar ferry, there are ruins, as also at Khisht Tapa (where the road from Kabadian to Tashkurghan leaves the river) and at Kalukh Tapa. At Khisht Tapa there is a tradition of a bridge having once existed.

Channel of the Oxus.—The Oxus river, as seen in flood at this part of its course, is an imposing stream. It is rarely less than 1000 yards wide, and in some places it is fully a mile across. Its winter channel may be estimated at from two-thirds to three-fourths of its flood channel, except where it is confined within narrow limits by a rocky bed, as at Kilif, where its unvarying width is only 540 yards. The average strength of the current in flood is about 4 miles per hour, varying from 2½ to 5 miles. The left bank of the Oxus above Kilif is, as a rule, low and flat, with reed swamps bordering the stream and a strip of jungle between the reeds and the edge of the elevated sandy desert. The jungle is chiefly tamarisk and padah (willow). Swamp deer, pheasants, and occasionally tigers are found in it. The right bank is generally higher, drier, more fertile, and more populated than the left.

Cultivation.—A wide belt of blown sand (or Chul), sprinkled with saxaul jungle, separates the swamps on the south side of the river from the cultivated plains of Afghan Turkestan; but in places, notably for about 12 miles above Khamiab, where the Russo-Afghan boundary touches the river, through the districts which are best known by the name of Khwaya Salar, and again in a less degree for 50 miles above the ferry at Kilif, a very successful war has been waged by the agricultural Turkman (of the Ersari tribes) against the encroaching sand-waves of the desert; and a strip of riverain soil averaging about a mile in width has been reclaimed and cultivated by irrigation. The cultivation, supported by canals drawn from the Oxus, the heads of which are constantly being destroyed by flood and again renewed, is of a very high order. Wheat and barley spread in broad crops over many square miles of rich soil; the fields are intersected by narrow little stone-walled lanes, bright with wayside flowers, amongst which the poppy and the purple thistle of Badghis are predominant; the houses are neatly built of stone, and stand scattered about the landscape in single homesteads, substantial and comfortable; and the spreading willow and the mulberry offer a most grateful shade to the wayfarer in summertime, when the heat is often insupportable. The fiery blasts of summer, furnace-heated over the red-hot Kizil Kum, are hardly less to be feared than the ice-cold shamshir (or north-western blizzard) of winter, which freezes men when it finds them in the open desert, and frequently destroys whole caravans.

Oxus Ferries.—The principle on which the Oxus ferries are worked is peculiar to those regions. Large flat-bottomed boats are towed across the river by small horses attached to an outrigger projecting beyond the gunwale by means of a surcingle or bellyband. They are thus partially supported in the water whilst they swim. The horses are guided from the boat, and a twenty- or thirty-foot barge with a heavy load of men and goods will be towed across the river at Kilif (where, as already stated, the width of the river is between 500 and 600 yards only) with ease by two of these animals. The Kilif ferry is on the direct high-road between Samarkand and Akcha. It is perhaps the best-used ferry on the Oxus.

Khwaya Salar.—Khwaya Salar derives some historical significance from the fact that it presented a substantial difficulty to the settlement of the Russo-Afghan boundary, in which it was assigned by agreement as the point of junction between that boundary and the Oxus. It had been defined in the agreement as a "post" on the river banks, and had been so described by Burnes in his writings some fifty years previously. But no post such as that indicated could be discovered. There was a district of that name extending from Khamiab to the neighbourhood of Kilif, and at the Kilif end of the district was a ziarat sacred to the Khwaya who bore the name. It was only after long inquiry amongst local cultivators and landowners that, about 2 miles below the ziarat, and nearly opposite to the site of the present Karkin bazaar, the position of a lost ferry was identified, which had once been marked by a riverside hamlet called by the name of the saint. The ferry had long disappeared, and with it a considerable slice of the riverside alluvial soil, which had been washed into the stream by the action of floods. The post had, in fact, subsided to the bottom of the river, but the consequences of its disappearance had been both far-reaching and expensive.

Lower Oxus.—Below Khamiab, to its final disappearance in the Aral Sea, the great river rolls in silent majesty through a vast expanse of sand and desert. Under Russian auspices a considerable strip of alluvial soil on the left bank has been brought under cultivation, measuring 4 or 5 miles in width, and there is more cultivation on the banks of the Oxus now than there is in the Merv oasis itself, but it is confined to the immediate neighbourhood of the river, for no affluents of any considerable size exist. The river is navigable below Charjui, and takes its place as an important unit in the general scheme of Russian frontier communications.

Junction with the Aral Sea.—An important feature in connexion with the course of the Oxus is the discussion that has arisen with regard to its former debouchment into the Caspian Sea. On this point much recent evidence has been collected, and it appears certain that there was a time in the post-Pliocene Age when a long gulf of the Caspian Sea protruded eastwards nearly as far as the longitude of Merv, covering the Kara Kum sands, but not the Kara Kum plateau to the north of the sands, which is separated from the sands by a distinct sea beach. At the same time another branch of the same gulf protruded northwards in the direction of the Aral, probably as far as the Sary Kamish depression, which lies to the west of the Khivan delta of the Oxus, separated from it by wide beds of loess, clays, and gravel, covering rocks of an unknown age. The Murghab river and the Hari Rud, which terminate in the oases of Merv and Sarakhs, almost certainly penetrated to the gulf of the Kara Kum, but the question whether the Oxus was ever deflected so as to enter the gulf with the Murghab cannot be said to be answered decisively at present. The former connexion between the Caspian and Aral by means of the gulf now represented by the Sary Kamish depression seems to be admitted by Russian scientists, nor would there appear to be much doubt about the connexion between the Khivan oasis and the northern extremity of the Sary Kamish. In this discussion the names of Kaulbars, Lessar, Annenkoff, Konshin, and other Russian geographers are conspicuous. The general conclusions are ably summed up by P. Kropotkin in the September number of the *Journal* of the Royal Geographical Society for 1898.

AUTHORITIES.—Although much has been written of late years about the sources of the Oxus within the region of the Pamirs, there is very little to be found in the writings of geographers of modern date descriptive of that part of its course which separates Darwaz and Afghan Turkestan from Bokhara, and that little is chiefly in the pages of reports and gazettes, &c., which are not available to the public. The following authorities may be consulted: The Report of the Pamir Boundary Commission of 1895, published at Calcutta, 1897.—REGEL, Dr A. "Journey in Karategin and Darwaz," *Investia*, Russian Geog. Soc., vol. xiii. 1882; translation, vol. iv. *Proc. R.G.S.*—MICHELL. "Regions of the Upper Oxus," vol. vi. *Proc. R.G.S.* 1884.—GRIESBACH. "Geological Field Notes," No. 3, Afghan Boundary Commission, 1885.—YATE, C. *Northern Afghanistan.* London, 1888.—CURZON. "The Pamirs," vol. viii. *Jour. R.G.S.* 1896.—KROPOTKIN. "Old Beds of the Oxus," *Jour. R.G.S.*, September 1898.—COBBOLD. *Innermost Asia.* London, 1900. To the above may be added the Reports of the Russo-Afghan Boundary Commission of 1884–85, and that of Lockhart's Mission in 1885, and the Indian Survey Reports.

(T. H. H*.)

Oyster Industry.—Oysters are more valuable than any other single product of the fisheries, and in at least twenty-five countries are an important factor in the food-supply. The approximate value of the world's oyster crop approaches £4,000,000 annually, representing over 30,000,000 bushels, or nearly 10 billion oysters. Not less than 150,000 persons are engaged in the industry, and the total number dependent thereon is fully half a million. The following table shows in general terms the yearly oyster product of the world:—

Country.	Bushels.	Value.
United States	26,853,760	£2,533,481
Canada	134,140	43,405
Great Britain and Ireland	113,700	154,722
France	3,260,190	716,778
Holland	100,000	84,400
Italy	68,750	44,000
Other European countries	29,930	40,250
Asia, Africa, and Oceania	275,000	111,400
Total	30,835,470	£3,728,436

The distinctive feature of oyster culture in continental Europe is the setting of tiles, wooden frames, and brush, on which the spat from adjacent beds is deposited; the young are subsequently reared in suitable enclosures. In Great Britain brood seed oysters, purchased in France and elsewhere, are placed on prepared grounds and left to spawn or to grow before marketing. Oyster culture in America consists in preparing the ground by the removal of rubbish and sowing shells of oysters and other molluscs, gravel, and broken stone, to which the spat will become attached.

United States.—The oyster is the chief fishery product in the United States. The states which lead in the quantity of oysters taken are Maryland, Virginia, New York, New Jersey, and Connecticut; the annual value of the output in each of these is over $1,000,000. Other states with important oyster interests are Rhode Island, North Carolina, Louisiana, and California. The oyster fisheries give employment to over 56,000 fishermen, who man 4000 vessels, valued at $4,000,000, and 23,000 boats, valued at $1,470,000; the value of the 11,000 dredges and 37,000 tongs, rakes, and other appliances used is $365,000. The quantity of oysters taken in 1898 was 26,853,760 bushels, with a value of $12,667,405. The output of cultivated oysters in 1899 was about 9,800,000 bushels, worth $8,700,000.

Canada.—Oyster banks of some importance exist in the Gulf of St Lawrence and on the coast of British Columbia. All of the grounds have suffered depletion, and cultural methods to maintain the supply have been instituted. The oyster output of the Dominion has never exceeded 200,000 bushels in a single year, and in 1898 was 134,140 bushels, valued at $217,024.

United Kingdom.—The natural oyster beds of Great Britain and Ireland have been among the most valuable of the fishery resources, and British oysters have been famous from time immemorial. The most important oyster region is the Thames estuary, the site of extensive planting operations. The present supply is largely from cultivated grounds. Important oyster-producing centres are Whitstable, Colchester, and Brightlingsea. The oysters landed on the coasts of England and Wales in 1898 numbered 35,809,000, valued at £122,320, and in 1899, 38,978,000, valued at £143,841. The Scottish fishery has its centre at Inveraray and Ballantrae, and in 1899 yielded 470,100 oysters, valued at £2356. Public oyster grounds of Ireland in 1898 produced 1,981,900 oysters, valued at £3559. The fishery is most extensive at Wicklow, Queenstown, Ballyheige, Galway, and Moville. Planting is carried on in seven counties; the oysters taken from cultivated beds in 1898 numbered 3,204,200, valued at £4966.

France.—The industry owes its importance to the attention given to oyster cultivation. In the fishery on public grounds in 1896 only 6370 fishermen were engaged, employing 1627 vessels and boats, valued at 1,473,449 francs, and apparatus worth 211,495 francs, while only 13,127,217 kilograms of oysters were taken, or about 320,000 bushels, valued at 414,830 francs. In the parks, claires, and reservoirs the private culture of oysters has attained great perfection. Fully 40,000 men, women, and children are employed, and the output in 1896 was 1,536,417,968 oysters, worth 17,537,778 francs. The principal centre is Arcachon, where in 1896 there were raised 802,880,000 oysters, valued at 4,663,040 francs.

Other Countries.—The natural oyster beds of Holland having become exhausted through neglect and overfishing, the Government about 1870 suspended all operations on public grounds and leased the available oyster-producing areas. The Scheldt estuary has become the region of greatest production. In 1897 the Dutch waters yielded 40,000,000 marketable oysters, valued at £84,000. Oyster culture in Italy is of great historic interest; the annual crop, which is almost wholly from cultivated grounds, does not exceed 25,000,000 to 30,000,000 oysters. The oyster industry of Germany, Belgium, Spain, Portugal, Russia, Denmark, and other countries of Europe does not yield over 30,000 bushels yearly, valued at about £40,000. Outside of Europe and America the industry is of little consequence. Algeria has a small fishery, the output in 1896 being valued at 33,739 francs. Oysters of large size and excellent flavour exist in Japan, and are cultivated to some extent. The annual output is estimated at 100,000 bushels, with a value of £14,000. In China the oyster product is doubtless large, but the extent of the industry is unknown. For centuries the Chinese have practised a rude form of oyster culture. The oyster grounds of New South Wales, Queensland, Tasmania, and other British colonies in the Pacific are rather extensive, but have been depleted. (H. M. S*.)

Paardeberg. See ORANGE RIVER COLONY and TRANSVAAL (*War*).

Paarl, a town of Cape Colony, a few miles north of Stellenbosch, 30 miles (36 by rail) east-north-east of Cape Town, with both of which places it is connected by rail. It stands at the point where the main line is deflected northwards by the steep Drakenstein escarpments of the outer coast range. Paarl ("Pearl") is one of the oldest places in the colony, and was so named by its Dutch settlers from a granite block crowning a rocky pedestal like a gem on a coronet. The gardens, orange groves, vineyards, and woodlands of the surrounding district make it a favourite summer resort for the citizens of Cape Town. Population (1891), 21,363 (white, 8226; natives, 13,137). (A. H. K.)

Pabianice, a town of Russian Poland, in the government and 22 miles north-west of the town of Piotrków, 10 miles from Łódz railway station. It lies amidst the extensive forests round the head-waters of the Ner, which were the hunting-grounds of the Polish kings. It has woollen, cloth, and paper mills, and manufactures agricultural implements. Population (1897), 26,900.

Pabna, or PUBNA, a town and district of British India, in the Rajshahi division of Bengal, on the river Ichhamati, near the old bed of the Ganges. Population (1881), 15,267; (1891), 16,486. The high school had 388 pupils in 1896–97.

The district of PABNA has an area of 1839 square miles; population (1881) 1,311,728, (1891) 1,362,392, (1901) 1,420,352, showing an increase of 4 per cent. between 1881 and 1891, and also between 1891 and 1901; average density, 772 persons per square mile. Classified according to religion, Mahommedans in 1891 numbered 998,776; Hindus, 361,957; Christians, 162, of whom 96 were Europeans; "others," 1497. The land revenue and rates in 1897–98 were Rs.4,69,337; the number of police was 403; boys at school in 1896–97 were 19,812, being 19·5 per cent. of the male population of school-going age; the registered death-rate in 1897 was 40 per thousand. The two staple crops are rice and jute. There are 18 jute presses, with an out-turn of 259,000 bales, valued at Rs.30,00,000. Sirajganj, on the Brahmaputra, is the largest mart for jute in Bengal, with a jute mill established in 1864. Indigo has ceased to be grown. The Eastern Bengal Railway cuts across the south-west corner of the district for five miles, near the Ganges. The district was affected by the earthquake of 12th June 1897, which was most severely felt at Sirajganj.

Pachino, a town of the province of Syracuse, Sicily, Italy, 4 miles from Cape Passaro, 26 miles south-south-west of Syracuse. It carries on the manufacture of vegetable fibre and baskets, fish-curing, cultivation of the vine, and herring-fishing (port $2\frac{1}{2}$ miles to the north-east). Population (1881), 8229; (1899), 10,000.

Pachuca, a city of Mexico, and capital of Hidalgo. It is connected with the city of Mexico by the Hidalgo, Mexican, and Central railways. It is the principal town of the state on account of its commerce, population (40,487), and mining industries. Amongst several fine buildings are the palace of justice, the scientific and literary institute, the meteorological observatory, and the school of mines and public library. The town has tramways, and several private railways in connexion with adjacent mines.

Pacific Blockade.—Pacific blockade is a term invented by Hautefeuille, the French writer on International Maritime Law, to describe a blockade exercised by a great Power for the purpose of bringing pressure to bear on a weaker state, without actual war. That it is an act of violence, and therefore in the nature of war, is undeniable, seeing that it can only be employed as a measure of coercion by maritime Powers able to bring into action such vastly superior forces to those the resisting state can dispose of, that resistance is out of the question. In this respect it is an act of war, and any attempt to exercise it against a Power strong enough to resist would be a commencement of hostilities and at once bring into play the rights and duties affecting neutrals. On the other hand, the object and justification of a pacific blockade being to avoid war, that is, general hostilities, and disturbance of international traffic with the state against which the operation is carried on, rights of war cannot consistently be exercised against ships belonging to other states than those concerned. And yet, if neutrals were not to be affected by it, the coercive effect of such a blockade might be completely lost. Recent practice has been to limit interference with them to the extent barely necessary to carry out the purpose of the blockading Powers.

It is usual to refer to the intervention of France, England, and Russia in Turkish affairs in 1827 as the first occasion on which the coercive value of pacific blockades was put to the test. Neutral vessels were not affected by it. This was followed by a number of other coercive measures described in the text-books as pacific blockades. The first case, however, in which the operation was really a blockade, unaccompanied by hostilities, and which therefore can be properly called a "pacific blockade," was that which in 1837 Great Britain exercised against New Granada. A British subject and consul of the name of Russell was accused of stabbing a native of the country in a street brawl. He was arrested, and after being kept in detention for some months he was tried for the unlawful carrying of arms and sentenced to six years' imprisonment. The British Government resented this treatment as "not only cruel and unjust towards Mr Russell, but disrespectful towards the British nation," and demanded the dismissal of the officials implicated and £1000 damages "as some compensation for the cruel injuries which had been inflicted upon Mr Russell" (State Papers, 1837–38, p. 183). The New Granada Government refused to comply with these demands, and the British representative, acting upon his instructions, called in the assistance of the West Indian fleet, but observed in his communication to the British naval officer in command that it was desirable to avoid hostilities, and to endeavour to bring about the desired result by a strict blockade only. This seems to be the first occasion on which it had occurred to anybody that a blockade without war might serve the purpose of war. This precedent was shortly afterwards followed by another somewhat similar case in which, from 16th April to 28th November 1838, the French Government blockaded the Mexican ports, to coerce the Mexican Government into acceptance of certain demands on behalf of French subjects who had suffered injury to their persons and damage to their property, through insufficient protection by the Mexican authorities.

The blockade of Buenos Aires and the Argentine coast from 28th March 1838 to 7th November 1840 by the French fleet, a coercive measure consequent upon vexatious laws affecting foreign residents in the Argentine Republic, seems to have been the first case in which the operation was notified to the different representatives of foreign states. This notification was given in Paris, and at Buenos Aires, and to every ship approaching the blockaded places. This precedent of notification was, a few years later (1845), followed in another blockade against the same country by Great Britain and France, and in one in 1842 and 1844 by Great Britain against the port of San Juan in Nicaragua. In 1850 Great Britain blockaded the ports of Greece in order to compel the Hellenic Government to give satisfaction in the Don Pacifico case. Don Pacifico, a British subject, claimed £32,000 as damages for unprovoked pillage of his house by an Athenian mob. Greek vessels only were seized, and these were only sequestered. Greek vessels *bona fide* carrying cargoes belonging to foreigners were allowed to enter the blockaded ports.

Before the next case of blockade which can be described as "pacific" occurred, came the Declaration of Paris (15th April 1856), requiring that "blockades in order to be binding must be effective, that is to say, maintained by a force sufficient really to prevent access to the coast of the enemy."

Some ill-defined measures of blockade followed, such as that of 1860, when Victor Emmanuel, then king of Sardinia, joined the revolutionary government of Naples in blockading ports in Sicily, then held by the king of Naples, without any rupture of pacific relations between the two governments; that of 1862, in which Great Britain blockaded the port of Rio de Janeiro, to exact redress for pillage of an English vessel by the local population, at the same time declaring that she continued to be on friendly terms with the emperor of Brazil; and that in 1880, when a demonstration was made before the port of Dulcigno by a fleet of British, German, French, Austrian, Russian, and Italian men-of-war, to compel the Turkish Government to carry out the treaty conceding this town to Montenegro, and it was announced that, if the town was not given up by the Turkish forces, it would be blockaded.

The blockade which first gave rise to serious theoretical discussion on the subject was that instituted by France in 1884 in Chinese waters. On 20th October 1884 Admiral Courbet declared a blockade of all the ports and roadsteads between certain specified points of the island of Formosa. The British Government protested that Admiral Courbet had not enough ships to render the blockade effective, and that it was therefore a violation of one of the articles of the Declaration of Paris of 1856; moreover, that the French Government could only interfere with neutral vessels violating the blockade if there was a state of war. If a state of war existed, England as a neutral was bound to close her coaling stations to belligerents. The British Government held that, in the circumstances, France was waging war, and not entitled to combine the rights of peace and warfare for her own benefit. Since then pacific blockades have only been exercised by the Great Powers as a joint measure in their common interest, which has also been that of peace, and in this respect the term is taking a new signification in accordance with the ordinary sense of the word "pacific." [1]

In 1886 Greece was blockaded by Great Britain, Austria, Germany, Italy, and Russia, to prevent her from engaging in war with Turkey, and thus forcing the Powers to define their attitude towards the latter Power. The instructions given to the British commander were to detain every ship under the Greek flag, coming out of or entering any of the blockaded ports or harbours or communicating with any ports within the limit blockaded; but if any parts of the cargo on board of such ships belonged to any subject or citizen of any foreign Power other than Greece, and other than Austria, Germany, Italy, and Russia, and had been shipped before notification of the blockade or after such notification but under a charter made before the notification, such ship was not to be detained.

On the blockade of Crete in 1897 it was notified that "the admirals in command of the British, Austro-Hungarian, French, German, Italian, and Russian naval forces" had decided to put the island of Crete in a state of blockade, that "the blockade would be general for all ships under the Greek flag," and that "ships of the six Powers or *neutral* Powers may enter into the ports occupied by the Powers and land their merchandise, but only if it is not for the Greek troops or the interior of the island," and that "these ships may be visited by the ships of the international fleets." (T. BA.)

Pacific Islands. See MELANESIA, MICRONESIA, POLYNESIA.

Pacific Ocean, the largest division of the hydrosphere, lying been Asia and Australia and North and South America. It is nearly landlocked to the north, communicating with the Arctic Ocean only by Bering Strait, which is 36 miles wide and of small depth. The southern boundary is now generally regarded as the parallel of 40° S., but sometimes the part of the great Southern

[1] The blockade in 1888 by Great Britain, Germany, Italy, and Portugal of Zanzibar was peculiar, being directed not against the reigning authority, but against a slave trade which that authority was powerless to stop.

Ocean (40° to 66½° S.) between the meridians passing through South Cape in Tasmania and Cape Horn is included. The north to south distance from Bering Strait to the Antarctic circle is 9000 miles, and the Pacific attains its greatest breadth, 10,000 miles, at the equator. The coasts of the Pacific are of varied contour. The American coasts are for the most part mountainous and unbroken, the chief indentation being the Gulf of California; but the general type is departed from in the extreme north and south, the southern coast of South America consisting of bays and fjords with scattered islands, while the coast of Alaska is similarly broken in the south, and becomes low and swampy towards the north. The coast of Australia is high and unbroken; there are no inlets of considerable size, although the small openings include some of the finest harbours in the world, as Moreton Bay and Port Jackson. The Asiatic coasts are for the most part low and irregular, and a number of seas are more or less completely enclosed and cut off from communication with the open ocean. Bering Sea is bounded by the Alaskan peninsula and the chain of the Aleutian Islands; the Sea of Okhotsk is enclosed by the peninsula of Kamchatka and the Kurile Islands; the Sea of Japan is shut off by Sakhalin Island, the Japanese Islands, and the peninsula of Korea; the Yellow Sea is an opening between the coast of China and Korea; the China Sea lies between the Asiatic continent and the island of Formosa, the Philippine group, Palawan, and Borneo. Amongst the islands of the Malay Archipelago are a number of enclosed areas, the Sulu, Celebes, Java, Banda, and Arafura seas. The Arafura Sea extends eastwards to Torres Strait, and beyond the strait is the Coral Sea, bounded by New Guinea, the islands of Melanesia, and north-eastern Australia.

Coasts and seas.

Extent, volume, and mean depth.

The following table gives the area and volume of the Pacific Ocean and its seas, with the mean depths calculated therefrom, as estimated by Murray (1888):—

	Area (sq. miles).	Volume (cub. miles).	Mean Depth (fathoms).
Pacific Ocean (to 40° S.)	50,308,450	141,516,050	2475
Southern Ocean (S. of the Pacific)	10,278,500	24,980,200	2139
Pacific Ocean to 66½° S.	60,586,950	166,496,250	2418
Bering Sea	859,450	621,500	636
Sea of Okhotsk	542,000	197,600	292
Sea of Japan	375,550	220,800	517
Yellow Sea	468,450	55,050	103
China Sea	1,366,600	835,200	538
Celebes Sea	181,950	288,150	1394
Sulu Sea	174,200	136,800	691
Banda Sea	422,000	417,750	871
Java Sea	360,050	34,900	85
Arafura Sea	565,200	79,150	123
Total	65,902,400	169,383,150	2253

Adopting a somewhat different arrangement, Karstens (1894) obtains the following:—

	Area (sq. kilom.).	Volume (cub. kilom.).	Mean Depth (fathoms).
Pacific Ocean to 66½° S.	161,137,973	657,926,344	2233
Bering Sea	2,264,664	2,513,558	607
Sea of Okhotsk	1,507,609	1,895,065	695
Sea of Japan	1,043,824	1,148,206	602
China Seas and Gulf of Siam	4,583,473	3,436,093	410
Sunda Archipelago	3,241,128	2,640,721	446
Sulu and Celebes Seas with Gulf of Carpentaria	1,499,659	1,983,291	723
Gulf of California	166,788	164,586	540
Total	175,445,118	671,707,864	2094

The Pacific Ocean has therefore one and three-quarter times the area of the Atlantic, the next largest division of the hydrosphere, and has more than double its volume of water. Its area is greater than the whole land surface of the globe, and the volume of its waters is six times that of all the land above sea-level. The total land area draining to the Pacific is estimated by Murray at 7,500,000 square miles, or little more than one-fourth of the area draining to the Atlantic. The American rivers draining to the Pacific are, with the exception of the Yukon, unimportant. The chief Asian rivers are the Amur, the Hwang-ho, and the Yangtse-kiang, none of which enters the open Pacific directly. Hence the proportion of purely oceanic area to the total area is greater in the Pacific than in the Atlantic, the supply of detritus being smaller, and terrigenous deposits are not borne so far from land.

Relief.

The bed of the Pacific is not naturally divided into physical regions, but for descriptive purposes the parts of the area lying east and west of 150° W. are conveniently dealt with separately (Fig. 1). The eastern region is characterized by great uniformity of depth; the 2000-fathom line keeps close to the American coast except off the Isthmus of Panama, whence an ill-defined ridge of less than 2000 fathoms runs south-westwards, and again off the coast of South America in about 40° S., where a similar bank runs west and unites with the former. The bank then continues south to the Antarctic Ocean, in about 120° W. Practically the whole of the north-east Pacific is therefore more than 2000 fathoms deep, and the south-east has two roughly triangular spaces, including the greater part of the area, between 2000 and 3000 fathoms. Notwithstanding this great average depth, the "deeps" or areas over 3000 fathoms are small in number and extent. Five small deeps are recognized along a line close to the coast of South America and parallel to it, in the depression enclosed by the two banks mentioned—they extend from about 12° to 30° S.—and are named, from north to south, Milne-Edwards deep, Krümmel deep, Bartholomew deep, Richards deep, and Haeckel deep. In the north-east the deeps are again few and small, but they are quite irregularly distributed, and not near the land. East of 150° W. the Pacific has few islands; the oceanic islands are volcanic, and coral formations are of course scanty. The most important group is the Galapagos Islands.

The western Pacific is in complete contrast to the part just described. Depths of less than 2000 fathoms occur continuously on a bank extending from south-eastern Asia, on which stands the Malay Archipelago. This bank continues southwards to the Antarctic Ocean, expanding into a plateau on which Australia stands, and a branch runs eastwards and then southwards from the north-east of Australia through New Zealand. The most considerable areas over 3000 fathoms are the Aldrich deep, an irregular triangle nearly as large as Australia, situated to the east of New Zealand, in which a sounding of 5155 fathoms was obtained by H.M.S. *Penguin*, near the Friendly Islands: and the Tuscarora deep, a long, narrow trough running immediately to the east of Kamchatka, the Kurile Islands, and Japan. A long strip within the Tuscarora deep forms the largest continuous area with a depth greater than 4000 fathoms. All the rest of the western Pacific is a region of quite irregular contour. The average depth varies from 1500 to 2500 fathoms, and from this level innumerable volcanic ridges and peaks rise almost or quite to the surface, their summits for the most part occupied by atolls and reefs of coral formation, while interspersed with these are depressions, mostly of small area, amongst which the deepest soundings recorded have been obtained. Recently the United States telegraph ship *Nero*, while surveying for a cable between Hawaii and the Philippines, sounded the greatest depth yet known between Midway Island and Guam, in 5269 fathoms, or almost exactly six miles.

The following table, showing the area of the floor of the Pacific (to 40° S.) and the volume of water at different levels, is due to Murray:—

Fathoms.	Areas (sq. miles).	Volume (cub. miles).
0–100	3,379,700	6,128,500
100–500	1,753,450	23,348,350
500–1000	1,707,650	28,323,700
1000–2000	6,902,550	52,628,500
2000–3000	39,621,550	32,545,400
3000–4000	2,164,150	1,357,900
over 4000	94,850	70,600
	55,623,900	144,402,950

So far as our knowledge goes, the present contours of the open Pacific Ocean are almost as they were in Palæozoic times, and in the intervening ages changes of level and form have been slight. There is no reason to suppose that any considerable part of the vast area now covered by the waters of the Pacific has ever been exposed as dry land. Hence the Pacific basin may be regarded as a stable and homogeneous geographical unit, clearly marked off round nearly all its margin by steep sharp slopes, extending in places through the whole known range of elevation above sea-level and of depression below it—from the Cordilleras of South America to the island chains of Siberia and Australia.

The deeper parts of the bed of the Pacific are covered by deposits

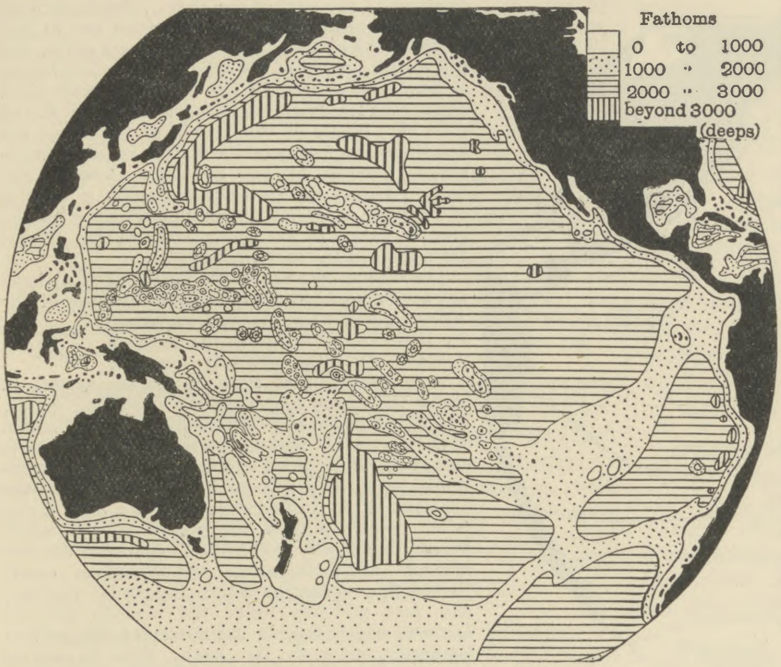


Fig. 1.—Chart of the Depths of the Pacific.

of red clay, which occupies an area estimated at no less than 105,672,000 square kilometres, or three-fifths of the whole (Fig. 2). Over a large part of the central Pacific, far removed from any possible land-influences or deposits of ooze, the red-clay region is characterized by the occurrence of manganese, which gives the clay a chocolate colour, and manganese nodules are found in vast numbers, along with sharks' teeth and the ear-bones and other bones of whales. Radiolarian ooze is found in the central Pacific in a region between 15° N. to 10° S. and 140° E. to 150° W., occurring in seven distinct localities, and covering an area of about 3,007,000 square kilometres. The *Challenger* discovered an area of radiolarian ooze between 7°–12° N. and 147°–152° W., and another in 2°–10° S., 152°–153° W. Between these two areas, almost on the equator, a strip of globigerina ooze was found, corresponding to the zone of globigerina in the equatorial region of the Atlantic. Globigerina ooze covers considerable areas in the intermediate depths of the west and south Pacific—west of New Zealand, and along the parallel of 40° S., between 80°–98° W. and 150°–118° W.—but this deposit is not known in the north-eastern part of the basin. The total area covered by it is estimated at 38,332,000 square kilometres—about two-thirds of that in the Atlantic. Pteropod ooze occurs only in the neighbourhood of Fiji and other islands of the western Pacific, passing up into fine coral sands and mud. All the enclosed seas are occupied by characteristic terrigenous deposits.

Deposits.

Partly on account of its great extent, and partly because there is no wide opening to the Arctic regions, the normal wind circulation is on the whole less modified in the north Pacific than in the Atlantic, except in the west, where the south-west monsoon of southern Asia controls the prevailing winds, its influence extending eastwards to 145° E., near the Ladrones, and southwards to the equator. In the south Pacific the north-west monsoon of Australia affects a belt running east of New Guinea to the Solomon Islands. In the east the north-east trade belt extends between 5° and 25° N.; the south-east trade crosses the equator, and its mean southern limit is 25° S. The trade winds are generally weaker and less persistent in the Pacific than in the Atlantic, and the intervening belt of equatorial calms is broader. Except in the east of the Pacific, the south-east trade is only fully developed during the southern winter; at other seasons the regular trade belt is cut across from north-west to south-east by a band twenty to thirty degrees wide, in which the trades alternate with winds from north-east and north, and with calms, the calms prevailing chiefly at the boundary of the monsoon region (5° N.–15° S., 160°–185° E.). This area, in which the south-east trade is interrupted, includes the Fiji, Navigator, and Society groups, and the Paumotus. In the Marquesas group the trade wind is constant. Within the southern monsoon region there is a gradual transition to the north-west monsoon of New Guinea in low latitudes, and in higher latitudes to the north-east wind of the Queensland coast. The great warming and abundant rainfall of the island regions of the western Pacific, and the low temperature of the surface water in the east, cause a displacement of the southern tropical maximum of pressure to the east; hence we have a permanent "south Pacific anticyclone" close to the coast of South America. The characteristic feature of the south-western Pacific is therefore the relatively low pressure and the existence of a true monsoon region in the middle of the trade-wind belt. It is to be noted that the climate of the islands of the Pacific becomes more and more healthy the farther they are from the monsoon region. The island regions of the Pacific are everywhere characterized by uniform high air temperatures; the mean annual range varies from 1° to 9° F., with extremes of 24° to 27°, and the diurnal range from 9° to 16°. In the monsoon region relative humidity is high—80 to 90 per cent. The rainfall is abundant; in the western island groups there is no well-marked rainy season, but over the whole region the greater part of the rainfall takes place during the southern summer, even as far north as Hawaii. In the trade-wind region we find the characteristic heavy rainfall on the weather sides of the islands, and a shorter rainy season at the season of highest sun on the lee side. Buchan describes the island-studded portion of the western Pacific as the most extensive region of the globe characterized by an unusually heavy rainfall. Beyond the tropical high-pressure belt, the winds of the north Pacific are under the control of an area of low pressure, which, however, attains neither the size nor the intensity of the "Iceland" depression in the north Atlantic. The result is that north-westerly winds, which in winter are exceedingly dry and cold, blow over the western or Asiatic area; westerly winds prevail in the centre, and south-westerly and southerly winds off the American coast. In the southern hemisphere there is a transition to the low-pressure belt encircling the Southern Ocean, in which westerly and north-westerly winds continue all the year round.

Meteorology.

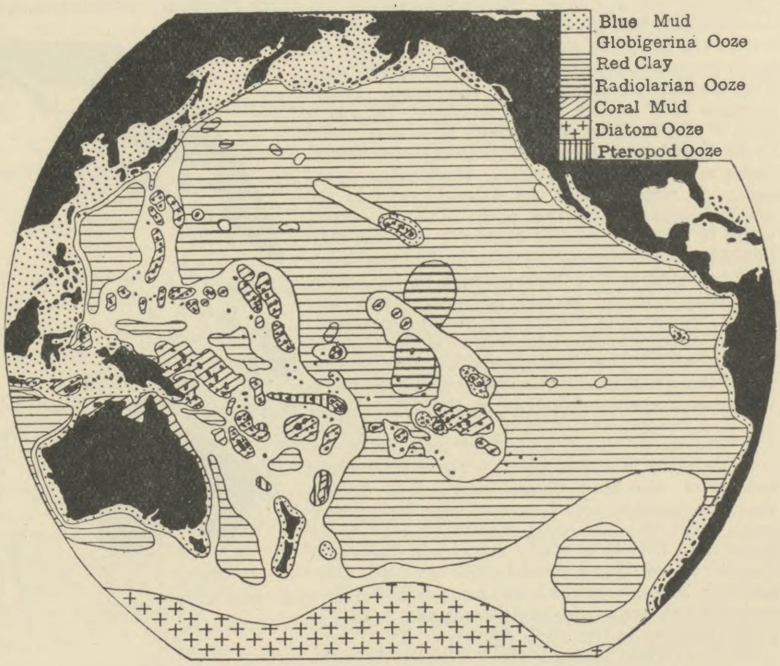


Fig. 2.—Chart of Deposits in the Pacific.

In the equatorial regions of the Pacific the mean annual temperature of the surface water is over 80°, except between 117° and 145° W., where a temperature of 75° to 80°, below the normal for the latitude, is found (Fig. 3). In the eastern Pacific the belt of high temperature lies wholly north of the equator, but in the west the temperature is over 80° from

Temperature.

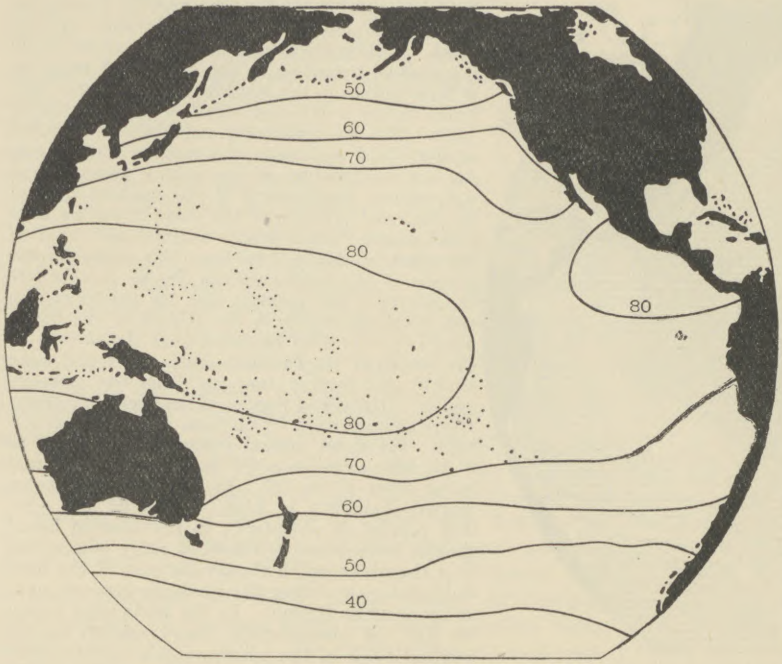


FIG. 3.—Chart of the Mean Surface Temperature of the Pacific.
(*The numbers indicate degrees Fahr.*)

20° N. to 20° S., to the east of Australia. In higher latitudes the eastern Pacific is colder than the western, at least to the parallels of 40° N. and S., but beyond this the isothermals run almost due east and west. Beyond the tropics the north Pacific is everywhere colder than the north Atlantic, especially in the east. In the open ocean the temperature everywhere falls from the surface downwards. The bottom temperature in the north Pacific averages 35·1°; south of the Sandwich Islands it is 35·0°; in the Low Archipelago it is 35·1°; and in 40° S. it is 34·7° in deep water. The isothermobaths of 50° to 70° rise nearer the surface in the equatorial regions, as in the Atlantic; and in the north Pacific, as in the north Atlantic, warm water is found at greater depths in the west than in the east. The greatest excess in the lower levels is found south-east of Japan, where in 30° N. the temperature is 60° in 200 fathoms. From this region temperature diminishes in all directions; even at the equator the temperature at 200 fathoms is only 48°. The isothermobaths sink farther below the surface near the equator, and temperatures are generally lower than in the Atlantic; in 21° S. a temperature of 36·5° occurs at a depth of 850 fathoms, compared with 1400 fathoms in the same latitude in the Atlantic. The characteristic feature of the temperature distribution in the Pacific is the thinness of warm surface layers compared with the enormous masses of cold water below, and this is specially marked in the north Pacific, where the surface layers having a temperature between 39° and 40° are not more than 20 to 30 fathoms in thickness, compared with 400 to 600 fathoms in the north Atlantic. The Pacific presents a further strong contrast with the Atlantic, inasmuch as the northern part is much colder than the southern. In the enclosed seas of the western Pacific temperature usually falls till a depth corresponding to that of the summit of the barriers which cut them off from the open ocean is reached, and below that point temperature is uniform to the bottom. In the Sulu Sea, for example, a temperature of 50·5° is reached at 400 fathoms, and this remains constant till the bottom is reached in 2500 fathoms.

The surface waters of the north Pacific are relatively fresh, the salinity being on the whole much lower than in the other great oceans. The saltest waters are found along a belt extending westwards from the American coast on the Tropic of Cancer to 160° E., then turning southwards to the equator. North of this salinity diminishes steadily, especially to the north-west, the Sea of Okhotsk showing the lowest salinity observed in any part of the globe. South and east of the axis mentioned salinity becomes less to just north of the equator, where it increases again, and the saltest waters of the whole Pacific are found, as we should expect, in the south-east trade-wind region, the maximum occurring in about 18° S. and 120° W. South of the Tropic of Capricorn the isohalines run nearly east and west, salinity diminishing quickly to the Southern Ocean. The bottom waters have almost uniformly a salinity of 34·8 per mille, corresponding closely with the bottom waters of the south Atlantic, but fresher than those of the north Atlantic.

Salinity.

The surface currents of the Pacific (Fig. 4) have not been studied in the same detail as those of the Atlantic, and their seasonal variations are little known except in the monsoon regions. Speaking generally, however, it may be said that they are for the most part under the direct control of the prevailing winds. The *North Equatorial Current* is due to the action of the north-east trades. It splits into two parts east of the Philippines, one division flowing northwards as the *Kuro Siwo* or Black Stream, the analogue of the Gulf Stream, to feed a drift circulation which follows the winds of the north Pacific, and finally forms the *Californian Current* flowing southwards along the American coast. Part of this rejoins the North Equatorial Current, and part probably forms the variable *Mexican Current*, which follows the coasts of Mexico and California close to the land. The *Equatorial Counter-Current* flowing eastwards is largely assisted during the latter half of the year by the south-west monsoon, and from July to October the south-west winds prevailing east of 150° E. further strengthen the current, but later in the year the easterly winds weaken or even destroy it. The *South Equatorial Current* is produced by the south-east trades, and is more vigorous than its northern counterpart. On reaching the western Pacific part of

Circulation.

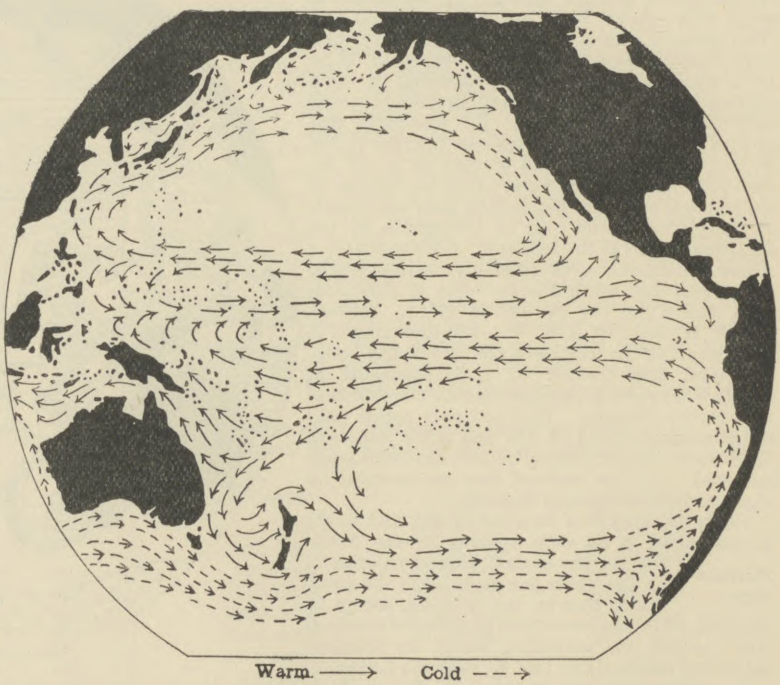


FIG. 4. Chart of the Currents of the Pacific.

this current passes southwards, east of New Zealand, and again east of Australia, as the *East Australian Current*, part northwards to join the Equatorial Counter-Current, and during the north-east monsoon part makes its way through the China Sea towards the Indian Ocean. During the south-west monsoon this last branch is reversed, and the surface waters of the China Sea probably unite with the Kuro Siwo. Between the Kuro Siwo and the Asiatic coast a band of cold water, with a slight movement to the southward, known as the *Oya Siwo*, forms the analogue of the "Cold Wall" of the Atlantic. In the higher latitudes of the south Pacific the surface movement forms part of the west wind-drift of the Roaring Forties. On the west coast of South America the cold waters of the *Humboldt* or *Peruvian Current*, corresponding to the Benguela Current of the south Atlantic, make their way northwards, ultimately joining the South Equatorial Current. The surface circulation of the Pacific is, on the whole, less active than that of the Atlantic. The centres of the rotational movement are marked by "Sargasso Seas" in the north and south basins, but they are of small extent compared with the Sargasso Sea of the north Atlantic. From the known peculiarities of the distribution of temperature, it is probable that definite circulation of water is in the Pacific confined to levels very near the surface, except in the region of the Kuro Siwo, and possibly also in parts of the Peruvian Current. The only movement in the depths is the slow creep of ice-cold water northwards along the bottom from the Southern Ocean; but this is more marked, and apparently penetrates farther north, than in the Atlantic. (H. N. D.)

Paderborn, a town and episcopal see of Prussia, province of Westphalia, 63 miles east-north-east of Dortmund by the railway to Hanover. The town hall (13th century) was restored in 1877–80, and the cathedral in 1891–93. There is a Roman Catholic seminary, with faculties in theology and philosophy. Printing and brewing are carried on, besides a trade in wool, corn, and cattle. There are mineral springs (65·5° Fahr.). Population (1885), 16,624; (1895), 19,980; (1900), 23,502.

Padron, a town of Spain, province of Corunna and diocese of Santiago, on the river Ulla, and on the Santiago–Carril railway. The population was 7662 in 1887 and 7287 in 1897. Floods are frequent. The country around is mountainous, and produces wine, wheat, and fruit. There are manufactures of cotton and woollen goods. The estuary from the bridge of Cesures at Padron to the mouth of the Ulla, a distance of 10 miles, is now only accessible for vessels of light draught, coasters, and fishing boats. Padron was one of the earliest Christian bishoprics. Normans and Saracens destroyed the ancient cathedral, of which only two towers and the 13th-century portico are still standing.

Padua, a city and capital of the province of Padua, Venetia, Italy. Its industry has greatly developed, many new factories and mills having been founded and those already existing enlarged. Corn and saw mills, distilleries, chemical factories, breweries, candle-works, ink-works, foundries, agricultural machine and automobile works, have been established and are flourishing. The trade of the district has grown to such an extent that Padua has become the central market for the whole of Venetia. The increase of railway traffic has also been noteworthy. Whereas in 1886 Padua stood twelfth on the list of important stations of the Adriatic line, it now holds the seventh place with a net revenue of nearly £80,000 per annum. The traffic of secondary and inter-provincial railways has correspondingly developed. The growth of population consequent upon this agricultural, industrial, and commercial advance has led to the extension of the inhabited area of the city. Population (1880), 70,753; (1900), 93,560.

Paducah, a city of Kentucky, U.S.A., capital of McCracken county. It is on the south bank of the Ohio river, at the mouth of the Tennessee, and on the Illinois Central and the Nashville, Chattanooga, and St Louis railways, in the western part of the state, at an altitude of 433 feet. Its trade is next in volume to that of Louisville in the state. Its traffic is in part by rail, in part by river, as it is connected by steamboat lines with all Ohio and Mississippi river ports. It is one of the largest tobacco markets, and contains many warehouses, and factories for its manufacture. There are also shipyards and a marine railway. Population (1890), 12,797; (1900), 19,446, of whom 516 were foreign-born and 5814 negroes.

Pagan, a subdivision and township of the Myingyan district of Upper Burma, 92 miles south-west by west of Mandalay. It was formerly for a period of four and a half centuries the capital of the Burmese empire. It was founded by King Pyinbya in A.D. 847, and remained the capital until the extinction of the dynasty in A.D. 1298. Pagan itself is a mere village now, but hundreds of pagodas in various stages of decay meet the eye in every direction. These are described in Yule's *Mission to Ava*. The bulk of the pagodas were built by King Anawra-hta, who overcame the Peguan king, Manuha of Thatôn. It was Anawra-hta who introduced the Buddhist religion in Upper Burma, and he carried off nearly the whole Thatôn population to build the pagodas at Pagan on the model of the Thatôn originals.

Pagani, a town of the province of Salerno, Campania, Italy, 12 miles north-west of Salerno by the railway to Naples. In the church is buried Alfonso de Liguori (1696–1787), founder of the order of the Redemptorists. It has cotton mills and macaroni factories; vegetables are grown for export. Population (1881), 12,780; (1899), about 13,000.

Paget, Sir James, Bart. (1814–1899), British surgeon, born at Yarmouth 11th January 1814, was the son of a brewer and shipowner. He was one of a large family, and his brother Sir George Paget (1809–1892), who became regius professor of physic at Cambridge in 1872, also had a distinguished career in medicine, and besides these honours was made a K.C.B. He attended a day-school in Yarmouth, and afterwards was destined for the navy; but this plan was given up, and at the age of sixteen he was apprenticed to a general practitioner, whom he served for four and a half years, during which time he gave his leisure hours to botanizing and made a great collection of the flora of East Norfolk. At the end of his apprenticeship he published with one of his brothers a very careful *Sketch of the Natural History of Yarmouth and its Neighbourhood*. In October 1834 he entered as a student at St Bartholomew's Hospital. Medical students in those days were left very much to themselves; there was no close supervision of their work, and it is probable that Paget gained rather than lost by having to fight his own way. He swept the board of prizes in 1835, and again in 1836; and in his first winter session he detected the presence of the *Trichina spiralis*, a minute parasite that infests the muscles of the human body.[1] In May 1836 he passed his examination at the Royal College of Surgeons, and became qualified to practise. The next seven years (1836–43) were spent in London lodgings, and were a time of poverty; for he made only £15 a year by practice, and his father failed in business, and could not give him any help. He managed to keep himself by writing for the medical journals, and preparing the catalogues of the hospital museum and of the pathological museum

[1] This discovery is usually credited to Owen (*q.v.*). The facts appear to be as follows. Paget was a first-year's student, and, by means of a pocket lens, found in the dissecting room that the specks in the infected muscles were parasitic worms and not, as previously thought, spicules of bone. Thomas Wormald, the senior demonstrator, who was no pathologist, sent a piece of the same muscle to Owen, who authoritatively pronounced the specks to be parasites and gave them their scientific name. It is probable that Owen did not realize that Paget had already made the discovery, and it was naturally associated with the name of the professor.

of the Royal College of Surgeons. In 1836 he had been made curator of the hospital museum, and in 1838 demonstrator of morbid anatomy at the hospital; but his advancement there was hindered by the privileges of the hospital apprentices, and by the fact that he had been too poor to afford a house-surgeoncy, or even a dressership. In 1841 he was made surgeon to the Finsbury Dispensary; but this appointment did not give him any experience in the graver operations of surgery. In 1843 he was appointed lecturer on general anatomy (microscopic anatomy) and physiology at the hospital, and warden of the hospital college then founded. For the next eight years he lived within the walls of the hospital, in charge of about thirty students resident in the little college. Besides his lectures and his superintendence of the resident students, he had to enter all new students, to advise them how to work, and to manage the finances and the general affairs of the school. Thus he was constantly occupied with the business of the school, and often passed a week, or more, without going outside the hospital gates. In 1844 he married Lydia, youngest daughter of the Rev. Henry North. In 1847 he was appointed an assistant-surgeon to the hospital, and Arris and Gale professor at the College of Surgeons. He held this professorship for six years, and each year gave six lectures in surgical pathology. (The first edition of these lectures, which were the chief scientific work of his life, was published in 1853.) In 1851 he was elected a Fellow of the Royal Society. In October 1851 he resigned the wardenship of the hospital. He had now become known as a great physiologist and pathologist; he had done for pathology in England what Virchow had done in Germany; but he had hardly begun to get into practice, and he had kept himself poor that he might pay his share of his father's debts—a task that it took him fourteen years to fulfil.

It is probable that no famous surgeon, not even John Hunter, ever founded his practice deeper in science than Paget did, or waited longer for his work to come back to him. In physiology he had mastered the chief English, French, German, Dutch, and Italian literature of the subject, and by incessant study and microscope work had put himself level with the most advanced knowledge of his time; so that it was said of him by Professor Owen, in 1851, that he had his choice, either to be the first physiologist in Europe, or to have the first surgical practice in London, with a baronetcy. His physiological lectures at the hospital were a chief cause of the raising again of its school, which in 1843 had gone down to a low point of its fortunes. In pathology his work was even more important. He fills the place in pathology that had been left empty by Hunter's death in 1793—the time of transition from Hunter's teaching, which for all its greatness was hindered by want of the modern microscope, to the pathology and bacteriology of the present day. It is Paget's greatest achievement that he made pathology dependent, in everything, on the use of the microscope—especially the pathology of tumours. He and Virchow may truly be called the founders of modern pathology; they stand together, Paget's *Lectures on Surgical Pathology* and Virchow's *Cellular-Pathologie*. When Paget, in 1851, began practice near Cavendish Square, he had still to wait a few years more for success in professional life. The "turn of the tide" came about 1854 or 1855; and in 1858 he was appointed surgeon extraordinary to Queen Victoria, and in 1863 surgeon in ordinary to the prince of Wales. He had for many years the largest and most arduous surgical practice in London. His day's work was seldom less than sixteen or seventeen hours. Cases sent to him for final judgment, with especial frequency, were those of tumours, and of all kinds of disease of the bones and joints, and all "neurotic" cases having symptoms of surgical disease. His supremacy lay rather in the science than in the art of surgery, but his name is associated also with certain great practical advances. He discovered the disease of the breast and the disease of the bones (osteitis deformans) which are called after his name; and he was the first at the hospital to urge enucleation of the tumour, instead of amputation of the limb, in cases of myeloid sarcoma.

In 1871 he nearly died from infection at a post-mortem examination, and, to lighten the weight of his work, was obliged to resign his surgeoncy to the hospital. In this same year he received the honour of a baronetcy. In 1875 he was president of the Royal College of Surgeons, and in 1877 Hunterian orator. In 1878 he gave up operating, but for eight or ten years longer he still had a very heavy consulting practice. In 1881 he was President of the International Medical Congress held in London; in 1880 he gave, at Cambridge, a memorable address on "Elemental Pathology," setting forth the likeness of certain diseases of plants and trees to those of the human body. Besides his shorter writings, he published *Lectures on Surgical Pathology* (1853), *Clinical Lectures and Essays* (1st ed. 1875), and *Studies of Old Case-books* (1891). In 1883, on the death of Sir George Jessel, he was appointed Vice-Chancellor of the University of London. In 1889 he was appointed a member of the Royal Commission on Vaccination. He died on 30th December 1899, in his eighty-fifth year. Sir James Paget had the gift of eloquence, and was one of the most careful and most delightful speakers of his time. He had a natural and unaffected pleasure in society, and he loved music. He possessed the rare gift of ability to turn swiftly from work to play; enjoying his holidays like a school-boy, easily moved to laughter, keen to get the maximum of happiness out of very ordinary amusements, emotional in spite of incessant self-restraint, vigorous in spite of constant over-work. In him a certain light-hearted enjoyment was combined with the utmost reserve, unfailing religious faith, and the most scrupulous honour. He was, all his life, profoundly indifferent toward politics, both imperial and medical; his ideal was the unity of science and practice in the professional life. (S. P.)

Pahang. See MALAY STATES (FEDERATED).

Paignton, a seaside invalid resort, in the Torquay parliamentary division of Devonshire, England, on Tor Bay, 2¾ miles south-west of Torquay by rail. The remains still exist of a palace of the bishops of Exeter. The Bible Tower, said to have been last occupied as a residence by Miles Coverdale, the translator of the Bible into English, consecrated bishop in 1551, has been again made habitable. The church of St John the Evangelist is ancient, and contains interesting monuments. There is a novitiate of the Marist Fathers, a town hall, a science and art school, a cottage hospital, various public halls, and a promenade pier. In the neighbourhood cider is made in great quantities. Population (1891), 6783; (1901), 8385.

Painesville, a village of Ohio, U.S.A., capital of Lake county, on the Grand river, near the shore of Lake Erie and on three railways, in the north-eastern part of the state. Population (1890), 4755; (1900), 5024, of whom 499 were foreign-born and 179 negroes.

Painting. See SCHOOLS OF PAINTING.

Paisley, a municipal and parliamentary burgh of Renfrewshire, Scotland, on the river Cart, 7 miles west by south of Glasgow by rail (5 stations). Borrowing powers for £130,000 were obtained in 1885–90 for the deepening of the Cart, which falls into the Clyde 3 miles below Paisley;

but the scheme was abandoned in 1891 for the time, and the debt on the river is now £123,664. Meanwhile the trustees have equipped the harbour with steam cranes, and a railway siding has been formed in connexion with it. The ancient abbey is being restored. The town hall, presented in 1882, cost £100,000. An observatory (1884–1898), three United Free churches, a court house, two Roman Catholic churches, county buildings (1891), a new post office, an Established church, an Episcopal church, a grammar school and academy (1898), a technical school, a drill hall, a magnificent memorial (Baptist) church, a new (1899) infirmary (£75,000), and a fire station are included in the erections since 1884. Electric light has been introduced (1899). The Dunn Square (1892) and the old quarry grounds converted into a recreation ground are additions to the parks and open spaces. A statue of Burns was erected in 1896, and statues of Sir Peter and Mr Thomas Coats in 1898. Thread and cotton spinning continues to be the staple industry. Of 3008 males and 7453 females who in 1891 were engaged in textile factories, 539 men and 5144 women were connected with the manufacture of cotton and linen, including thread. The thread mills form the governing factor in the combination which regulates the larger part of the thread trade of the world. From the shipbuilding yards in 1889, 15 vessels of 5423 tons were launched, and in 1899, 18 vessels of 8020 tons. The Neilson Endowed Institution had an average attendance in 1898–99 of 735. Population (1881), 55,638; (1891), 66,425; (1901), 79,355.

Pakhoi, a treaty port in the province of Kwangtung, China. The trade has declined rather than increased. In 1896 it reached a total of £773,535, whereas in 1900 the total was only £601,654; and it is probable that with the opening of the port of Kwang-chow-Wan and of the West river to steam traffic it will decline still more. The preparation of dried fish is a speciality of Pakhoi, the fish being exported to Hong Kong. The population is estimated at 25,000. The French obtained a concession to build a railway from this port to Nanning on the West river.

Pakôkku, a district in the Minbu division of Upper Burma, lying west of the Irrawaddy river and south of Mandalay, with the line of the Chin hills as a general boundary on the west. It has an area of 6210 square miles and a population of 311,959 (1891); 355,099 (1901). In 1898–99 there were 1354 villages in the district, paying Rs.8,22,535 revenue. The part of the district along the Irrawaddy and Chindwin rivers is peat and alluvial. Beyond this, however, the country rises gradually to the low Shinmadaung and Tangyi ridges, where it is very arid. To the westward there is a rapid drop to the well-watered valley of the Yaw river, and then a rise over broken, dry country before the valleys of the Myit-tha and Môln rivers are reached. The principal products are millet, sesamum, and sugar produced from toddy-palms in the riverain districts, which also grow rice, grain, peas, and beans. Tobacco and vegetables are also produced in some quantity, and maize is grown largely for the sake of the husk, which is used for native cheroot-wrappers, under the name of *yawpet*. The Yenangyat oil-fields, which produce quantities of petroleum, are in the south of the district, and iron used to be worked in a small way. There were 1053 square miles of reserved forests in the district. A good deal of teak and cutch is worked out. The yaw cutch is particularly esteemed. The average rainfall does not exceed 35 inches annually, and in many places water has to be carted for miles. West of the Pôndaung ridge, however, under the Chin hills, the rainfall exceeds 50 inches. The heat in May and June is very great, and the thermometer rises considerably above 100° F. in the shade; 110° is a common record during these months.

The great majority of the population is Burmese, but in Yaw there is a peculiar race called Taungthas, who claim to be quite distinct from both Burmese and Chins. The population in 1891 was classified thus:—Buddhists and Jains, 306,121; Hindus, 1665; Mahommedans, 1318; aborigines, Taungthas, and Chins, 2655; and Christians, 200. Of a total acreage of 3,974,147 there were 407,299 acres cropped in 1898–99. There were 492,223 acres available for cultivation, besides 19,898 acres of current fallow; 101,120 acres were under forest; and 1,196,782 were not cultivated. The headquarters town, Pakôkku, stands on the right bank of the Irrawaddy, and has grown into importance since the British occupation. It is the great boat-building centre of Upper Burma. The population in 1898 was 19,972. It may be described as the emporium of the trade of the Chindwin and Yaw river valleys. The steamers of the Irrawaddy Flotilla Company call here regularly, and it is the starting-point for the vessels plying on the Chindwin.

Palacio Valdés, Armando (1853– ——), Spanish novelist and critic, was born at Entralgo, in the province of Asturias, on 4th October 1853. His first writings were printed in the *Revista Europea*. These were pungent essays, remarkable for independent judgment and refined humour, and found so much favour with the public that the young beginner was soon appointed editor of the *Revista*. The best of his critical work is collected in *Los Oradores del Ateneo* (1878), *Los Novelistas españoles* (1878), *Nuevo Viaje al Parnaso* and *La Literatura en 1881* (1882), this last being written in collaboration with Leopoldo Alas. In 1881 he published a novel, *E. Señorito Octavio*, which shows an uncommon power of observation, and the promise of better things to come. In *Marta y María* (1883), a portrayal of the struggle between religious vocation and earthly passion, somewhat in the manner of Valera, Palacio Valdés achieved a very popular triumph which placed him in the first rank of contemporary Spanish novelists. *El Idilio de un Enfermo* (1884), a most interesting fragment of autobiography, has scarcely met with the recognition which it deserves: perhaps because the pathos of the story is too sincere and unadorned. The publication of Pereda's *Sotileza* is doubtless responsible for the conception of *José* (1885), in which Palacio Valdés gives a realistic picture of the manners and customs of seafaring folk, creates the two convincing characters whom he names José and Leonarda, and embellishes the whole with passages of animated description barely inferior to the finest penned by Pereda himself. The emotional imagination of the writer expressed itself anew in the charming story *Riverita* (1886), one of whose most attractive characters develops into the heroine of *Maximina* (1887); and from *Maximina*, in its turn, is taken the novice who figures as a professed nun among the personages of *La Hermana San Sulpicio* (1889), in which the love-passages between Zeferino Sanjurjo and Gloria Bermúdez are set off with elaborate, romantic descriptions of Seville. *El Cuarto Poder* (1888) is, as its name implies, concerned with the details, not always edifying, of journalistic life. Two novels issued in 1892, *La Espuma* and *La Fe*, were enthusiastically praised in foreign countries, but in Spain their reception was cold. The explanation is to be found in the fact that the first of these books is an avowed satire on the Spanish aristocracy, and that the second was construed into an attack upon the Roman Catholic Church. During the acrimonious discussion which followed the publication of *La Espuma*, it was frequently asserted that the artist had improvised a fantastic caricature of originals whom he had never seen; yet as the characters in Coloma's *Pequeñeces* are painted in darker tones, and as the very critics who were foremost in charging Palacio Valdés with incompetence and ignorance are almost unanimous in praising Coloma's fidelity, it is manifest that the indictment against *La Espuma* cannot be maintained. Of late, Palacio Valdés has returned to his earlier and better manner in *Los Majos de Cádiz* (1896) and in *La Algería del Capitán Ribot* (1899), in both of which he contrives to free himself from the reproach of undue submission to French influences. It can scarcely be said that he has fulfilled all the hopes that were once set upon him; but nevertheless he takes a prominent place in modern Spanish literature as a keen analyst of emotion and a sympathetic, delicate, humorous observer.

PALÆOBOTANY.

In the present article the subject of vegetable palæontology is treated from a botanical point of view. The science of botany is concerned with the vegetable kingdom as a whole, and not merely with the flora now living. The remains of the plants of former periods, which have come down to us in the fossilized state, are almost always fragmentary, and often imperfectly preserved; but their investigation is of the utmost importance to the botanist, as affording the only direct evidence of the past history of vegetable organisms. Since the publication of the *Origin of Species* the general acceptance of the doctrine of evolution has given a vastly increased significance to palæontological data. The determination of the course of descent has now become the ultimate problem for the systematist: this is a historical question, and the historical documents available are the remains of the ancient organisms preserved in the rocks. The palæobotanist thus endeavours to trace the history of plants in the past, with the hope of throwing light on their natural affinities and on the origin of the various groups. His investigations must embrace not only the comparative morphology and anatomy of fossil plants, but also their distribution over the earth's surface at different periods—a part of the subject which, besides its direct biological interest, has obvious bearings on ancient climatology and geography.

Preservation.—Before considering the results of palæobotanical research, some account must be given of the way in which the evidence is presented, or, in other words, of the modes of preservation of vegetable remains. These fall under two main heads. On the one hand, there is the mode of preservation which gives rise to casts, moulds, and generally impressions, exhibiting the *superficial* features of the specimen. The great majority of vegetable fossils are of this kind, and the term *incrustation* is used as a general term to cover all such methods of fossilization. On the other hand, there are specimens in which the tissues of the plant have been permeated by some mineral in solution, which, subsequently setting hard, has fixed and preserved the internal structure, often with astonishing perfection of detail. This second method of fossilization is termed *petrifaction.* In the case of incrustation the whole substance of the fossilized specimen—*e.g.*, a stem of *Sigillaria*—may be replaced by mineral matter, such as sandstone or shale, giving a cast of the whole, on the outer surface of which the external markings, such as the bases of leaves and the scars left by their fall, are visible in their natural form. Usually the original organic substance remains as a thin carbonaceous layer forming the surface of the cast, but sometimes it has entirely disappeared. The surrounding matrix will of course show the *mould* of the cast, with its elevations and depressions reversed. In the case of thin, flat organs such as leaves, the whole organ may be spread out in the plane of stratification, leaving its impress on the overlying and underlying layers. Here there has not necessarily been any replacement of organic by inorganic material; the whole leaf, for example, may remain, though reduced to a carbonaceous film. In such carbonaceous impression, not only are the form and markings, such as venation, perfectly preserved, but something of the actual structure may remain. The cuticularized epidermis, especially, is often thus preserved, and may be removed by the use of appropriate reagents and examined microscopically. If sporangia and spores are present, they also may persist in a perfectly recognizable form, and in fact much of our knowledge of the fructification of fossil Ferns has been derived from specimens of this kind.

In many cases *internal* casts have been formed, some large cavity, such as a fistular pith, having become filled with mineral substance, which has taken the impress of the surrounding structures, such as the wood. The common casts of Calamites are of this nature, representing the form of the hollow medulla, and bearing on their surface the print of the nodal constrictions and of the ridges and furrows on the inner surface of the wood. The whole organic substance may have been removed, or may persist merely as a thin carbonaceous layer. Mistakes have often arisen from confusing these *medullary* casts with those of the stem as a whole.

Although some information as to minute structure may occasionally be gleaned from the carbonaceous coating of impressions, the fossils preserved by *petrifaction* are the main source of our knowledge of the structural characters of ancient plants. The chemical bodies which have played the most important part as agents of petrifaction are silicic acid and calcium carbonate, though other substances, such as magnesium carbonate, calcium sulphate, and ferric oxide have also been concerned, either as the chief constituents of petrifactions, or mixed with other bodies. A large number of the most important remains of plants with structure preserved are silicious; this is the case, for example, with the famous French Permo-Carboniferous fossils of St Etienne, Autun, &c., which in the hands of Brongniart, Renault, and others have yielded such brilliant scientific results. At a more recent horizon, the silicified specimens of the Mesozoic Gymnosperms from Great Britain, France, and especially North America, are no less important. Calcified specimens are especially characteristic of the British Carboniferous formation; their preservation is equally perfect with that of the silicified fossils, and their investigation by Witham, Binney, Williamson, and others has proved no less fertile. In the Coal Measures of England and of certain German districts (*e.g.*, Langendreer in Westphalia) calcareous nodules, crowded with vegetable fragments of every kind, occur in certain mines embedded in the substance of the coal and representing its raw material in a petrified condition. Even the most delicate tissues, such as cambium and phloem, or even the endosperm of seeds, are frequently preserved cell for cell, both in calcareous and silicious material. As a rule, the petrified remains, all-important for the revelation of structure, are fragmentary, and give little idea of the habit or external characters of the plants from which they were derived. Hence they must be brought into relation with the specimens preserved as casts or impressions, in order to gain a better conception of the plant as a whole. This is often a difficult task, and generally the fragmentary nature of practically all vegetable fossils is the chief hindrance to their investigation. Owing to this, it has become the common practice of palæobotanists to give distinct generic names to detached parts of plants which may even have belonged to one and the same species. Thus the roots of *Sigillaria* are called *Stigmaria*, detached leaves *Sigillariophyllum*, and the fructifications *Sigillariostrobus*; the name *Sigillaria* applies to the stem, which, however, when old and partly decorticated has been called *Syringodendron*, while its woody cylinder has often been described under the name *Diploxylon*. This naming of portions of plants, however objectionable, is often not to be avoided; for detached organs constantly have to be described long before their relation to other parts is established—which, indeed, may never be accomplished. For example, the form and structure of *Stigmaria* have long been well known, but it has so far proved impossible to determine which Stigmariæ belonged to the genus *Sigillaria* and which to *Lepidodendron*. The correct piecing together of the fragmentary remains is one of the first problems of the palæobotanist, and the gradual disappearance of superfluous names affords a fair measure of the progress of his science. The recent advance of fossil botany has depended in a very great degree on the study of petrified specimens with their structure preserved; so far, at least, as the older strata are concerned, it is, as a rule, only with the help of specimens showing structure that any safe conclusions as to the affinities of fossil plants can be arrived at.

The subject of coal is treated elsewhere (see COAL, *Ency. Brit.* vol. vi.). Here it need only be said that the masses of vegetable substance, more or less carbonized and chemically altered, of which coal is composed, frequently contain cells and fragments of tissue in a condition recognizable under the microscope, as for example spores (sometimes present in great quantities), elements of the wood, fibres of the bark, &c. These remnants, however, though interesting as revealing something of the sources of coal, are too fragmentary and imperfect to be of any botanical importance. In lignite, on the other hand, the organized structure is sometimes excellently preserved. In the Wealden of Belgium, for example, specimens of Ferns and Coniferæ occur, in the form of lignite, which can be sectioned, like recent plants, with a razor, and exhibit an almost unaltered structure.

I. Palæozoic.

The present section is concerned with the botany of the Palæozoic age, from the oldest rocks in which vegetable remains have been found up to the close of the Permian period. The Glossopteris flora of India and the southern hemisphere, the age of which has been disputed, but is often regarded as Permo-Carboniferous, is, however, dealt with in the succeeding section, in connexion with the Mesozoic floras. The various groups of plants represented in the Palæozoic rocks will first be considered in systematic order, after which some account will be given of the succession and distribution of the various floras during the period.

In dealing with the plants of such remote epochs, the relative importance of the various groups, so far as they are known to us, is naturally very different from that which they assume at the present day. There is no evidence that the Angiospermous flowering plants, now the dominant class, existed during the Palæozoic period; they do not appear till far on in the Mesozoic epoch, and their earlier history is as yet entirely unknown. On the other hand, Gymnosperms were abundant, though belonging almost entirely to families now extinct, while the Pteridophyta attained a development far exceeding in every respect anything that they can now show. Among the lower classes of plants we have scarcely any knowledge of Palæozoic Bryophyta; Fungi were probably abundant, but their remains give us little information; while well characterized specimens are scanty among the Algæ, which, however, are better represented.

Algæ. With few exceptions, the remains of Palæozoic Algæ are of comparatively little botanical interest. A vast number of "species" have been described, but, as has been said, "by far the greater number of the supposed fossil Algæ have no claim to be regarded as authentic records of this class of Thallophytes" (Seward, 1898). The investigations of Nathorst, Williamson, and others have shown that a very large proportion of the casts and impressions attributed to Algæ had in all probability a totally different origin. Some represent the tracks or burrows of worms, crustaceans, or other animals; others, the course of rills of water on a sandy or muddy shore; others, again, the marks left on the bottom by bodies drifted along by the waves. In cases of doubt, evidence may be obtained from traces of organic structure, from the presence of carbonaceous matter, or, as Zeiller has pointed out, by the remains of animals such as Bryozoa being attached to the cast, showing that it represents a solid body and not a mere cavity or furrow. Evidence from traces of organization is alone conclusive; the presence of carbonaceous matter, though a useful indication, may be deceptive, for the organic substance may have been derived from other sources than the body which left the impression. The mere external form of the supposed Algæ is rarely so characteristic as to afford satisfactory evidence of their nature. Some of the better-attested examples, among which are a few of considerable interest, may now be considered. Of Cyanophyceæ, as we should expect, the Palæozoic remains are very doubtful. *Gloioconis*, found by Renault in a coprolite of Permian age, is regarded by him as a Cyanophycean allied to *Glœocapsa*; this may be so, but the argument which he draws from the absence of nuclei, considering the extreme rarity of recognizable nuclei even in the best-preserved fossil tissues, can hardly be taken seriously. *Girvanella*, found in Cambrian, Ordovician, and Silurian rocks, as well as in later deposits, appears to have played a part in the origination of oölitic rock-structure. It consists of minute interwoven tubular filaments, and has been variously interpreted as possibly representing the sheaths of a Cyanophycean Alga, and as constituting a Siphoneous thallus of the type of the Codieæ. The non-cellular order Siphoneæ is fairly well represented in Palæozoic strata, especially by calcareous verticillate forms referable to the family Dasycladeæ; the separate tubular joints of the articulated thallus, bearing the prints of the whorled branches, are sometimes cylindrical (*Arthroporella*, *Vermiporella*, &c.), sometimes oval (*Sycidium*) or spherical (*Cyclocrinus*). These forms, and others like them, go back to the Silurian and Ordovician; while *Gyroporella*, from the Permian, is another fairly characteristic Siphoneous type. There can be no doubt that the verticillate Siphoneæ, a group much isolated among recent organisms, are among the most ancient families of plants. The gigantic *Nematophycus*, to be described below, has been regarded as having Siphoneous affinities. Little trace of Confervaceæ has been found; *Confervites chantransioides*, apparently consisting of branched cellular filaments, may perhaps represent a Cambrian Confervoid. *Cladiscothallus*, from the Culm of Russia, in which the filaments are united to form hemispherical or globular tufts, has been compared by Renault to a *Chætophora*. This is one of the somewhat doubtful Algæ occurring in boghead coal or torbanite, a carbonaceous rock the nature of which has been much disputed, in the law courts as well as in scientific literature. The boghead of Scotland, Autun, and New South Wales is regarded by Renault and Bertrand as mainly composed of gelatinous Algæ (*Pila* and *Reinschia*), having a hollow, saccate thallus formed of a single layer of cells. It is difficult to believe that a body containing 65 per cent. of carbon can be so largely made up of gelatinous Algæ in a comparatively little altered condition; even the organic nature of the supposed thalli is not absolutely beyond doubt. Scarcely anything is known of Palæozoic Florideæ; *Solenopora*, ranging from the Ordovician to the Jurassic, resembles, in the structure of its thallus, with definite zones of growth, Corallinaceæ such as *Lithothamnion*, and may probably be of the same nature. A branched filamentous organism from the Lower Carboniferous of Scotland, described by Kidston under the name of *Bythotrephis worstoniensis*, shows some remains of cellular structure, and may probably be a true Alga, resembling some of the filamentous Florideæ in habit.

Apart from the multitude of supposed fossil Algæ described as "Fucoids," but usually not of Algal nature, and never presenting determinable characters, very little remains that can be referred to Palæozoic Brown Algæ. The most striking of all fossil Algæ, however, *Nematophycus*, may possibly be a Phæophycean. The first species of the genus, *Nematophycus Logani*, was discovered by Dawson in 1856 in the Lower and Middle Devonian of Canada, and was described by him as a Conifer under the name of *Prototaxites*. Carruthers, however, in 1872 established its Algal nature, and gave it the more appropriate name of *Nematophycus*. In *N. Logani* the stem, which is found in a silicified state, may be as much as 3 feet in diameter. The tissue is made up of large, unseptate, occasionally branching tubes, with an undulating vertical course, among which much smaller tubes are irregularly interwoven. Radially placed gaps in the tissue (erroneously interpreted at first as medullary rays, but subsequently more aptly compared to the air-spaces of large Algæ) contain very sparse hyphæ, which here branch more freely than elsewhere. The concentric rings of growth, which form a characteristic feature, are due to periodic variations in the size of the larger tubes. Transverse septa have occasionally, but rarely, been detected in the smaller hyphæ. Penhallow maintains that these smaller tubes arise as branches from the larger, but other observers have failed to confirm this. In *N. Storriei*, from the Silurian (Wenlock) of South Wales, described by Barber, there is no sharp differentiation of the two kinds of tubes; they are rarely observed to branch, except in the gaps, which in this species are not radially directed. In *N. Ortoni* (Penhallow), from the Devonian of Canada, the tubes are quite uniform, and there are no spaces or concentric rings. The tubes have their cavity dilated at intervals, and Penhallow has therefore compared them with the trumpet-hyphæ of Laminariaceæ, but no transverse septa are anywhere visible. Several other species have been described. Carruthers compared the usually non-cellular structure of *Nematophycus* with that of Siphoneæ such as *Halimeda*, while recognizing the points of resemblance to Laminariaceæ (*e.g.*, *Lessonia*) in the dimensions of the stem and its concentric rings of growth. Later writers, influenced by the occasional occurrence of transverse walls in the smaller hyphæ, have laid more stress on Laminariaceous affinities. The existence of these gigantic Algæ in Palæozoic times, attested by such well-preserved specimens, is a fact of great interest, though their systematic position is still an open question. *Pachytheca*, a spherical organism, usually about the size of a small pea, found in rocks of Silurian and Devonian age, has been much investigated and discussed, without any decisive light having been thrown on its nature. It was once regarded as connected with *Nematophycus* (with which it sometimes occurs in association), possibly as its fructification. For this view, however, there is no evidence, though the tissues of the two fossils are somewhat similar. *Pachytheca* is formed of cellular filaments resembling those of a *Cladophora*, irregularly interwoven in the central region, radiating towards the periphery, and often forked. In one case the spherical thallus was found seated in a cup-like receptacle. There can be little doubt of the Algal nature of the fossil, but beyond this it is impossible at present to carry its determination.

On the whole, it cannot be said that the Palæozoic remains have as yet thrown much light on the evolution of the Algæ, though we may not be prepared to maintain, with Zeiller, that plants of this class appear never to have assumed a form very different from that which they present at the present day.

Bacteria. The first evidence for the existence of Palæozoic Bacteria was obtained in 1879 by Van Tieghem, who found that in silicified vegetable remains from the Coal Measures of St Étienne the cellulose membranes showed traces of subjection to butyric fermentation, such as is produced at the present day by *Bacillus Amylobacter;* he also claimed to have detected the organism itself. Since that time a number of fossil Bacteria, mainly from Palæozoic strata, have been described by Renault, occurring in all kinds of fossilized vegetable and animal débris. The supposed *Micrococci* present little that is characteristic; the more definite, rod-like form of the *Bacilli* offers a better means of recognition, though far from an infallible one; in a few cases dark granules, suggestive of endospores, have been found within the rods. On the whole, the occurrence of Bacteria in Palæozoic times—so probable *à priori*—may be taken as established, though the attempt to discriminate species among them is probably futile.

Fungi. Fungi were no doubt abundant among Palæozoic vegetation. In examining the tissues of fossil plants of that epoch, nothing is more common than to meet with mycelial hyphæ in and among the cells; in many cases the hyphæ are septate, showing that the higher Fungi (Mycomycetes), as distinguished from the more algoid Phycomycetes, already existed. An endophytic Fungus of the latter group (*Peronosporites antiquarius,* W. Smith) bears very definite terminal, or intercalary, spherical vesicles, which may probably be regarded as reproductive organs—either oögonia or sporangia. A minute Fungus bearing sporangia, found by Renault in the wood of a *Lepidodendron,* and named by him *Oöchytrium lepidodendri,* is referred with much probability to the Chytridineæ. Small spores, almost certainly those of Fungi, are very common in the petrified tissues of Palæozoic plants. Spherical sacs, bearing forked spines, described by Williamson under the name of *Zygosporites,* are frequent, usually in an isolated state. Mr Seward, however, has found a Zygosporites *in situ,* terminating an apparently fungal hypha: he suggests a possible comparison with the mould *Mucor.* Bodies closely resembling the perithecia of Sphæriaceous Fungi have often been observed on impressions of Palæozoic plants, and may probably belong to the group indicated. Conceptacles containing spores, and strongly suggesting the perithecia of some Pyrenomycetous Fungus, have recently been found, in petrified material, on the leaves of an *Alethopteris,* which appears to have undergone decay before fossilization set in. The few and incomplete data which we at present possess as to Palæozoic Fungi do not as yet justify any inferences as to the evolution of these plants. The writer is not aware of any evidence for the occurrence of Palæozoic Lichens.

Bryophyta. The important class of the Bryophyta, which, on theoretical grounds, is commonly regarded as more primitive than the Pteridophyta, is as yet scarcely represented among known fossils of Palæozoic age. In the Lower Carboniferous of Scotland Mr Kidston has found several specimens of a large dichotomous thallus, with a very distinct midrib; the specimens, referred to the provisional genus *Marchantites,* much resemble the larger thalloid Liverworts. Similar fossils have been described from still older rocks. In one or two cases Palæozoic plants, resembling the true Mosses in habit, have been discovered; the best example is the *Muscites polytrichaceus* of Renault and Zeiller, from the Coal Measures of Commentry. In the absence, however, both of reproductive organs and of anatomical structure, it cannot be said that there is at present conclusive evidence for the existence of either Hepaticæ or Musci in Palæozoic times.

Pteridophyta. Our knowledge of the Vascular Cryptogams of the Palæozoic period is more extensive than of any other class of plants, and in fact it is here that the evidence of Palæontology first becomes of essential importance to the botanist. They extend back through the Devonian, possibly to the Silurian system, but the systematic summary now to be given is based primarily on the rich materials afforded by the Carboniferous and Permian formations, from which our detailed knowledge of Palæozoic plants has been chiefly derived.

In addition to the three classes, Equisetales, Lycopodiales, and Filicales, under which recent Pteridophytes naturally group themselves, a fourth class, Sphenophyllales, existed in Palæozoic times, related to the Horsetails on the one side and to the Club-mosses on the other, but with peculiarities of its own demanding an independent position. We further find that, whereas the Ferns of the present day form a well-defined and even isolated class, this was not the case at the time when the Primary rocks were deposited. A considerable number of Palæozoic plants, showing evident affinity to Ferns, have proved to exhibit at the same time characters common to Gymnosperms, especially Cycads. This interesting group of plants will be treated as an appendix to the Filicales, under Potonié's name of Cycadofilices. The arrangement which we shall adopt for the Palæozoic Pteridophyta is therefore as follows:—

I. *Equisetales.*
II. *Sphenophyllales.*
III. *Lycopodiales.*
IV. *Filicales,* with the *Cycadofilices.*

The last-named group appears to form the natural transition to the Gymnosperms which follow. We must bear in mind that throughout the Palæozoic period, and indeed far beyond it, Vascular plants, so far as the existing evidence shows, were represented only by the Pteridophyta and Gymnosperms. Although the history of the Angiosperms may probably go much farther back than present records show, it is certain that they played no considerable part in Palæozoic vegetation. Consequently, the Pteridophytes and Gymnosperms had the field to themselves, so far as regards the higher plants, and filled places in nature which have now for the most part been seized on by families of more modern origin. Hence it is not surprising to find that the early Vascular Cryptogams were, beyond comparison, more varied and more highly organized than their displaced and often degraded successors. It is among the fossils of the Palæozoic rocks that we first learn the possibilities of Pteridophytic organization.

I. *Equisetales.*—This class, represented in the recent Flora by the single genus *Equisetum,* with about twenty species, was one of the dominant groups of plants in Carboniferous times. The Calamarieæ, now known to have been the chief Palæozoic representatives of the Horsetail stock, attained the dimensions of trees, reaching, according to Grand' Eury, a height of from 30 to 60 metres, and show in all respects a higher and more varied organization than their recent successors.

Their remains occur in three principal forms of preservation: (1) carbonaceous impressions of the leafy branches, the fructifications, and other parts; (2) casts of the stem; these are usually internal, or *medullary* casts, as described above. Around the cast the organic tissues may be represented by a carbonaceous layer, on the outer surface of which the external features, such as the remains of leaves, can sometimes be traced. More usually, however, the carbonaceous film is thin, and merely shows the impress of the medullary cast within; (3) petrified specimens of all parts—stem, roots, leaves, and fructifications—showing the internal structure, more or less perfectly preserved. The correlation of these various remains presents considerable difficulties. Casts surrounded by wood, with its structure preserved, have sometimes been found, and have established their true relations. The position of the branches is shown both on casts and in petrified specimens, and has helped in their identification, while the petrified remains sometimes show enough of the external characters to allow of their correlation with impressions. Fructifications have often been found in connexion with leafy shoots, and the anatomical structure of the axis in sterile and fertile specimens has proved a valuable means of identification.

In **habit** the Calamarieæ appear to have borne, on the whole, a general resemblance to the recent Equisetaceæ, in spite of their enormously greater bulk. The leaves were constantly in whorls, and were usually of comparatively small size and of simple form. In the oldest known Calamarian, however, *Archæocalamites* (Devonian and Lower Carboniferous), the leaves were repeatedly forked. There is evidence that in some, at least, of the Calamarieæ the leaves of each verticil were united at the base to form a sheath. The free lamina, however, was always considerably more developed than in the recent family; in form it was usually linear, or narrowly lanceolate. Different genera have been founded on leaf-bearing branches of Calamarieæ; apart from *Archæocalamites*, already mentioned, and *Autophyllites* (Grand' Eury), in both of which the leaves were dichotomous, we have *Annularia*, *Asterophyllites*, and *Calamocladus* (in Grand' Eury's limited sense), with simple leaves. In some species of *Annularia* the extremely delicate ultimate twigs, bearing whorls of small lanceolate leaves, give a characteristic habit, suggesting that they may have belonged to herbaceous plants; other Annulariæ, however, have been traced with certainty into connexion with the stems of large Calamites. In *Asterophyllites*, the generic distinction of which from *Annularia* is not always clear, the narrow linear leaves are in crowded whorls, and the ultimate branches distichously arranged; in the *Calamocladus* of Grand' Eury—characteristic of the Upper Coal Measures—the whorls are more remote, and the twigs polystichous in arrangement. In all these groups a leaf-sheath has been recognized.

The distribution of the branches on the main stem shows considerable variations, on which genera or sub-genera have been founded by C. E. Weiss. In *Archæocalamites*, which certainly deserves generic rank, the branches may occur on every node, but only in certain parts of the stem; the ribs of successive internodes do not alternate, but are continuous, indicating that the leaves were superposed. Using *Calamites* as a generic name for all those Calamarian stems in which the ribs alternate at the nodes, we have, on Weiss's system, the following sub-genera:—*Stylocalamites*, branches rare and irregularly arranged; *Calamitina*, branches in regular verticils, limited to certain nodes, which surmount specially short internodes; *Eucalamites*, branches present on every node. These distinctions can be recognized on petrified specimens, as well as on the casts, but their taxonomic value is somewhat doubtful. In many Calamites there is evidence that the aërial stem sprang from a horizontal rhizome, as in the common species *C.* (*Stylocalamites*) *Suckowi*; in other specimens the aërial stem had an independent, rooting base.

The **anatomical structure** of all parts of the plant is now known, in various Calamarieæ, thanks more especially to the work of Williamson in England and of Renault in France. The stem has a structure which may be briefly characterized as that of an *Equisetum* with secondary growth in thickness (Fig. 1, Plate). The usually fistular pith is surrounded by a ring of collateral vascular bundles (see ANATOMY OF PLANTS, and PTERIDOPHYTA), each of which, with rare exceptions, has an intercellular canal at its inner edge containing the disorganized spiral tracheæ, just as in the recent genus. The cortex is often preserved; in certain cases it was strengthened by hypodermal strands of fibres, as in *Equisetum*. It is only in the rare cases where a very young twig is preserved that the primary structure of the stem is found unaltered. In all the larger specimens a broad zone of wood, with its elements in radial series, had been added. This secondary wood, in the true Calamites (*Arthropitys*, Goeppert), has a simple structure comparable to that of the simplest Coniferous woods; it is made up entirely of radial bands of tracheides interspersed with medullary rays. The pitting of the tracheides is more or less scalariform in character, and is limited to the radial walls. In favourable cases remains of the cambium are found on the outer border of the wood, and phloem is also present in the normal position, though it does not seem to have attained any considerable thickness. In the old stems the primary cortex was replaced by periderm, giving rise to a thick mass of bark. The above description applies to the stems of *Calamites* in the narrower sense (*Arthropitys* of the French authors) to which the specimens from the British Coal Measures mostly belong. *Archæocalamites* appears to have had a similar structure, but in some specimens from the Lower Carboniferous of Burntisland, perhaps referable to this genus, centripetal wood was present in the stem. In *Calamodendron* (Upper Coal Measures) the wood has a more complex structure than in *Calamites*, the principal rays including radial tracts of fibrous tissue, in addition to the usual parenchyma. *Arthrodendron* (Lower Coal Measures) approaches *Calamodendron* in this respect. The longitudinal course of the vascular bundles and their relation to the leaves in Calamarieæ generally followed the *Equisetum* type, though more variable and sometimes more complex. The attachment of the branches was immediately above the node, and usually between two foliar traces, as in the recent genus. Where the structure of the leaves is preserved it proves to be of an extremely simple type; the narrow lamina is traversed by a single vascular bundle, separated by a sheath from the surrounding palisade-parenchyma. Stomata of the usual structure have been detected in the epidermis.

The roots (formerly described as a separate genus, *Astromyelon*) were borne directly on the nodes, not on short lateral branches as in *Equisetum*. They are of similar structure in all known Calamarieæ, the main roots having a large pith, while the rootlets had little or none. The structure is in all respects that typical of roots, as shown by the centripetal primary wood, and the alternation of xylem and phloem groups observable in exceptionally favourable young specimens. A striking feature is the presence of large, radiating intercellular cavities in the cortex, suggesting an aquatic habit.

A considerable number of Calamarian **fructifications** are known, preserved, some as carbonaceous impressions, others as petrified specimens, exhibiting the internal structure. In many cases the cones have been found in connexion with branches bearing characteristic Calamarian foliage. Almost all strobili of the Calamarieæ are constructed on the same general lines as those of *Equisetum*, with which some agree exactly; in most, however, the organization was more complex, the complexity consisting in the intercalation of whorls of sterile bracts, between those of the sporangiophores. In several cases heterospory, unknown among recent Equisetaceæ, has been demonstrated in their Palæozoic representatives.

Four main types of structure may be distinguished among Calamarian strobili.

1. *Calamostachys*, Schimper. Here the whorls of peltate sporangiophores alternate regularly with those of sterile bracts, the former being inserted on the axis midway between the latter (Fig. 2). The sporangiophores, which are usually half as numerous in each verticil as the bracts, have the same form as in *Equisetum*, but each bears four sporangia only. The spores are frequently found to be still united in tetrads. In some species, *e.g.*, the British *C. binneyana*, numerous specimens have been examined and only one kind of spore observed; here, then, there is a strong presumption that the species was homosporous. In other cases, however, *e.g.*, *C. casheana*, Will., two kinds of spore occur, in different sporangia, but on the same strobilus and even on the same sporangiophore. The megaspores, of which there are many in the megasporangium, have a diameter about three times that of the microspores. The abortion of certain spores, which is known to have taken place both in the homosporous *C. binneyana* and in the megasporangia of *C. casheana*, may throw some light on the origin of the heterosporous condition. The bracts were sometimes coherent in their lower part (*e.g.*, *C. binneyana*), sometimes free (*e.g.*, *C. Lugwigi*); in all cases their free extremities formed a protection to the fertile whorl above. In some Continental species (*e.g.*, *C. Grand' Euryi*, Ren.) radial membranous plates hung down from each verticil of bracts, forming compartments in which the subjacent sporangiophores were enclosed. The anatomy of the axis is essentially similar to that of a young Calamarian twig, with some variations in detail. Strobili of the *Calamostachys* type occur in connexion both with *Annularia* and *Asterophyllites* foliage.

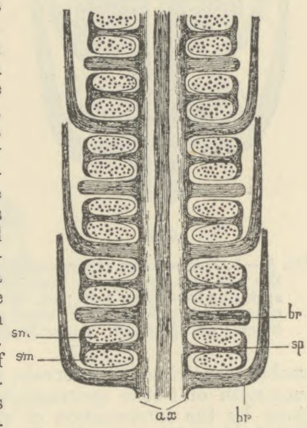


FIG. 2.—*Calamostachys.* Diagrammatic longitudinal section of the cone, showing the axis (*ax*) bearing alternate whorls of bracts (*br*) and peltate sporangiophores (*sp*) with their sporangia (*sm*). The upturned tips of the bracts are only shown in every alternate verticil.

2. *Palæostachya*, Weiss. Here, as in the previous genus, sterile and fertile verticils are ranged alternately on the axis of the cone. The only difference is that in *Palæostachya* the sporangiophores, instead of standing midway between the whorls of bracts, are inserted immediately above them, springing, as it were, from the axil of the sterile verticil (Fig. 3, A). This singular arrangement suggests doubts as to the correctness of the current interpretation of the Equisetaceous sporangiophore as a modified leaf (cf. *Cheirostrobus* below). In all other respects the two genera agree; there is evidence for the occurrence of heterospory in some strobili referred to *Palæostachya*. The anatomy of the axis is that of a young branch of a Calamite. According to Grand' Eury, the *Palæostachya* fructification was most commonly associated with *Asterophyllites* foliage. The external aspect of a *Palæostachya* is shown in Fig. 4 (Plate).

3. *Equisetum* type of strobilus. In certain cases the strobili of Palæozoic Calamarieæ appear to have had essentially the same organization as in the recent genus, the axis bearing sporangio-

phores only, without intercalated bracts. It is remarkable that fructifications of this kind have been found by Renault in close association with the most ancient of the Calamarieæ—*Archæocalamites.* In these strobili the peltate scales, like the vegetative leaves of the plant, are in superposed verticils; each appears to have borne four sporangia (Fig. 3, B). Other cones, however, namely, those known as *Pothocites*, have also been attributed on good grounds to the genus *Archæocalamites;* they are long

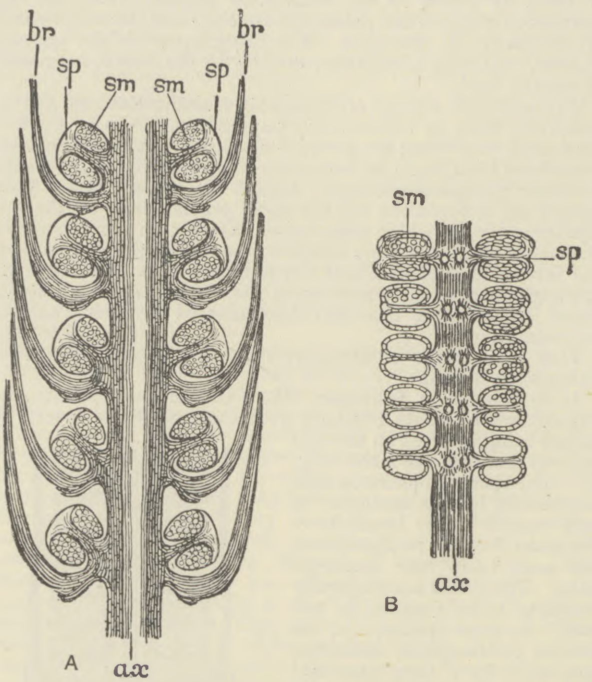


FIG. 3.—A, *Palæostachya.* Diagrammatic longitudinal section of cone, showing the axis (*ax*) bearing the bracts (*br*) with peltate sporangiophores (*sp*) springing from their axils; *sm*, sporangia. B, *Archæocalamites.* Part of cone, showing the axis (*ax*) bearing peltate sporangiophores (*sp*) without bracts; *sm*, sporangia. (*After Renault.*) (*Scott*, "*Studies.*")

strobili, constricted at intervals, and it is probable that here the succession of fertile sporangiophores was interrupted here and there by the intercalation of sterile bracts. Cones from the Middle Coal Measures, described by Kidston under the name of *Equisetum Hemingwayi*, but probably belonging to one of the Calamarieæ, bear a striking external resemblance to those of a recent *Equisetum.*

4. *Cingularia*, Weiss. This form of strobilus, from the Coal Measures of Germany, is imperfectly known, and its relation to Calamarieæ not beyond doubt. In the lax strobili the sporangiophores, which are not peltate, but strap-shaped, were borne, according to Weiss, immediately *below* the verticils of bracts, the position thus being the reverse of that in *Palæostachya.*

The Palæozoic Calamarieæ, though so far surpassing recent Equisetaceæ, both in stature and complexity of organization, clearly belonged to the same class of Vascular Cryptogams. There is no satisfactory evidence for attributing Phanerogamic affinities to any members of the group, and the view, of which Williamson was the chief advocate, that they form a homogeneous Cryptogamic family, is now fully established.

II. *Sphenophyllales.*—The class of *Sphenophyllales*, as known to us at present, is of limited extent, embracing the two genera *Sphenophyllum* and *Cheirostrobus*, which may serve as types of two families within the class. The characters of *Sphenophyllum* are known with some completeness, while our knowledge of *Cheirostrobus* is confined to the fructification; the former will therefore be described first.

1. *Sphenophyllum.*—The genus *Sphenophyllum*, of which a number of species have been described, ranging probably from the Middle Devonian, through the Carboniferous, to the Permian, consisted of herbaceous plants of moderate dimensions. The long, slender stems, somewhat tumid at the nodes, were ribbed, the ribs running continuously through the nodes, a fact correlated with the superposition of the whorled leaves, the number of which in each verticil was some multiple of 3, and usually 6. In the species on which the genus was founded the leaves, as the generic name implies, are cuneate, entire, or toothed on their anterior margin;[1] in other cases they are deeply divided by dichotomy into narrow segments, or the whorl consists of a larger number (up to 24) of apparently simple, linear leaves, which may represent the segments of a smaller number. The different forms of leaf may occur on the same plant, the deeply divided foliage often characterizing the main stem, while the cuneate leaves were borne on lateral shoots. A comparison, formerly suggested, with the two forms of leaf in Batrachian Ranunculi has not proved to hold good; the idea of an aquatic habit is contradicted by the anatomical structure, and the hypothesis that the plants were of scandent growth is more probable. The species of *Sphenophyllum* have a graceful appearance, which has been compared with that of the trailing Galiums of hedgerows. Branches sprang from the nodes, though perhaps not truly axillary in position. The cones, more or less sharply differentiated, terminated certain of the branches.

The anatomy of the stem of *Sphenophyllum*, investigated by Renault, Williamson, and others, is highly characteristic (Fig. 5, Plate). The stem is traversed by a single stele, with solid wood, without pith; the primary xylem is triangular in section, the spiral elements forming one or two groups at each angle, while the phloem occupied the bays, so that the structure resembles that of a triarch root. The leaf-trace bundles started from the angles of the stele, and forked, in passing through the cortex, to supply the veins of the leaf, or its subdivisions. The cortex was deeply furrowed on its outer surface. The primary structure is only found unaltered in the youngest stems; secondary growth by means of a cambium set in very early, xylem being formed internally and phloem externally in a perfectly normal manner. At the same time a deep-seated periderm arose, by which the primary cortex was soon entirely cut off. The secondary wood in the Lower Carboniferous species, *S. insigne*, has scalariform tracheides, and is traversed by regular medullary rays, but in the forms from later horizons the tracheides are reticulately pitted, and the rays are for the most part replaced by a network of xylem-parenchyma. There are no recent stems with a structure like that of *Sphenophyllum;* so far as the primary structure is concerned, the nearest approach is among the *Psiloteæ*, with which other characters indicate some affinity. The diarch roots of a *Sphenophyllum* have been described by Renault, who has also investigated the leaves; they were strongly constructed mechanically, and traversed by slender vascular bundles branching dichotomously.

Fructification.—Williamson thoroughly worked out, in petrified specimens, the organization of a cone which he named *Bowmanites Dawsoni;* it was subsequently demonstrated by Zeiller that this fructification belonged to a *Sphenophyllum*, the cones of the well-known species *S. cuneifolium* having a practically identical structure. The type of fructification described by Williamson and now named *Sphenophyllum Dawsoni* consists of long cylindrical cones, in external habit not unlike those of some Calamarieæ. The axis, which in structure resembles the vegetative stem in its primary condition, bears numerous verticils of bracts, those of each verticil being coherent in their lower part, so as to form a disc or cup from the margin of which the free limbs of the bracts arise. The sporangia, which are about twice as numerous as the bracts, are seated singly on pedicels or sporangiophores springing from the upper surface of the bract-verticil, near its insertion on the axis (Fig. 6). As a rule two sporangiophores belong to each bract. The sporangium is attached to the enlarged distal end of its pedicel, from which it hangs down, so as to suggest an anatropous ovule on its funiculus. Dehiscence appears to have taken place at the free end of the sporangium; the spores are numerous, and, so far as observed, of one kind only. Each sporangiophore is traversed throughout its length by a vascular bundle connected with that which supplies

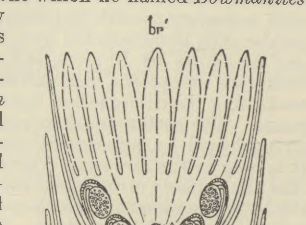


FIG. 6.—*Sphenophyllum Dawsoni.* Diagram of cone in longitudinal section. *ax*, axis; *br*, bracts; *sp*, sporangiophores, each bearing a sporangium, *sm*; *br'*, whorl of bracts in surface view.

[1] Sometimes the leaves in a whorl were of unequal size; see Fig. 3 (Mesozoic).

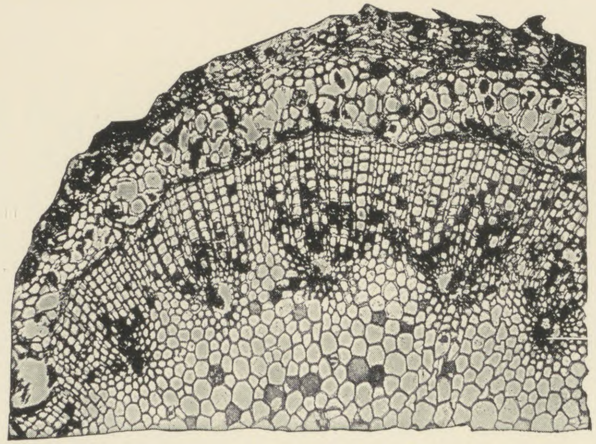


FIG. 1.—*Calamites.* Part of transverse section of a young stem, showing pith, vascular bundles with secondary wood, and cortex. × about 40. *From a photograph (Scott, "Studies").*

FIG. 5.—*Sphenophyllum insigne.* Transverse section of stem, showing triangular primary wood secondary wood, remains of phloem, and primary cortex. × about 30. *From a photograph (Scott, "Studies").*

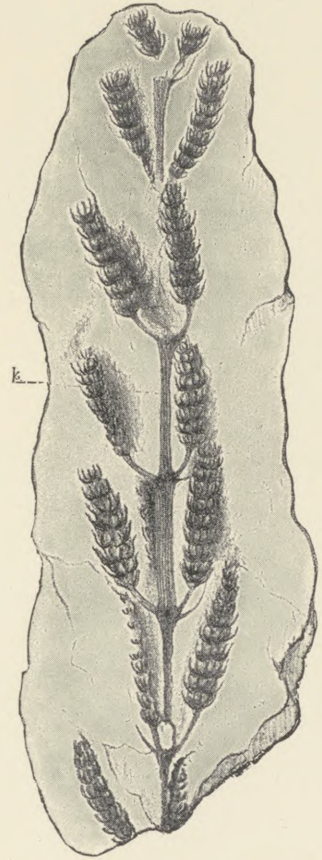


FIG. 4.—*Palæostachya pedunculata.* Fertile shoot, bearing numerous cones and a few leaves. $\frac{2}{3}$ of nat. size. *After Williamson (Scott, "Studies").*

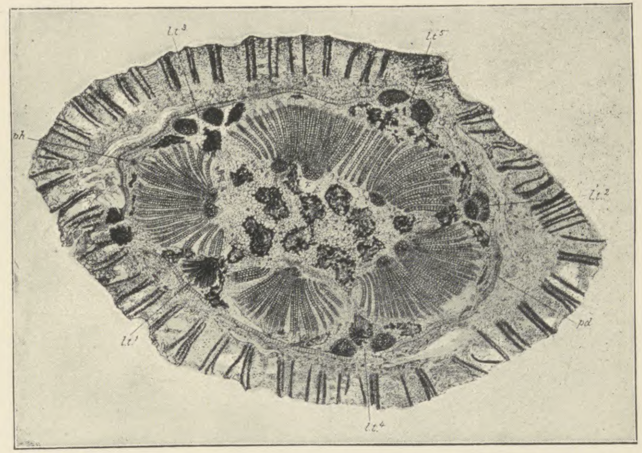


FIG. 18.—*Lyginodendron oldhamium.* Transverse section of stem, showing the pith containing groups of sclerotic cells, the primary xylem-strands, secondary wood and phloem, pericycle, and cortex. lt^1-lt^5, leaf-traces, numbered according to the phyllotaxis, lt^5 belonging to the lowest leaf of the five; *ph*, a group of primary phloem; *pd*, periderm, formed from pericycle. × 3.

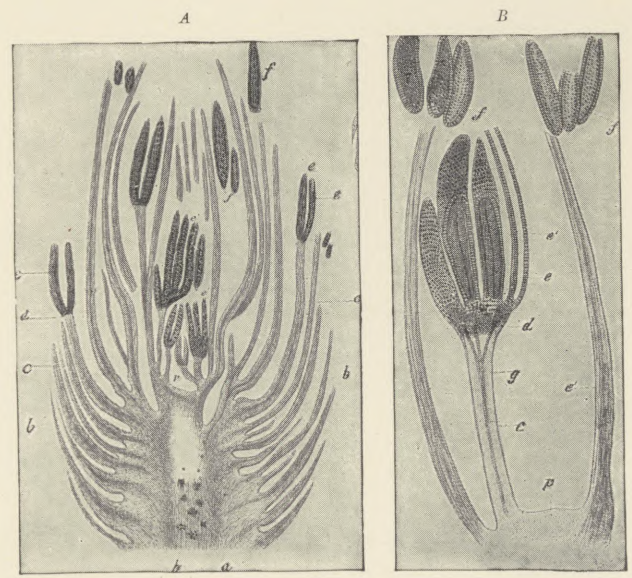


FIG. 20.—*Cordaianthus Penjoni.* *A*, Male catkin in longitudinal section: *a*, axis; *b*, bracts; *c*, *d*, filaments of stamens, bearing the pollen-sacs (*e* and *f*) at the top; *v*, apex of axis. × 6½. *B*, Stamens more highly magnified: *g*, vascular bundle of filament; *e*, pollen-sac after dehiscence. × 23. *After Renault (Scott, "Studies").*

the subtending bract. This form of fructification appears, from Zeiller's researches, to have been common to several species of *Sphenophyllum*, but others show important differences. Thus *Bowmanites Römeri*, a fructification fully investigated by Solms-Laubach, differs from *S. Dawsoni* in the fact that each sporangiophore bears two sporangia, attached to a distal expansion approaching the peltate scale of the Equisetales. It is thus proved that the sporangiophore is not a mere sporangial stalk, but a distinct organ, in all probability representing a ventral lobe of the subtending bract. In *Sphenophyllum majus*, where the cones are less sharply defined, the forked bract bears a group of four sporangia, but their mode of insertion has not yet been made out.

2. *Cheirostrobeæ.*—The family *Cheirostrobeæ* is only known from a petrified fructification (*Cheirostrobus pettycurensis*) derived from the Lower Carboniferous of Burntisland in Scotland. The excellence of the preservation has, however, rendered it possible to investigate the complex structure in detail. The cone is of large size—3·5 cm. in diameter; the stout axis bears numerous whorls of compound sporophylls, the members of successive verticils being superposed. The sporophylls, of which there are twelve in a whorl, are each composed of six segments, three being inferior or dorsal, and three superior or ventral. The dorsal segments are sterile, corresponding to the bracts of *Sphenophyllum Dawsoni*, while the ventral segments constitute peltate sporangiophores, each bearing four sporangia, just as in a Calamarian fructification (Fig. 7). The great length and

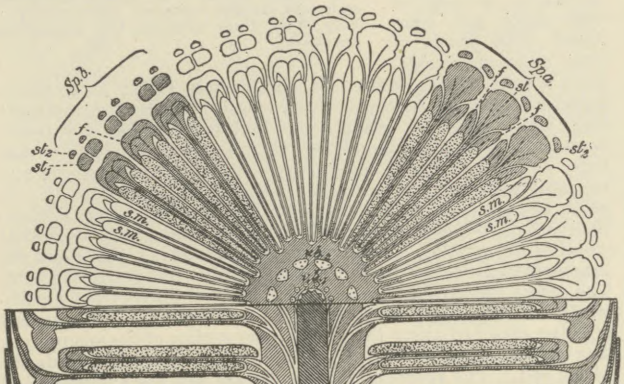


FIG. 7.—*Cheirostrobus.* Diagram of cone, the upper part in transverse, the lower in longitudinal section. In the transverse section six sporophylls, each showing three segments, are represented. *Sp.a*, section through sterile segments; *Sp.b*, section through sporangiophores; *st*, laminæ of sterile segments; *f*, peltate expansions of sporangiophores; *sm*, sporangia; *v.b*, vascular bundles; *cy*, stele of axis (*Ax*). In the longitudinal section the corresponding parts are shown. (Scott, "*Studies.*")

slender proportions of the segments give the cone a peculiar character, but the relations of position appear to leave no doubt as to the homologies with the fructification of Sphenophylleæ; as regards the sporangiophores, *Bowmanites Römeri* occupies exactly the middle place between *S. Dawsoni* and *Cheirostrobus*. The axis of the cone in *Cheirostrobus* contains a dodecarch stele, with solid wood, from the angles of which vascular bundles pass out, dividing in the cortex, to supply the various segments of the sporophylls. In the peduncle of the strobilus secondary tissues are formed. While the anatomy has a somewhat Lycopodiaceous character, the arrangement of the appendages is altogether that of the Sphenophylleæ; at the same time Calamarian affinities are indicated by the characters of the sporangiophores and sporangia.

The Sphenophyllales as a whole are best regarded as a synthetic group, combining the characters of the Lycopods and Equisetales, while showing marked peculiarities of their own. Among existing plants their nearest affinities would appear to be with the Psiloteæ, as indicated not merely by the anatomy, but much more strongly by the way in which the sporangia are borne. There is good reason to believe that the ventral synangium of the Psiloteæ corresponds to the ventral sporangiophore with its sporangia in the Sphenophyllales. Professor Thomas of New Zealand has brought forward some interesting variations in *Tmesipteris* which appear to afford additional support to this view.

III. *Lycopodiales.*—In Palæozoic ages the Lycopods formed one of the dominant groups of plants, remarkable alike for the number of species and for the great stature which many of them attained. The best known of the Palæozoic Lycopods were trees, reaching 100 feet or more in height, but side by side with these gigantic representatives of the class, small herbaceous Club-mosses, resembling those of the present day, also occurred. Broadly speaking, the Palæozoic Lycopods, whatever their dimensions, show a general agreement in habit and structure with our living forms, though often attaining a much higher grade of organization. We will first take the arborescent Lycopods, as in every respect the more important group. They may all be classed under the one family Lepidodendreæ, which is here taken to include *Sigillaria*.

Lepidodendreæ.—The genus *Lepidodendron*, with very numerous species, ranging from the Devonian to the Permian, consisted of trees, with a tall upright shaft, bearing a dense crown of dichotomous branches, clothed with simple narrow leaves, ranged in some complex spiral phyllotaxis. In some cases the foliage is preserved *in situ;* more often, however, especially in the main stem and larger branches, the leaves had been shed, leaving behind them their scars and persistent bases, on which the characteristic sculpturing of the Lepidodendroid surface depends. The cones, often of large size, were either terminal on certain of the smaller twigs, or borne laterally on special branches of considerable dimensions. In the latter case the cones have left peculiar marks on the fertile branches, for which special genera have been founded. At its base the main stem terminated in dichotomous roots or rhizophores, bearing numerous rootlets. To these underground organs the name *Stigmaria* is applied; they are not clearly distinguishable from the corresponding parts of *Sigillaria*. The numerous described species of *Lepidodendron* are founded on the peculiarities of the leaf-cushions and scars, as shown on casts or impressions of the stem. The usually crowded leaf-cushions are spirally arranged, and present no obvious orthostichies, thus differing from those of *Sigillaria*. Each leaf-cushion is slightly prominent; towards its upper end is the diamond-shaped or triangular scar left by the fall of the actual leaf (Fig. 8). On the scar are three prints, the central one alone representing the vascular bundle, while the lateral prints (*parichnos*) mark the position of merely parenchymatous strands. In the median line, immediately above the leaf-scar, is a print representing the ligule, or rather the pit in which it was seated. On the flanks of the cushion, below the scar, are two superficial prints, perhaps comparable to lenticels. In the genus *Lepidophloios* the leaf-cushions are more prominent than in *Lepidodendron*, and their greatest diameter is in the transverse direction; on the older stems the leaf-scar lies towards the lower side of the cushion. The genus *Bothrodendron*, going back to the Upper Devonian, differs from *Lepidodendron* in its minute leaf-scars and the absence of leaf-cushions, the scars being flush with the smooth surface of the stem. In the Lower Carboniferous of central Russia beds of coal occur consisting of the cuticles of a *Bothrodendron*, which are not fossilized, but retain the consistency and chemical composition of similar tissues in recent plants.

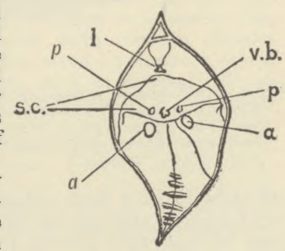


FIG. 8.—Leaf-base of a *Lepidodendron*. *s.c.*, scar left by the leaf; *v.b.*, print of vascular bundle; *p, p*, parichnos; *l*, ligule; *a, a*, superficial prints below scar. (*After Stur.*) (Scott, "*Studies.*")

The **anatomy** of *Lepidodendron* is now well known in a number of species; the Carboniferous rocks of Great Britain are especially rich in petrified specimens, which formed the subject of Williamson's extensive investigations. The stem is in all cases monostelic; in most of the forms the central cylinder underwent secondary growth, and the distinction between primary and secondary wood is very sharply marked. In *L. Harcourtii*, however, the species earliest investigated (by Witham, 1833, and

Brongniart, 1837), no secondary wood has yet been found. The primary wood of *Lepidodendron* forms a continuous cylinder, not broken up into distinct bundles; its development was clearly centripetal, the spiral elements forming more or less prominent peripheral groups. In the larger stems of most species there was a central pith, but in certain of the smaller branches, and throughout the stem in some species (*L. rhodumnense, L. selaginoides*), the wood was solid. A single leaf-trace, usually collateral in structure, passed out into each leaf. The primary structure of the stem was thus of a simple Lycopodiaceous type, resembling on a larger scale what we find in the upright stem of *Selaginella spinosa*. In most species (*e.g., L. selaginoides, L. wunschianum, L. veltheimianum*) secondary growth in thickness took place, and secondary wood was added, in the centrifugal direction, showing a regular radial arrangement, with medullary rays between the series of tracheides (Fig. 9). The tissue thus formed often attained a considerable thickness. While primary phloem can be recognized with certainty in favourable cases, the question of the formation of secondary phloem by the cambium is not yet fully cleared up. In the *Lepidodendron fuliginosum* of Williamson, shown by its

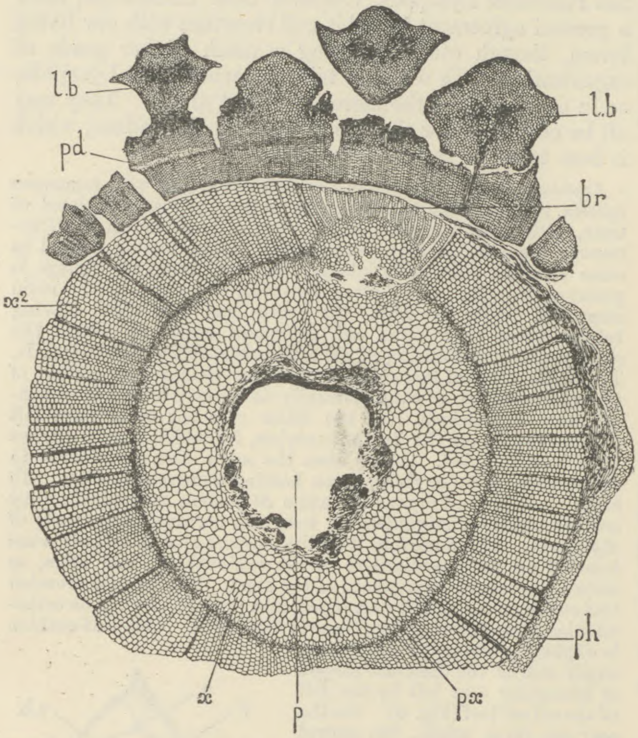


FIG. 9.—*Lepidodendron veltheimianum.* Transverse section of stem. *p*, pith, almost destroyed; *x*, zone of primary wood; *px*, protoxylem; x^2, secondary wood; *ph*, phloem and pericycle; *br*, stele of a branch; *pd*, periderm; *l.b*, leaf-bases. The primary cortex between stele and periderm has perished. ×4½. (*Scott*, "*Studies.*")

leaf-bases to have been a *Lepidophloios*, the secondary wood is very irregular, and consists largely of parenchyma. The occurrence of secondary growth in these plants, demonstrated by Williamson's researches, is a point of great interest. Some analogy among recent Lycopods is afforded by the stem of *Isoëtes*, and by the base of the stem in *Selaginella spinosa;* in the fossils the process was of a more normal type, but some of its details need further investigation. The cortex, often sharply differentiated into sclerotic and parenchymatous zones, is bordered externally by the persistent leaf-bases. The development of periderm was a constant feature, and this tissue attained a great thickness, consisting chiefly of a phelloderm, produced on the inner side of the formative layer.

The most interesting point in the structure of the leaf-base is the presence of a ligule, like that of *Isoëtes* or *Selaginella*, which was seated in a deep pit, opening on the upper surface of the cushion, just above the insertion of the lamina. The latter shows marked xerophytic adaptations; the single vascular bundle was surrounded by a sheath of short tracheides, and the stomata were sheltered in two deep furrows of the lower surface.

The cones of *Lepidodendron* and its immediate allies are for the most part grouped under the name *Lepidostrobus.* These cones, varying from an inch to a foot in length, according to the species, were borne either on the ordinary twigs, or on the special branches (*Ulodendron* and *Halonia*) above referred to. In Ulodendron the large circular, distichously arranged prints appear to have been formed by the pressure of the bases of sessile cones, while in the Halonial branches characteristic of the genus *Lepidophloios* the tubercles mark the points of insertion of pedunculate strobili. The organization of *Lepidostrobus* is essentially that of a Lycopodiaceous cone. The axis, which in anatomical structure resembles a vegetative twig, bears numerous spirally arranged sporophylls, each of which carries a single large sporangium on its upper surface (Fig. 10). The sporophyll, usually almost horizontal in position, has an upturned lamina beyond the sporangium, and a shorter dorsal lobe, so that the form of the whole is somewhat peltate. A ligule is present immediately below the lamina, its position showing that the whole of the elongated horizontal pedicel on which the sporangium is seated, corresponds to the short base of a vegetative leaf. The sporangia, usually of very large size compared with those of most recent Lycopods, have a palisade-like outer wall, and contain either an immense number of minute spores or a very small number of exceedingly large spores (Fig. 10). It is very doubtful whether any homosporous *Lepidostrobi* existed, but there is reason to believe that here, as in the closely allied *Lepidocarpon*, microsporangia and megasporangia were in some cases borne on different strobili. In other species (*e.g.,* in the cone attributed to the Lower Carboniferous *Lepidodendron veltheimianum*) the arrangement was that usual in *Selaginella*, the microsporangia occurring above and the megasporangia below in the same strobilus (diagram, Fig. 10).

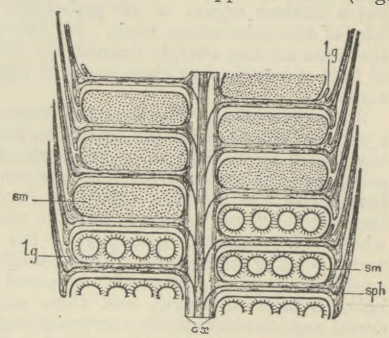


FIG. 10.—*Lepidostrobus.* Diagram of cone, in longitudinal section. *ax*, axis, bearing the sporophylls (*sph*), on each of which a sporangium (*sm*) is seated; *lg*, ligule. The upper sporangia contain numerous microspores; in each of the lower sporangia four megaspores are shown.

The genus *Spencerites* (Lower Coal Measures) differs from *Lepidostrobus* mainly in the insertion of the sporangium, which, instead of being attached along the whole upper surface of the sporophyll, was only connected with it by a small neck of tissue towards the distal end. The spores of this genus are curiously winged, and intermediate in size between the microspores and megaspores of *Lepidostrobus;* the question of homospory or heterospory is not yet decided. A more important deviation from ordinary Lepidostroboid structure is shown by the new genus *Lepidocarpon*, from the English Coal Measures and the Lower Carboniferous of Scotland. In this fructification the organization is at first altogether that of a *Lepidostrobus;* in each megasporangium, however, only a single megaspore came to maturity, occupying almost the whole of the sporangial cavity, but accompanied by the remains of its three abortive sister cells. An integument grew up from the superior surface of the sporophyll, completely enveloping the sporangium, except for a narrow crevice left open along the top. In favourable cases the prothallus is found preserved, within the functional megaspore or embryo-sac, and the whole appearance, especially as seen in a section tangential to the strobilus, is then remarkably seed-like (see diagram, Fig. 11). The seed-like body was detached as a whole from the cone, and in this condition has been known for many years under the name of *Cardiocarpon anomalum*, having been wrongly identified with a true Gymnospermous seed so named by Carruthers. The analogies with a seed are obvious; the chief difference is in the micropyle, which is not tubular, but forms a

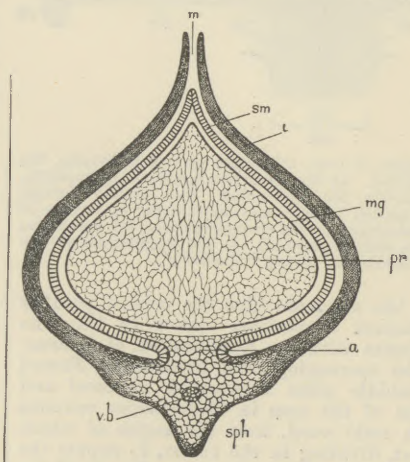


FIG. 11.—*Lepidocarpon Lomaxi.* Diagrammatic section of "seed" in plane tangential to the parent strobilus. *sph*, sporophyll; *vb*, its vascular bundle; *i*, integument; *m*, micropylar crevice; *a*, base, *sm*, wall of sporangium; *mg*, membrane of functional megaspore, which is filled by the prothallus, *pr*.

long crevice, running in a direction radial to the strobilus. *Lepidocarpon* affords a striking instance of homoplastic modification, for there is no reason to suppose that the Lycopods were on the line of descent of any existing Spermophyte. In a male cone, probably belonging to *Lepidocarpon Lomaxi*, the microsporangia are provided with incomplete integuments.

Sigillaria. — The great genus *Sigillaria*, even richer in "species" than *Lepidodendron*, ranges throughout the Carboniferous, but has not yet been detected in earlier rocks. The Sigillariæ, like the Lepidodendra, were large trees, but must have differed from those of the previous group in habit, for they appear to have branched sparingly or not at all, the lofty upright shaft terminating, like some modern *Xanthorrhœa*, in a great sheaf of long, grass-like leaves. The strobili were stalked, and borne on the main stem, among the leaves. The roots, or at least their functional representatives, resembled those of *Lepidodendron.* The chief distinctive character of *Sigillaria* lies in the arrangement of the leaf-scars, which form conspicuous vertical series on the surface of the stem. In one great division of the genus—the Eusigillariæ—the stems are ribbed, each rib bearing a vertical row of leaf-scars; the ribbed Sigillariæ were formerly divided into two sub-genera—*Rhytidolepis*, with the scars on each rib rather widely spaced, and *Favularia*, where they are approximated and separated by transverse furrows, each rib thus consisting of a series of contiguous leaf-bases. This distinction, however, has proved to have no constant taxonomic value, for both arrangements may occur on different parts of the same specimen. The species without ribs — Subsigillariæ — were in like manner grouped under the two sub-genera *Clathraria* and *Leiodermaria*; in the former each scar is seated on a prominent cushion, while in the latter the surface of the stem (as in *Bothrodendron*) is perfectly smooth. Here also the distinction has proved not to hold good, *S. Brardi*, for example, showing both conditions on the same stem. All these names, however, are still in use as descriptive terms. Generally, the Eusigillariæ are characteristic of the older Carboniferous strata, the Subsigillariæ of the Upper Coal Measures and Permian. The leaf-scars throughout the genus show essentially the same prints as in *Lepidodendron*, differing only in details, and here also a ligule was present (Fig. 12).

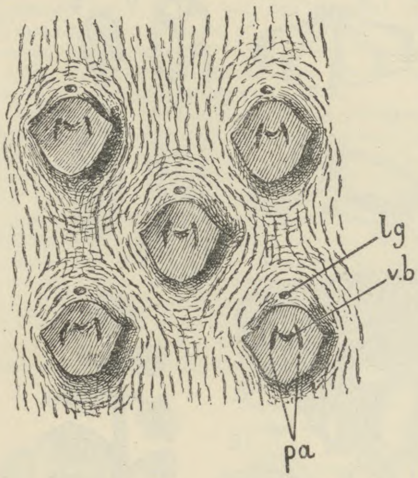


Fig. 12.—*Sigillaria Brardi.* Part of surface of stem, showing five leaf-scars. *vb*, print of vascular bundle; *pa*, parichnos; *lg*, ligule. $\times 1\frac{1}{2}$. (*After Weiss.*) (*Scott*, "*Studies.*")

The **anatomy** of *Sigillaria* is not so well known as that of *Lepidodendron*, for specimens showing structure are rare, a fact which may be correlated with the infrequency of branching in the genus. The structure of a Clathrarian *Sigillaria* (*S. Menardi*), from the Permian of Autun, was accurately described by Brongniart as long ago as 1839, and a similar species, *S. spinulosa* (= *S. Brardi*) was investigated by Renault in 1875, but it was long before we had any trustworthy data for the anatomy of the ribbed forms. This gap in our knowledge has now been partially filled up, owing especially to Bertrand's investigation of a specimen referred by him to *S. elongata*. The structure of the ribbed Sigillariæ, as at present known, essentially resembles that of a medullate *Lepidodendron*, though the ring of primary wood was narrower. Its outer margin was crenulated, the leaf-traces being given off from the middle of each bay. Secondary wood was formed in abundance, precisely as in most species of *Lepidodendron.* In the Subsigillarian species *S. Menardi* the primary wood is broken up into distinct bundles, while in *S. spinulosa* their separation is sometimes incomplete. The secondary cortex or periderm attained a great development, and in some cases shows considerable differentiation. On the whole, the anatomy of *Sigillaria* is closely related to that of the preceding group, and in fact a continuous series can be traced from the anatomically simplest species of *Lepidodendron* to the most modified *Sigillariæ.* The leaves of *Sigillaria* are practically identical in structure with those of *Lepidodendron.*

The nature of the **fructification** of *Sigillaria* was first satisfactorily determined in 1884 by Zeiller, who found the characteristic Sigillarian leaf-scars on the peduncles of certain large strobili (*Sigillariostrobus*). The cones, of which several species have been described, bear a strong general resemblance to *Lepidostrobus*, differing somewhat in the form of the sporophylls and some other details. The megaspores (reaching 2 mm. or more in diameter) were found lying loose on the sporophylls by Zeiller; the sporangia containing them were first observed by Kidston, in a species from the Coal Measures of Yorkshire. That the cones were heterosporous there can be no doubt, though little is known as yet of the microsporangia. The discovery of *Sigillariostrobus*, which was the fructification of Subsigillariæ as well as of the ribbed species, has finally determined the question of the affinities of the genus, once keenly discussed; *Sigillaria* is now clearly proved to have been a genus of heterosporous Lycopods, with the closest affinities to *Lepidodendron.*

Stigmaria.—On present evidence there is no satisfactory distinction to be drawn between the subterranean organs of *Sigillaria* and those of *Lepidodendron* and its immediate allies. These organs, still known by the name *Stigmaria* given them by Brongniart, have been found in connexion with the upright stems both of *Sigillaria* and *Lepidodendron.* In the Coal Measures they commonly occur in the underclay beneath the coal-seams. Complete specimens of the stumps show that from the base of the aërial stem four Stigmarian branches were given off, which took a horizontal or obliquely descending course, forking at least twice. These main Stigmarian axes may be 2 to 3 feet in diameter at the base, and 30 or 40 feet in length. Their surface is studded with the characteristic scars of their appendages or rootlets, which radiated in all directions into the mud. Petrified specimens of the main *Stigmaria* are frequent, and those of its rootlets extraordinarily abundant. The two parts are very different in structure: in the main axis, as shown in the common Coal Measure form *Stigmaria ficoides*, the centre was occupied by the pith, which was surrounded by a zone of wood, centrifugally developed throughout. In other species, however, the centripetal primary xylem is represented. Phloem, surrounding the wood, is recognizable in good specimens; in the cortex the main feature is the great development of periderm. The rootlets, which branched by dichotomy, contain a slender monarch stele exactly like that in the roots of *Isoëtes* and some *Selaginellæ* at the present day. The morphology of *Stigmaria* has been much discussed; possibly the main axes, which do not agree perfectly either with rhizomes or roots, may best be regarded as comparable with the rhizophores of *Selaginella;* the homologies of the appendages with the roots of recent Lycopods appear manifest. It has been maintained by some palæobotanists that the aërial stems of *Sigillaria* arose as buds on a creeping rhizome, but the evidence for this conclusion is as yet unconvincing.

Lycopoditeæ.—Under the name *Lycopoditeæ* are included those Palæozoic Lycopods—for the most part referred to the provisional genus *Lycopodites*—which from their habit appear to have been herbaceous plants; such specimens occur occasionally from the Devonian onwards. While some have uniform spirally arranged leaves, like most species of the recent *Lycopodium*, others have tetrastichous, dimorphic foliage, such as is usually found in *Selaginella*, though it must be remembered that a similar arrangement exists in certain species of *Lycopodium.* In some cases the sporangia of *Lycopodites* have been recognized, borne either on special sporophylls forming definite strobili (*e.g.*, *L. Stockii*), or on ordinary leaves (*e.g.*, *L. ciliatus*), as in the recent *Lycopodium Selago.* A form described by Zeiller, from the French Upper Coal Measures, closely resembles *Selaginella*, both in the foliage and the arrangement of the sporangia. The megaspores were, however, more numerous in each sporangium than in the recent genus. *Miadesmia*, English Lower Coal Measures, discovered by Bertrand, is the only member of the Lycopoditeæ so far found with structure preserved. In the presence of a ligule and other points there is here also an approach to the organization of *Selaginella.* Some evidence has been adduced for the heterospory of *Miadesmia;* the megasporangia attributed to it appear to present some analogies with those of *Lepidocarpon.* Although our knowledge of the Lycopoditeæ is very imperfect, their existence in Palæozoic times makes it probable that the recent genera *Lycopodium* and *Selaginella* may have been derived from forms which have always been herbaceous, rather than by reduction from the arborescent Lepidodendreæ. There is, however, some evidence that *Isoëtes*, which in several points agrees most nearly with the latter group, may actually represent its last degenerate survivors. (See *Pleuromeia*, in section II., Mesozoic.)

IV. *Filicales.*—Of all Vascular Cryptogams, the Ferns have best maintained their position down to the present day. The class was well represented in the Palæozoic period, when, indeed, it was relatively, and perhaps absolutely, far richer in species even than in the recent Flora. The great majority of specimens of fossil Ferns are preserved in the form of carbonaceous impressions of fronds, often of remarkable perfection and beauty. The characters shown by such specimens, however, when, as is usually the case, they are in the barren state, are notoriously unstable, or of small taxonomic value, among recent Ferns. Hence palæobotanists have found it necessary to adopt a purely artificial system of classification, based on form and venation of the frond, in the absence of adequate data for a more natural grouping. The well-known form-genera *Pecopteris*, *Sphenopteris*, *Odontopteris*, &c., are of this provisional nature. In the meantime, however, a number of Palæozoic fern-fructifications have been brought to light, often in connexion with the fronds that bore them, and such discoveries, aided in some cases by the observation of anatomical characters in the petrified specimens, have afforded the basis for a more natural arrangement, though as yet this is very incomplete. In habit the Palæozoic Ferns show as great variety as their recent allies: most, no doubt, were herbaceous plants, with a creeping or upright rhizome; some were climbers, using larger plants as supports; while many were tree-ferns, often of large size, and resembling the tree-ferns of the present day, though, as we shall see, of very different affinities. In the great majority the fronds were compound, perfectly comparable to the typical fern-fronds of to-day; then, as now, a certain number of simple-leaved forms were present. In one respect the fronds of many Palæozoic Ferns were peculiar, namely, in the presence in their rachis, and at the base of their pinnæ, of anomalous leaflets, often totally different in form and venation from the ordinary pinnules. These curious appendages (*Aphlebiæ*), at first regarded as parasitic growths, have been compared with the feathery outgrowths which occur on the rachis in the Cyatheaceous genus *Hemitelia*, and with the anomalous pinnules found in certain species of *Gleichenia*, at the points of bifurcation of the frond.

Marattiaceæ.—A large number of the Palæozoic Filices show indications—more or less decisive—of Marattiaceous affinities; some account of this group will first be given. The reference of these Ferns to the family Marattiaceæ, so restricted in the recent Flora, rests, of course, primarily on evidence drawn from the fructifications. Typically Marattiaceous sori, consisting of exannulate sporangia united to form synangia, are frequent, and are almost always found on fronds with the character of *Pecopteris*, large, repeatedly pinnate leaves, resembling those of Cyatheaceæ or some species of *Nephrodium*. In certain cases the anatomical structure of these leaves is known, and found to agree generally with that of recent coriaceous fern-fronds. The petiole was usually traversed by a single vascular bundle, hippocrepiform in section—a marked point of difference from the more complex petioles of recent Marattiaceæ. There is evidence that in most cases these Pecopteroid fronds belonged to tree-ferns, the stems on which they were borne reaching a height of as much as 60 feet. These stems, known as *Megaphytum* when the leaves were in two rows, and as *Caulopteris* in the case of polystichous arrangement, are frequent, especially in the Permian of the Continent; when petrified, so that their internal structure is preserved, the name *Psaronius* is employed. Their structure is a complex one, the central region containing an elaborate system of numerous anastomosing steles, accompanied by sclerenchyma; the cortex is permeated or coated by a multitude of adventitious roots, forming a thick envelope to the stem. The whole structure bears a general resemblance to that of recent Marattiaceæ, though differing in detail. We will now describe some of the fructifications, which are grouped under generic names of their own; these genera, as having a more natural basis, tend to supersede the artificial groups founded on vegetative characters. The genus *Asterotheca* includes a number of Ferns, chiefly of Coal Measure age, with fronds of the *Pecopteris* type. The sori, or synangia, ranged in two series on the under-side of the fertile pinnules, are circular, each consisting of 3 to 6 sporangia, attached to a central receptacle and partly united to each other (Fig. 13, A); the sporangia separated when mature, dehiscing by a ventral slit. Stur's genus *Hawlea* (Fig. 13, H), characterized by the separation of the sporangia, may only represent an advanced stage of an *Asterotheca*. In *Ptychocarpus* the fusion of the sporangia to form the syrangium was much more complete; *Scolecopteris* resembles *Asterotheca*, but each synangium is stalked. In all these genera there is an obvious similarity to the synangia of *Kaulfussia*, while in some respects *Marattia* or *Danæa* is approached. In another Pecopteroid genus, *Sturiella*, the synangia resemble those of *Asterotheca*, but each sporangium is provided with a band of enlarged cells of the nature of an annulus (Fig. 13, D). As a similar differentiation, though less marked, appears in the recent genus *Angiopteris*, the presumption is in favour of the Marattiaceous affinities of *Sturiella*. In the genus *Danæites*, from the Coal Measures of the Saar, the synangia are much like those of the recent *Danæa*, each sporangium opening by an apical pore. In the *Grand' Eurya* of Stur the sporangia appear to have been free from each other, as in *Angiopteris*. On the whole there is thus abundant evidence for the frequency of Marattiaceæ in the Palæozoic period, and there can be no doubt that this group of Eusporangiate Ferns was far more prominent then than in any later flora. In a certain number of genera the reference to Marattiaceæ is much more doubtful. In

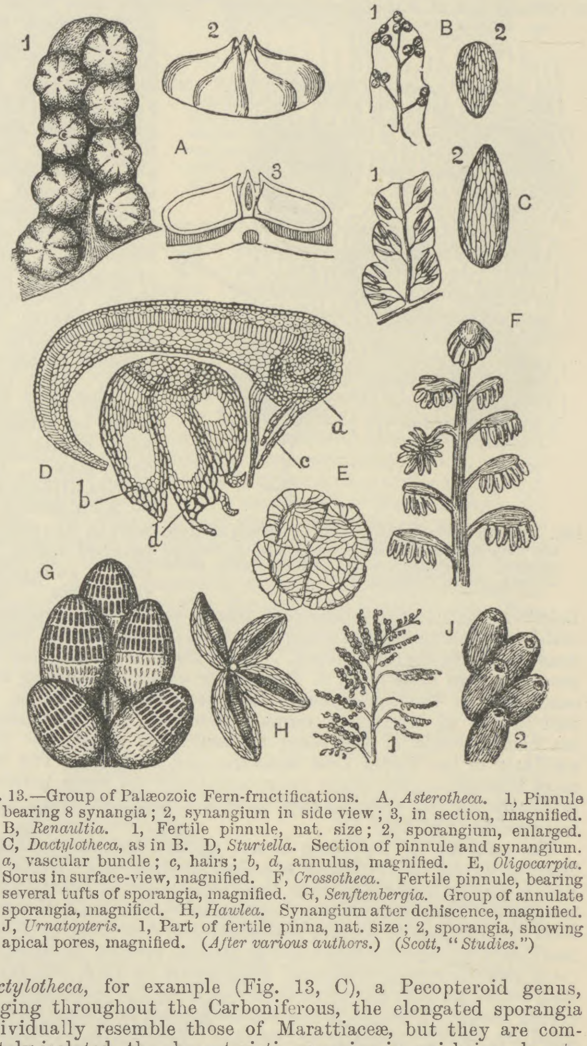


FIG. 13.—Group of Palæozoic Fern-fructifications. A, *Asterotheca*. 1, Pinnule bearing 8 synangia; 2, synangium in side view; 3, in section, magnified. B, *Renaultia*. 1, Fertile pinnule, nat. size; 2, sporangium, enlarged. C, *Dactylotheca*, as in B. D, *Sturiella*. Section of pinnule and synangium. *a*, vascular bundle; *c*, hairs; *b*, *d*, annulus, magnified. E, *Oligocarpia*. Sorus in surface-view, magnified. F, *Crossotheca*. Fertile pinnule, bearing several tufts of sporangia, magnified. G, *Senftenbergia*. Group of annulate sporangia, magnified. H, *Hawlea*. Synangium after dehiscence, magnified. J, *Urnatopteris*. 1, Part of fertile pinna, nat. size; 2, sporangia, showing apical pores, magnified. (*After various authors.*) (*Scott, "Studies."*)

Dactylotheca, for example (Fig. 13, C), a Pecopteroid genus, ranging throughout the Carboniferous, the elongated sporangia individually resemble those of Marattiaceæ, but they are completely isolated, the characteristic grouping in sori being absent; the same remark applies to the Sphenopteroid Fern *Renaultia* of Zeiller (Fig. 13, B); the foliage of *Sphenopteris*, one of the most extensive of Palæozoic frond-genera, with many different types of fructification, resembled that of various species of *Asplenium* or *Davallia*. In many Ferns of this period the fronds were dimorphic, the fertile leaves or pinnæ having a form quite different from that of the vegetative portions. This was the case in *Urnatopteris* (Kidston), with Sphenopteroid sterile foliage; the sporangia, borne on the filiform pinnules of the fertile rachis, appear to have dehisced by an apical pore (Fig. 13, J) suggesting Marattiaceous analogies. Another curious dimorphic genus is *Crossotheca*, Zeiller (Fig. 13, F), with the sterile fronds either of *Pecopteris* or *Sphenopteris*, according to the species; the sporangia, according to Zeiller's interpretation, hung down from the edges of the fertile pinnules. Here we have no clue to the affinities. The magnificent Devonian Fern *Palæopteris hibernica*, with a somewhat Adiantiform habit, bore specially fertile pinnæ; the fructification is still imperfectly understood, but the presence of stipules, observed by Kidston, has been adduced in support of Marattiaceous affinities.

Other Families.—The Marattiaceæ are the only recent family of Ferns which can be said to have existed in anything like its present form in Palæozoic times. Of other recent orders the indications are meagre and dubious, and there can be no doubt that a large proportion of Ferns from the older rocks belonged to families quite distinct from any which we recognize in the Flora of our own day. Little or nothing is known of Palæozoic Ophioglossaceæ; a species of the genus *Rhacopteris*, from the Lower Carboniferous, which had somewhat the habit, though not the morphology, of a *Botrychium*, has been referred to this family on insufficient grounds, and other indications are also doubtful. Certain fructifications have been referred to Gleicheniaceæ (*Oligocarpia*, Fig. 13, E), Schizæaceæ (*Senftenbergia*, Fig. 13, G), Hymenophyllaceæ, and Osmundaceæ, and on good grounds, so far as the external characters of the sporangia are concerned; our knowledge of the Ferns in question is, however, far too incomplete to justify us in asserting that they actually belonged to the families indicated. Numerous more or less isolated fern-sporangia occur in the petrified material of the Carboniferous formation; the presence of an annulus is a frequent character among these specimens, while synangic sori are rare; it is thus certain that families remote from the Marattiaceæ were abundantly represented during this period.

Botryopterideæ.—The family *Botryopterideæ*, first discovered by Renault, stands out with striking clearness among the Palæozoic Ferns, and differs widely from any group now in existence. The *Botryopterideæ* are chiefly known from petrified specimens; in the two genera *Botryopteris* and *Zygopteris* we have a fairly complete knowledge of all parts of the plant. The type-genus *Botryopteris*, represented both in the Permo-Carboniferous of France and in the Coal Measures of Great Britain, had a rhizome, with a very simple monostelic structure, bearing spirally-arranged compound leaves, with lobed pinnules, probably of a somewhat fleshy texture. In the French species, *B. forensis*, the plant was covered with characteristic jointed hairs, which have served to identify the various organs on which they occur. The sporangia were large pyriform sacs, shortly stalked, and borne in tufts on the branches of the fertile rachis, which developed no lamina. Each sporangium had, on one side only, a longitudinal or slightly oblique annulus, several cells in width; the numerous spores were all of the same size; certain differences among them, which have been interpreted as indicating heterospory, have now proved to depend merely on the state of preservation. The genus *Zygopteris*, of which several Carboniferous and Permian species are known, likewise had a monostelic stem, but the structure of its vascular cylinder was somewhat complex, resembling that of the most highly differentiated Hymenophyllaceæ, with which *Zygopteris* also agreed in the presence of axillary shoots. There is evidence that the stem in some species was a climbing one; the pinnate leaves, arranged on the stem in a two-fifths spiral, were dimorphic, the sterile fronds resembling some forms of *Sphenopteris*. On the fertile rachis the sporangia were borne in tufts, much as in the preceding genus; they were still larger, reaching 2·5 mm. in length, and had a multiseriate annulus, extending, however, to both sides of the sporangium (see Fig. 14, A and B). The genus *Corynepteris* of Baily is interesting from the fact that its sporangia, while individually similar to those of *Zygopteris*, were grouped in sori or synangia, resembling those of an *Asterotheca*. The family Botryopterideæ appears to have included a number of other genera, though in most cases the evidence from vegetative structure is alone available. The genus *Diplolabis* of Renault, probably identical with the *Asterochlæna* of Corda, and showing much in common with *Zygopteris* as regards anatomical structure, resembles *Corynepteris* in possessing a synangic fructification. The family as a whole is of great interest, as presenting points of contact with various recent orders, especially Hymenophyllaceæ, Osmundaceæ, and Ophioglossaceæ; the group appears to have been a synthetic one, from which several lines of descent may have sprung.

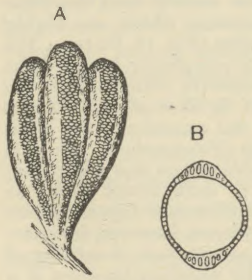


FIG. 14.—*Zygopteris pinnata.* A, Group of sporangia, in surface view. B, Single sporangium, in transverse section, showing annulus on both sides, magnified. (*After Renault.*)

A number of genera of Palæozoic fern-fronds have been described, of the fructification of which nothing is known. This is the case, for example, with *Diplotmema*, a genus only differing from *Sphenopteris* in the dichotomy of the primary pinnæ, and with *Mariopteris*, which bears a similar relation to *Pecopteris*. The same holds good of the Pecopteroid Ferns included under *Callipteris* and *Callipteridium*. In many such cases the apparent absence of fructification may be probably explained by dimorphism, the fertile fronds or pinnæ not having been as yet brought into relation with the sterile foliage. Several examples of fern-like fronds will be best considered under the heading Cycadofilices, for there is reason to believe that they belonged to plants which were in some respects intermediate between Ferns and Gymnosperms.

A natural classification of the Palæozoic Ferns will only be attainable when our knowledge of their reproduction and structural characters has become much more complete than it is at present. The great relative importance, in early periods, of eusporangiate Ferns of the Marattiaceous type is one of the most striking results hitherto arrived at. The Botryopterideæ also stand out definitely as a group now wholly extinct, but possibly having genetic relations with certain existing families. There are some indications that Ferns approaching the recent Schizaeaceæ, Osmundaceæ, and Hymenophyllaceæ may have already existed in Palæozoic times, while Cyatheaceæ and Polypodiaceæ, so predominant in the recent Flora, appear, on present evidence, to have been wholly unrepresented.

Cycadofilices.—A considerable number of Palæozoic genera are now known which in habit were more or less completely fern-like, while in their anatomical structure they combined the characters of Ferns with those of Gymnosperms. To this group the convenient name Cycadofilices has been given by Potonié. In some of the plants in question the fern-characters still predominate, in others the balance inclines to the Gymnospermous side. Unfortunately we have as yet no satisfactory knowledge of the fructification of any member of the group; the evidence at present before us is, however, sufficient to show that in the Palæozoic period a class of plants existed which, to judge by their known characters, held a position intermediate between Ferns and Gymnosperms, having a special affinity with the Cycadales and with the extinct family Cordaiteæ. A number of the most familiar fossil "fern fronds" have proved to belong to this transitional group, in which several families have been distinguished; the Lyginodendreæ are perhaps the most interesting from an evolutionary point of view.

Lyginodendreæ.—Of the genus *Heterangium*, which still stands very near the true Ferns, several species are known, the oldest being *H. Grievii*, of Williamson, from the Lower Carboniferous of Scotland. This plant had a long, somewhat slender ridged stem, the ridges corresponding to the decurrent bases of the spirally arranged leaves (Fig. 15). The specimens on which the genus was founded are petrified, showing structure rather than habit, but conclusive evidence has now been obtained that the foliage of *H. Grievii* was of the type of *Sphenopteris* (*Diplotmema*) *elegans* (Fig. 16), and was thus in appearance altogether that of a Fern, with somewhat the habit of an *Asplenium*. The stem has a single stele, resembling in general primary structure that of one of the simpler species of *Gleichenia*; there is no pith, the wood extending to the centre of the stele. The leaf-traces, where they traverse the cortex, have the structure of the foliar bundles in Cycads, for they are of the collateral type, and their xylem is mesarch, the spiral elements lying in the interior of the ligneous strand. The leaf-traces can be distinguished as distinct strands at the periphery of the stele, as shown in Fig. 17. Most of the specimens have formed a zone of secondary wood and phloem resembling the corresponding tissues in a recent Cycad; the similarity extended to minute histological details, as is shown especially in *H. tiliæoides*, a Coal Measures species, where the preservation is remarkably perfect. The cortex was strongly constructed mechanically; in addition to the strands of fibres at the periphery, horizontal plates of stone-cells were present in the inner cortex, giving both stem and petiole a transversely striated appearance, which has served to identify the different parts of the plant, even in the carbonized condition (cf. Figs. 15 and 16). The single vascular bundle which traversed the petiole and its branches was concentric, the leaves resembling those of Ferns in structure as well as in habit. *Heterangium* shows, on the whole, a decided preponderance of Filicinean characters, though in the leaf-traces and the secondary tissues the Cycads are approached. In the Coal Measures genus *Megaloxylon*, of Seward, which in structure bears a general resemblance to *Heterangium*, the primary wood consists for the most part of short wide tracheides; probably, as the secondary tissues increased, it had become superfluous for conducting purposes, and was adapted rather for water-storage. In the genus *Lyginodendron*, of which *L. oldhamium*, from the Coal Measures, is the best-known species, the central wood has disappeared altogether and is replaced by pith; the primary wood is only represented in the leaf-trace strands, which form a ring of distinct collateral bundles around the pith; thus the "medullate-monostelic" structure characteristic of the higher plants was already attained. The individual bundles, however, have the same structure as in *Heterangium*, and agree exactly with the foliar bundles of Cycads. The secondary tissues, which are highly developed, are also of a Cycadean character (Fig. 18, Plate). The vegetative organs of the plant are very completely known; the foliage has proved to be that of a *Sphenopteris*, identical with the species long known under the name of *S. Höninghausi*. Apart from the important advance shown in the anatomy of the stem, *Lyginodendron* agrees structurally with *Heterangium*. There is reason to believe that *Lyginodendron oldhamium* was a climbing plant, comparable in some respects to such recent Ferns as *Davallia aculeata*. As regards the fructification of *Lyginodendron* there is still much uncertainty; the evidence, however, indicates that it was of the type known as *Calymmatotheca*, consisting of tufts of long capsules pendent from the ultimate branches of a naked rachis; unfortunately the microscopic structure of this fructification is not certainly known, and it has even been doubted whether the capsules were of the nature of sporangia or sporocarps. In spite of this serious gap in our knowledge, there can be no question that the genus *Lyginodendron*, while having much in common with true Ferns, shows anatomically an unmistakable approach to Cycadean structure.

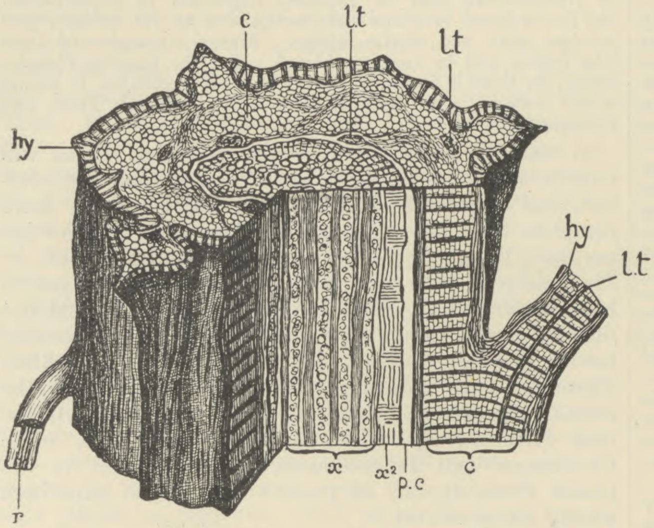


FIG. 15.—*Heterangium Grievii.* Restoration of stem, shown partly in transverse and longitudinal section, partly in surface view. *x*, primary, x^2, secondary wood; *p.c*, phloem and pericycle; *c*, cortex; *hy*, hypoderma; *l.t*, *l.t*, leaf-traces; *r*, adventitious root. The several leaf-bases are shown. (*After Williamson.*) (*Scott, "Studies."*)

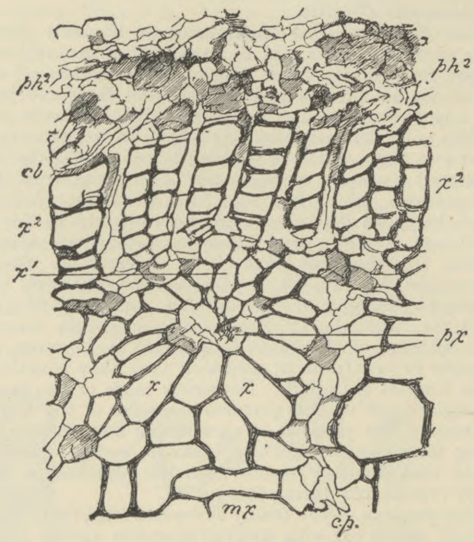


FIG. 17.—*Heterangium Grievii.* Part of the stele of the stem in transverse section, showing a primary xylem-strand and adjacent tissues. *px*, protoxylem of strand; *x*, centripetal, x^1, centrifugal primary wood; *mx*, part of the internal wood; *c.p*, conjunctive tissue; x^2, secondary wood; *cb*, cambium; ph^2, phloem. ×135. (*Scott, "Studies."*)

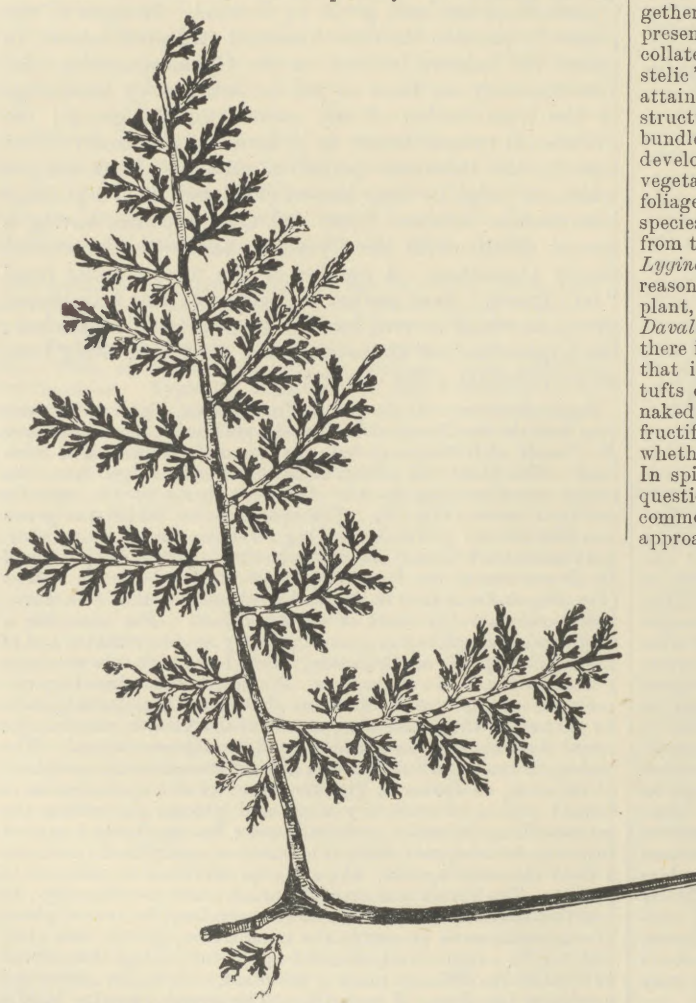


FIG. 16.—*Sphenopteris elegans* (foliage of *Heterangium Grievii*). Part of frond, ⅔ nat. size. (*After Stur.*) (*Scott, "Studies."*)

Cycadoxyleæ.—A few Coal Measures and Permian stems (*Cycadoxylon* and *Ptychoxylon*) resemble *Lyginodendron* in the general character of their tissues, but show a marked reduction of the primary wood, together with an extensive development of anomalous wood and bast around the pith, a peculiarity which appears as an individual variation in some specimens of *Lyginodendron oldhamium*. It is probable that these stems belonged to plants with the fructification and foliage of Cycads, taking that group in the widest sense. It is only quite at the close of the Palæozoic period that Cycads begin to appear. The *Lyginodendreæ* type of structure, however, appears to have formed the transition not only to the Cycadales, but also to the extinct family Cordaiteæ, the characteristic Palæozoic Gymnosperms (see p. 419).

Medulloseæ.—In some respects the most remarkable family of the Cycad-fern alliance is that of the Medulloseæ, plants often of great size, with a fern-like foliage, and a singularly complex anatomical structure without parallel among recent plants. Some of the Medulloseæ must have had a habit not unlike that of tree-ferns, with compound leaves of enormous dimensions, belonging to various frond-genera—especially, as has now been proved, to *Alethopteris* and *Neuropteris*; these are among the most abundant of the Carboniferous fronds commonly attributed to Ferns, and extend back to the Devonian. In habit some species of *Alethopteris* resembled the recent *Angiopteris*, while the *Neuropteris* foliage may be compared with that of an *Osmunda*. The *Medullosa* stems have been found chiefly in the Permo-Carboniferous of France and Germany, but a Coal Measures species (*M. anglica*) has been discovered in Lancashire. The great anatomical characteristic of the stem of the Medulloseæ is its polystelic structure with secondary development of wood and bast around each stele. In *M. anglica*, the simplest species known, the steles are uniform, and usually only three in number; the structure of the stem is essentially that of a polystelic *Heterangium*. In the Permo-Carboniferous species, such as *M. stellata* and *M. Leuckarti*, the arrangement is more complicated, the steles showing a differentiation into a central and a peripheral system; the secondary growth was extensive and unequal, usually attaining its maximum on the outer side of the peripheral steles. In certain cases the structure was further complicated by the appearance of extrafascicular zones exterior to the whole stelar system. The spirally arranged petioles (*Myeloxylon*) were of great size, and their decurrent bases clothed the surface of the stem; their structure is closely similar to that of recent Cycadean petioles; in fact, the leaves generally, like those of *Stangeria* at the present day, while fern-like in habit, were Cycadean in structure. In the case of *Medullosa anglica* we have an almost complete knowledge of the vegetative organs —stem, leaf, and root; Cycadean characters no doubt predominate, but the primary organization of the stem was that of a polystelic Fern. Some authors have been so much impressed by the similarity of this extinct family to the Cycads, that they have regarded them as being on the direct line of descent of the latter group; it is more probable, however, that they formed a short divergent phylum, distinct, though not remote, from the Cycadean stock. We have as yet no good evidence as to the fructification of the Medulloseæ; the fronds belonging to them scarcely ever show any trace of reproductive organs, and where any such indications have been detected, they are too obscure to be of any real assistance. There is, however, some indirect evidence for regarding it as not improbable that some of the isolated seeds found in the Carboniferous deposits may have belonged to members of this group.

The Cycadofilices, of which only a few examples have been mentioned, were probably very numerous during the Palæozoic period, though it is only in the comparatively rare cases where structure is preserved that the attribution is certain; in a large number of the so-called fern-fronds there is no evidence for Filicinean fructification, and it is probable that many of these belonged to this transitional or rather synthetic group, which may have been almost as extensive in early periods as that of the true Ferns.

Gymnosperms.

Gymnospermous remains are common in Palæozoic strata from the Devonian onwards. The investigations of the last quarter of the 19th century have established that these early representatives of the class did not, as a rule, belong to any of its existing families, but formed for the most part a distinct group, that of the Cordaiteæ, which has long since died out. Specimens of true Cycads or Conifers are rare or doubtful until we come to the latest Palæozoic rocks. Our present knowledge of the family Cordaiteæ is chiefly due to the two French investigators, Grand' Eury and Renault, who have successfully brought into connexion the various fragmentary remains, and made known their exact structure.

The discovery of the fossil trunks and of their rooted bases has shown that the Cordaiteæ were large trees, reaching 30 metres or more in height; the lofty shaft bore a dense crown of branches, clothed with long simple leaves, spirally arranged. Fig. 19, founded on one of Grand' Eury's restorations, gives an idea of the habit of a tree of the genus *Dorycordaites*, characterized by its lanceolate acute leaves; in the typical *Cordaites* they were of a blunter shape, while in *Poacordaites* they were narrow and grass-like. The leaves as a rule far exceeded in size those of any of the Coniferæ, attaining in some species a length of a metre. Of living genera, *Agathis* probably comes nearest to the extinct family in habit, though at a long interval. The stem resembled that of Cycads in having a large pith, sometimes as much as 4 inches in diameter; the wood, however, was dense, and had the structure of that of an Araucarian Conifer; specimens of the wood have accordingly been commonly referred to the genus *Araucarioxylon*, and at one time the idea prevailed that wood of this type indicated actual affinity with Araucarieæ. Other characters, however, prove that the Cordaiteæ were far remote from that family, and the name *Araucarioxylon* is best limited to wood from later horizons, where a near relationship to Araucarieæ is more probable.[1] In some cases the external tissues of the Cordaitean stem are well preserved; the cortex possessed a system of hypodermal strands of fibres, comparable to those found in the Lyginodendreæ. In some cases the leaf-traces passed out from the stem in pairs, as in the recent *Ginkgo*; in others the bundles of each trace were more numerous. In many Cordaiteæ the pith was *discoid*, *i.e.*, fistular, and partitioned by frequent diaphragms, as in some species of *Pinus* and other plants at the present day. The curious, transversely-ribbed fossils known as *Sternbergia* or *Artisia* have proved to be casts of the medullary cavity of Cordaiteæ; their true nature was first demonstrated by Williamson in 1850. In those stems which have been referred with certainty to the Cordaiteæ there is no centripetal wood; the spiral elements are adjacent to the pith, as in a recent Conifer or Cycad; certain stems, however, are known which connect this type of structure with that of the Lyginodendreæ; this, for example, is the case in the Permian genus *Poroxylon*, investigated by Bertrand and Renault, which in general structure has much in common with Cordaiteæ, but possesses strands of primary wood, mainly centripetal, at the boundary of the pith, as is the case in *Lyginodendron*. Corresponding strands of primary xylem have been observed in stems of the genus *Pitys* (Witham), of Lower Carboniferous age, which consisted of large trees, probably closely allied to *Cordaites*. There appears, in fact, so far as stem-structure is concerned, to have been no sharp break between the typical Palæozoic Gymnosperms and pronounced Cycadofilices such as *Lyginodendron*.

Fig. 19.—*Dorycordaites*. Restoration, showing roots, trunk, and branches bearing long lanceolate leaves and fructifications. The trunk is shown too short. (*After Grand' Eury, modified*.) (*Scott, "Studies."*)

The long, parallel-veined leaves of the Cordaiteæ, which were commonly referred to Monocotyledons before their structure or

[1] Endlicher's name *Dadoxylon* is conveniently used for Palæozoic specimens of the kind in question when nothing beyond the wood-structure is known.

connexion with other parts of the plant was known, have been shown by Renault to have essentially the same anatomy as a single leaflet of a Cycad such as *Zamia*. The vascular bundles, in particular, show precisely the characteristic collateral mesarch structure which is so constant in the recent family (see ANATOMY OF PLANTS). In fact, if the foliage alone were taken into account, the Cordaiteæ might be described as simple-leaved Cycads. The reproductive organs, however, show that the two groups were in reality very distinct. Both male and female inflorescences have frequently been found in connexion with leaf-bearing branches (see restoration, Fig. 19). The inflorescence is usually a spike bearing lateral flowers or catkins, arranged sometimes distichously, sometimes in a spiral order. The investigation of silicified specimens has, in the hands of Renault, yielded striking results. A longitudinal section of a male *Cordaianthus* (the name applied to isolated flowers) is shown in Fig. 20, A, Plate. The organ figured is one of the catkins (about a centimetre in length) which were borne laterally on the spike. Some of the stamens are inserted between the bracts, in an apparently axillary position, while others are grouped about the apex of the axis. Each stamen consists of a long filament, bearing several erect, cylindrical pollen-sacs at its summit (cf. Fig. 20, B, Plate). Some of the pollen-sacs had dehisced, while others still retained their pollen. The stamens are probably best compared with those of *Ginkgo*, but they have also been interpreted as corresponding to the male "flowers" of the Gnetaceæ. In any case the morphology of the male Cordaitean flower is clearly very remote from that of any of the Cycads or true Coniferæ. The female inflorescences vary considerably in organization; in some species the axis of the spike bears solitary ovules, each accompanied by a few bracts, while in others the lateral appendages are catkins, each containing from two to several ovules. In the catkin shown in longitudinal section in Fig. 21, A, it appears that each ovule was borne terminally, on an extremely short axillary shoot, as in *Taxus* among recent Gymnosperms. The ovule consists of an integument (regarded by some writers as double) enclosing the nucellus. In the upper part of the nucellus is a cavity or pollen-chamber, with a narrow canal leading into it, precisely as in the ovules of *Stangeria* or other Cycads at the present day (Fig. 21, B). Within the pollen-chamber, and in the canal, pollen-grains are found, agreeing with those in the anthers, but usually of larger size (Fig. 21, C). It was in this case that Renault first made the exceedingly interesting discovery that each pollen-grain contains a group of cells, presumably representing an antheridium (Fig. 21, C). Recent observations have completely confirmed Renault's interpretation of the facts, on which some doubt had been cast. In the isolated seeds of Cordaiteæ and allied Palæozoic Gymnosperms, pollen-grains are often found within the pollen-chamber, and the pluricellular structure of these pollen-grains has been repeatedly demonstrated. In the light of recent discoveries in *Ginkgo* and the Cycads there can scarcely be a doubt that spermatozoids were formed in the cells of the antheridium of the Cordaitean pollen-grain; the antheridium is much more developed than in any recent Gymnosperm, and it may be doubted whether any pollen-tube was formed. The morphology of the female inflorescence of Cordaiteæ has not yet been cleared up, but *Taxus* and *Ginkgo* among recent plants appear to offer the nearest analogies. Much further investigation will be needed before the homologies between Cordaitean flowers and the fructification of the higher Cryptogams can be established. Anatomically the connexion of the family with the Cycadofilices (and through them, presumably, with some primitive group of Ferns) seems clear, but we have as yet no indications of the stages in the evolution of their reproductive organs. The family Cordaiteæ extends back to the Devonian, and it must be borne in mind that our knowledge of their fructifications is practically limited to specimens from the latest Palæozoic horizons.

Isolated fossil seeds are common in the Carboniferous and Permian strata; in all cases they are of the orthotropous type, and resemble the seeds of Cycads or *Ginkgo* more nearly than those of any other living plants. Their internal structure is sometimes admirably preserved, so that the endosperm with its archegonia is clearly shown (Fig. 21, D). It is a curious fact that in no case has an embryo been found in any of these seeds; probably fertilization took place after they were shed, and was followed immediately by germination. There is good evidence that many of the seeds belonged to Cordaiteæ, especially those seeds which had a flattened form, such as *Cardiocarpus*, *Cycadinocarpus*, *Samaropsis*, &c. Seeds of this kind have been found in connexion with the *Cordaianthus* inflorescences; the winged seeds of *Samaropsis*, borne on long pedicels, are attributed by Grand' Eury to the genus *Dorycordaites*. Other forms of seed, and especially those which show radial symmetry, as for example *Trigonocarpon*, *Stephanospermum*, and *Lagenostoma*, are still of doubtful nature, and may have belonged, in part at least, to some of the plants grouped under Cycadofilices. The abundance and variety of Palæozoic seeds, so often of undetermined nature, indicate how much still remains to be done in the investigation of the Gymnosperms of that period.

The modern Gymnospermous orders have but few authentic representatives in Palæozoic rocks. The history of the Ginkgoales will be found in the Mesozoic section of this article, and in the article GYMNOSPERMS; their nearest Palæozoic representatives "were probably members of the Cordaitales, an extinct stock with which the Ginkgoaceæ are closely connected" (Seward). Remains referable to Cycadales, so extraordinarily abundant in the succeeding period, are scanty. The curious genus *Dolerophyllum* (Saporta) may be mentioned in this connexion. This genus, from the Permo-Carboniferous of Autun, is represented by large, fleshy, reniform leaves or leaflets, with radiating dichotomous venation; the vascular bundles have in all respects the structure of those in leaves of Cycads or Cordaiteæ. The male sporophylls are similar in form to the vegetative leaves, but

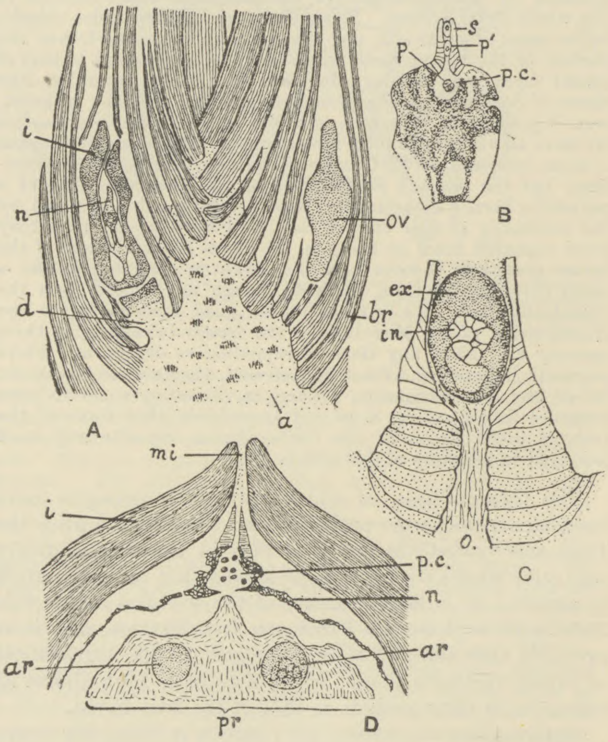


FIG. 21.—*Cordaianthus*. A, *C. Williamsoni*. Part of longitudinal section of ♀ catkin; *a*, axis, showiug v. bundles in tangential section; *br*, bracts; *d*, short axillary shoot, bearing a bracteole and a terminal ovule; *i*, integument; *n*, nucellus of ovule; *ov*, another ovule seen from the outside. × about 10. B, *C. Grand' Euryi*. Nucellus of an ovule; *p.c*, pollen-chamber; *s*, canal leading to *p.c*; *p*, pollen-grains in *p.c*; p^1, do. in canal. × about 30. C, *C. Grand' Euryi*. Lower part of canal, enlarged. *o*, cavity of canal, surrounded by a sheet of cells, dilated towards the bottom of canals, in which a large pollen-grain is caught; *ex*, exterior of polleu-grain; *in*, internal group of prothallial or antheridial cells. ×150. D, *Cycadinocarpus Augustodunensis*. Upper part of seed, in longitudinal section; *i*, integument; *mi*, micropyle; *n*, remains of nucellus; *p.c*, pollen-chamber (containing pollen-grains), with its canal extending up to the micropyle; *pr*, part of prothallus; *ar*, archegonia, magnified. (*All after Renault.*)

smaller; sunk in their parenchyma are numerous tubular loculi, containing large pollen-grains, which are pluricellular like those of *Cordaites;* the female fructification is still unknown. The curious male sporophylls may perhaps be remotely comparable to those recently discovered in Mesozoic Cycadales of the group Bennettiteæ. Some leaves of Cycadean habit (*e.g.*, *Pterophyllum*, *Sphenozamites*) occur in the Coal Measures and Permian, and it is possible that the obscure Coal Measures genus *Noeggerathia* may have Cycadean affinities. An inflorescence from the Permian of Autun, named *Cycadospadix milleryensis* by Renault, appears to belong without doubt to this family.

Now that the numerous specimens of wood formerly referred to Coniferæ are known to have belonged to distinct orders, but few true Palæozoic Conifers remain to be considered. The most important are the upper Coal Measures or Permian genera *Walchia*, *Ullmannia*, and *Pagiophyllum*, all of which resembled certain Araucarieæ in habit. In the case of *Walchia* there is some evidence as to the fructifications, which in one species (*W. filiciformis*) appear to be comparable to female Araucarian cones. There are also some anatomical points of agreement with that family. It is probable, however, that under the same generic name very heterogeneous plants have been confounded. In the case of *Ullmannia* the anatomical structure of the leaf, investigated by Solms-Laubach, proves at any rate that the tree was Coniferous.

There is no proof of the existence of Gnetaceæ in Palæozoic times. The very remarkable plumose seeds described by Renault under the name *Gnetopsis* are of uncertain affinity.

Succession of Floras.

Our knowledge of vegetation older than the Carboniferous is still far too scanty for any satisfactory history of the Palæozoic Floras to be even attempted; a few, however, of the facts may be advantageously recapitulated in chronological order.

No recognizable plant-remains, if we except one or two doubtful Algal specimens, have so far been yielded by the Cambrian. From the Ordovician and Silurian, however, a certain number of authentic remains of Algæ (among many more that are questionable) have been investigated; they are for the most part either verticillate Siphoneæ, or the large—possibly Laminariaceous—Algæ named *Nematophycus*, with the problematical but perhaps allied *Pachytheca*. The evidence for terrestrial Silurian vegetation is still dubious; apart from some obscure North American specimens, the true nature of which is not established, Potonié has described well-characterized Pteridophytes (such as a Fern, *Sphenopteridium*, and *Bothrodendron* among Lycopods) from supposed Silurian strata in North Germany; the horizon, however, appears to be open to much doubt, and the specimens agree so nearly with some from the Lower Carboniferous as to render their Silurian age difficult of credence. The high development of the terrestrial flora in Devonian times shows, however, that land-plants must have existed far back in the Silurian ages, or still earlier. Even in the Lower Devonian, Ferns and Lepidodendreæ have been recognized; the Middle and Upper Devonian beds contain a flora in which all the chief groups of Carboniferous plants are already represented. Considering the comparative meagreness of the Devonian record, we can scarcely doubt that the vegetation of that period, if adequately known, would prove to have been practically as rich as that of the succeeding age. Among Devonian plants, Equisetales, including not only *Archæocalamites*, but forms referred to *Asterophyllites* and *Annularia*, occur; *Sphenophyllum* is known from Devonian strata in North America and Bear Island; Lycopods are represented by *Bothrodendron*, *Lepidodendron*, and the characteristic *Psilophyton*, as to the true nature of which, however, there is much doubt. Ferns such as Sphenopterideæ, *Palæopteris*, and *Adiantites*, with occasional arborescent Pecopterideæ, are frequent; other genera, *Alethopteris*, *Neuropteris*, and *Megalopteris*, more probably belonged, not to true Ferns, but to Cycadofilices; in the absence, as a rule, of any structural evidence, it is impossible to be certain of the true nature of many of the plants. The presence of Cordaitean leaves indicates that Gymnosperms of high organization already existed, a striking fact, showing the immense antiquity of this class compared with the angiospermous flowering plants. Any detailed account of the horizons of Carboniferous plants would carry us much too far. For our present purpose we may divide the formation into Lower Carboniferous, and Lower and Upper Coal Measures. In the Lower Carboniferous (Culm of Continental authors) many Devonian types survive—*e.g.*, *Archæocalamites*, *Bothrodendron*, *Palæopteris*, *Megalopteris*, &c. Among Ferns, *Diplotmema* and *Rhacopteris* are characteristic; some of the Lepidodendreæ appear to approach *Sigillariæ* in external characters. Sphenophylleæ are still rare; it is to this horizon that the isolated type *Cheirostrobus* belongs. Many specimens with structure preserved are known from the Lower Carboniferous, and among them Cycadofilices (*Heterangium*, *Calamopitys*, *Cladoxylon*, *Protopitys*) are well represented. Of Gymnosperms we have Cordaitean leaves, and the stems known as *Pitys*, which probably belonged to the same family.

The Lower Coal Measures (Westphalian) have an enormously rich flora, embracing most of the types referred to in our systematic description. *Calamarieæ* with the *Arthropitys* type of stem-structure abound, and Sphenophylleæ are now well represented. *Bothrodendron* still survives, but *Lepidodendron*, *Lepidophloios*, and the ribbed Sigillariæ are the characteristic Lycopods. The heterogeneous "Ferns" grouped under Sphenopterideæ are especially abundant. Marattiaceous Ferns are common, but arborescent stems of the *Psaronius* type are still comparatively rare. Numerous fronds such as *Alethopteris*, *Neuropteris*, and possibly *Mariopteris*, belonged, in part at least, to Cycadofilices, of which specimens showing structure are frequent in certain beds. *Cordaites*, *Dorycordaites*, and many stems of the *Dadoxylon* type represent Gymnosperms, of which the seeds begin to be common. The Upper Coal Measures (Stephanian) are characterized among the Calamarieæ, now more than ever abundant, by the prevalence of the Calamodendreæ; new species of *Sphenophyllum* make their appearance; among the Lycopods, *Lepidodendron* and its immediate allies diminish, and smooth-barked Sigillariæ are the characteristic representatives. Ferns are even more strongly represented than before, and this is the age in which Marattiaceous tree-ferns reached their maximum development. Among Cycadofilices it is the family Medulloseæ which is especially characteristic. Cordaiteæ still increase, and Gymnospermous seeds become extraordinarily abundant. In the Upper Coal Measures the first Cycadales and Coniferæ make their appearance. The Permian, so far at least as its lower beds are concerned, shows little change from the Stephanian; Conifers of the *Walchia* type are especially characteristic. The remarkable Permo-Carboniferous flora of India and the southern hemisphere is described in the next section of this article. During the earlier part of the Carboniferous epoch the vegetation of the world appears to have been remarkably uniform; while the deposition of the Coal Measures, however, was in progress, a differentiation of floral regions began. The sketch given above extends, for the later periods, to the vegetation of the northern hemisphere only.

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II. MESOZOIC.

The period dealt with in this section does not strictly correspond with that which it is customary to include within the limits of the Mesozoic system. The Mesozoic era, as defined in geological text-books, includes the Triassic, Jurassic, and Cretaceous epochs; but from the point of view of the evolution of plants and the succession of floras, this division is not the most natural or most convenient. Our aim is not simply to give a summary of the most striking botanical features of the several floras that have left traces in the sedimentary rocks, but rather to attempt to follow the different phases in the development of the vegetation of the world, as expressed by the contrasts exhibited by a comparison of the vegetation of the Coal period forests with that of the succeeding Mesozoic era up to the close of the Wealden period.

Towards the close of the Palæozoic era, as represented by the Upper Carboniferous and Permian plant-bearing strata, the vegetation of the northern hemisphere, and that of several regions in the southern hemisphere, consisted of numerous types of Vascular Cryptogams, with some members of the Gymnospermæ, and several genera referred to the Cycadofilices (see section I. PALÆOZOIC). In the succeeding Permian period the vegetation retained for the most part the same general character; some of the Carboniferous genera died out, and a few new types made their appearance. The Upper Carboniferous and Permian plants may be grouped together as constituting a Permo-Carboniferous flora characterized by the predominance of Vascular Cryptogams. This flora had a wide distribution in North America, Europe, and parts of Asia; it extended to China and to the Zambezi region of tropical Africa (Map A, I. and II.).

Glossopteris flora.

On the other hand, the plant-beds of the Permo-Carboniferous age in South Africa, South America, India, and Australia demonstrate the existence of a widely-distributed vegetation which agrees in age with the Upper Carboniferous and Permian vegetation of the north, but differs from it to such an extent as to constitute a distinct flora. We must begin by briefly considering this southern Palæozoic province if we would trace the Mesozoic floras to their origin, and obtain a connected view of the vegetation of the globe as it existed in late Palæozoic times and at the beginning of the succeeding era.

In Australia, South America, and South Africa a few plants have been found which agree closely with Lower Carboniferous types of the northern hemisphere. In New South Wales, for example, we have such genera as *Rhacopteris* and *Lepidodendron* represented by species very similar to those recorded from Lower Carboniferous or Culm rocks in Germany, Austria, England, Spitzbergen, North and South America, and elsewhere. It is, in short, clear that the Culm flora, as we know it in the northern hemisphere, existed in the extreme south, and it is probable that during the earlier part of the Carboniferous period the vegetation of the world was uniform in character. We may possibly go a step farther, and assume that the climatic conditions under which the Culm plants of the Arctic regions flourished were not very different from those which prevailed in Europe, Asia, Chile, and South Australia. From strata in New South Wales overlying Devonian and Lower Carboniferous rocks certain plants were discovered in the early part of the 19th century which were compared with European Jurassic genera, and for several years it was believed that these plant-beds belonged to the Mesozoic period. These supposed Mesozoic plants include certain genera which are of special interest. Foremost among these is the genus *Glossopteris* (Fig. 1), founded by Brongniart in 1828 on specimens from India and Australia, a fern characterized by simple sub-lanceolate or tongue-shaped leaves, with a central midrib giving off lateral veins which repeatedly anastomose and form a network, like that in the leaves of *Anthrophyum*, an existing member of the Polypodiaceæ. The stems, long known from Australia and India as *Vertebraria*, have in recent years been proved to be the rhizomes of *Glossopteris*. Associated with *Glossopteris* occurs another fern, *Gangamopteris*, usually recognized by the absence of a well-marked midrib, though this character does not always afford a satisfactory distinguishing feature. An Equisetaceous plant, which Brongniart named *Phyllotheca* in 1828, is another member of the same flora; this type bears a close resemblance to *Equisetum* in the long internodes and the whorled leaves encircling the nodes, but differs in the looser leaf-sheaths and in the long spreading filiform leaf-segments, as also in the structure of the cones. *Phyllotheca* has been recognized in Europe in strata of Palæozoic age, and Professor Zeiller has discovered a new species—*P. Rallii*—in Upper Carboniferous rocks in Asia Minor (Map A, VII.), which points to a close agreement between this genus and the well-known Palæozoic *Annularia*. *Phyllotheca* occurs also in Jurassic rocks in Italy, and in Siberian strata originally described as Jurassic, but which Zeiller has shown are no doubt of Permian age. Some examples of this genus, described by Etheridge from Permo-Carboniferous beds in New South Wales, differ in some respects from the ordinary form, and bear a superficial resemblance to the Equisetaceous genus *Cingularia* from the Coal Measures of Germany. Other genera characteristic of this southern flora are mentioned later. The extraordinary abundance of *Glossopteris* in Permo-Carboniferous rocks of Australia, and in strata of the same age in India and South Africa, gave rise to the term "Glossopteris flora" for the assemblage of plants obtained from southern hemisphere rocks overlying beds containing Devonian and Lower Carboniferous fossils. The Glossopteris flora of Australia occurs in certain regions in association with deposits which are now recognized as true boulder-beds, formed during widespread glacial conditions. In India the same flora occurs in a thick series of fresh-water sediments, known as the Lower Gondwana system, including basal boulder-beds like those of Australia. Similar glacial deposits occur also in South America, and members of the Glossopteris flora have been discovered in Brazil and elsewhere. In South Africa, *Glossopteris, Gangamopteris*, and other genera, identical with those from Australia and India, are abundantly represented, and here again, as in India and South America, the plants are found in association with extensive deposits of undoubted glacial origin. To state the case in a few words, there is in South Africa, South America, Australia, and India an extensive series of sediments containing *Glossopteris, Gangamopteris*, and other genera, and including beds full of ice-scratched boulders. These strata are homotaxial with Permo-Carboniferous rocks in Europe and North America, as determined by the order of succession of the rocks, and by the occurrence of typical Palæozoic shells in associated marine deposits. The most important evidence on which this conclusion is based is afforded by the occurrence of European forms of Carboniferous shells in marine strata in New South Wales, which are intercalated between Coal Measures containing members of the Glossopteris flora, and by the discovery of similar shells, many of which are identical with the Australian species, in strata in the north-west of India and in Afghanistan, forming part of a thick series of marine beds known as the Salt Range group. This group of sediments in the extra-peninsular area of India includes a basal boulder-bed, referred on convincing evidence to the same geological horizon as the glacial deposits of the Indian peninsula (Talchir boulder-beds), South Africa (Ecca boulder-beds), Australia and Tasmania (Bacchus Marsh boulder-beds, &c.), and South America, which are associated with Glossopteris-bearing strata. We have a flora of wide distribution in South Africa, South America, Borneo, Australia, Tasmania, and India, which is clearly of Permo-Carboniferous age, but which differs in its composition from the flora of the same age in other parts of the world. This flora appears to have abruptly succeeded an older flora in Australia and elsewhere, which was precisely similar to that of Lower Carboniferous age in the northern hemisphere. The frequent occurrence of ice-formed deposits at the base of the beds in which *Glossopteris* and other genera make their appearance, almost necessitates the conclusion that the change in the character of the vegetation was connected with a lowering of temperature and the prevalence of glacial conditions over a wide area in India and the southern hemisphere. There can be little doubt that the Indian Lower Gondwana rocks, in which the boulder-beds and the Glossopteris flora occur, must be regarded as belonging to a vast continental area of which remnants are preserved in Australia, South Africa, and South America. This continental area has been described as "Gondwana Land," a tract of enormous extent occupying an area, part of which has since given place to a southern ocean, while detached masses persist as portions of more modern continents, which have enabled us to read in their fossil plants and ice-scratched boulders the records of a lost continent in which the Mesozoic vegetation of the northern hemisphere had its birth. Of the rocks of this southern continent those of the Indian Gondwana system are the richest in fossil plants; the most prominent types recorded from these Permo-Carboniferous strata are *Glossopteris, Gangamopteris*, species referred to *Sphenopteris, Pecopteris, Macrotæniopteris*, and other Ferns; *Schizoneura* (Fig. 2) and *Phyllotheca* among the Equisetales, *Nœggerathiopsis* and *Euryphyllum*, probably members of the Cordaitales (*q.v.* in section I. PALÆOZOIC); *Glossozamites* and *Pterophyllum* among the Cycadales, and various vegetative shoots recalling those of the coniferous genus *Völtzia*, a well-known Permian and Triassic plant of northern latitudes. There are no undoubted species of *Lepidodendron, Sigillaria, Stigmaria*, or *Calamites*—genera which played so great a share in the vegetation of the same age in the northern hemisphere.

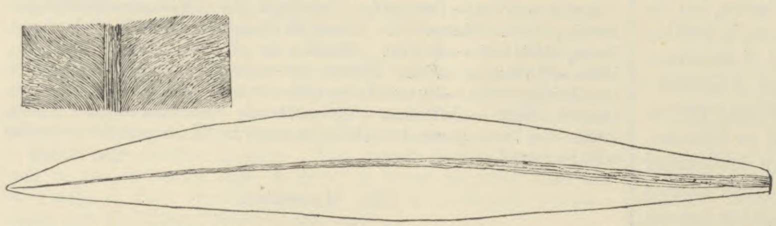
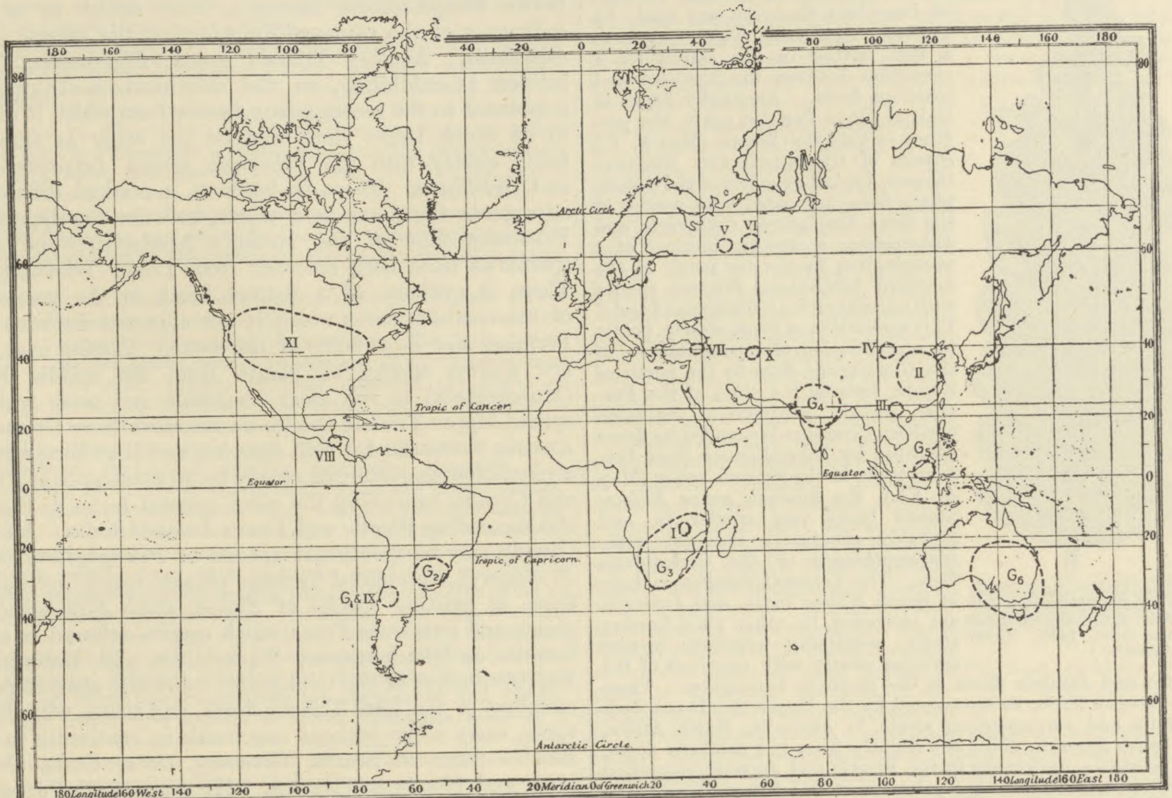


FIG 1.—*Glossopteris* frond, with portion enlarged to show the venation. (Natural size=36 cm. in length.) From Lower Gondwana rocks of India.

We may next inquire what types occur in the Glossopteris flora agreeing more or less closely with members of the rich Permo-Carboniferous vegetation of the north. The genus *Sphenophyllum*, abundant in the Coal Measures and Permian rocks of Europe and America, is represented by a single species recorded from India, *Sphenophyllum speciosum* (Fig. 3); *Annularia*, another common northern genus, is recorded from Australia, and the closely allied *Phyllotheca* constitutes another link between the two Permo-Carboniferous floras. The genus *Cordaites* may be compared with certain forms recorded from India, South America, South Africa, and Australia. While a few similar or even identical types may be recognized in both floras, there can be no doubt that, during



MAP A.—G_1–G_6, Glossopteris Flora. I, II. Upper Carboniferous plants of the northern hemisphere facies, in the Zambezi district and in China; III. Rhætic flora of Tongking (*Glossopteris*, &c.; associated with northern types); IV. Carboniferous plants (prov. Kansu); V. *Glossopteris*, &c., in Permian rocks in prov. Vologda; VI. Permian (Pechora valley); VII. Upper Carboniferous (Herakleion); VIII. Rhætic (Honduras); IX. Lower Jurassic, Upper Gondwana (Argentine); X. Rhætic (Persia); XI. Triassic—Cretaceous.

a considerable period subsequent to that represented by the Lower Carboniferous or Culm rocks, there existed two distinct floras, one of which had its headquarters in the northern hemisphere, while the other flourished in a vast continental area in the south. Recent discoveries have shown that representatives of the two floras coexisted in certain regions; there was, in fact, a dovetailing between the northern and southern botanical provinces. In 1895 Professor Zeiller described several plants from the province of Rio Grande do Sul in South America (Map A, G 2), including a few typical members of the Glossopteris flora associated with a European species, *Lepidophloios laricinus*, one of the characteristic types of the Coal period, and with certain ferns resembling some species from European Permian rocks. A similar association was found also in Argentine rocks by Kurtz (Map A, G_1), and from South Africa *Sigillaria Brardi*, another northern type, is recorded in company with *Glossopteris*, *Gangamopteris*, and *Nœggerathiopsis*.

FIG. 2.—*Schizoneura Gondwanensis*, from Lower Gondwana rocks of India. (*After Feistmantel.*)

The Coal-bearing strata which occupy a considerable area in China (Map A, II.), contain abundant samples of a vegetation which appears to have agreed in the main features with the Permo-Carboniferous floras of the northern hemisphere. In his account of some plants from the Coal Measures of Kansu (Map A, IV.) Dr Krasser has drawn attention to the apparent identity of certain leaf-fragments with those of *Nœggerathiopsis Hislopi*, a typical member of the Glossopteris flora; but this plant, so far as the evidence of vegetative leaves may be of value, differs in no essential respects from certain species of a European genus *Cordaites*. A comparatively rich fossil flora was described in 1882 from Tongking (Map A, III.) by Professor Zeiller—and this author has recently made important additions to his original account—which demonstrates an admixture of Glossopteris types with others which were recognized as identical with plants characteristic of Rhætic strata in Europe. In the Tongking area, therefore, a flora existed during the Rhætic period consisting in part of genera which are abundant in the older Glossopteris beds of the south,

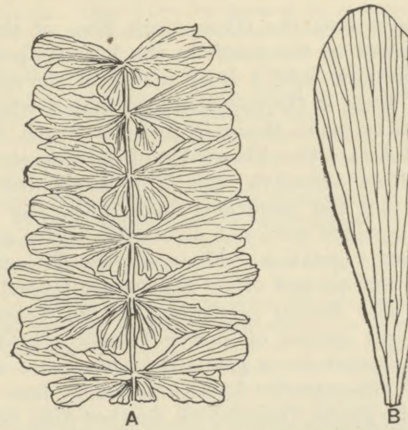


FIG. 3.—*Sphenophyllum speciosum*. From Lower Gondwana rocks, India. A, nat. size; B, leaflet enlarged. (*After Feistmantel.*)

and in part of well-known constituents of European Rhætic floras. A characteristic member of the southern botanical province, *Schizoneura Gondwanensis* (Fig. 2) of India, is represented also by a closely allied if not an identical species—*S. paradoxa*—in the Lower Trias (Bunter) sandstones of the Vosges Mountains, associated with European species which do not occur in the Glossopteris flora. Another plant found in the Vosges sandstones—*Neuropteridium grandifolium*—is also closely allied to species of the same fern recorded from the Lower Gondwana strata of India (Fig. 4) and South America, and recently discovered, but not yet described, by Mr Leslie at Vereeniging in South Africa. These two instances—the Tongking beds of Rhætic age and the Bunter sandstones of the Vosges—afford evidence of a northern extension of Glossopteris types and their association with European species. In 1898 an important discovery was made by Professor Amalitzky, which carries us a step farther in our search for a connexion between the northern and southern floras. Amalitzky found in beds of Upper Permian age in the province of Vologda (Russia) (Map A, V.) species of *Glossopteris* and *Nœggerathiopsis*, typical members of the Glossopteris flora, associated with species of the ferns *Tœniopteris*, *Callipteris*, and *Sphenopteris*, a striking instance of a commingling in the far north of the northern hemisphere Permian species with migrants from "Gondwana Land." This association of types clearly points to a penetration of representatives of the Glossopteris flora to the north of Europe towards the close of the Permian period. Evidence of the same northern extension is supplied by floras described by Schmalhausen from Permian rocks in the Pechora valley (Map A, VI.), the Siberian genus *Rhiptozamites* being very similar to, and probably generically identical with, *Nœggerathiopsis* of the Glossopteris flora. The Permo-Carboniferous beds of South Africa, India, and Australia are succeeded by other plant-bearing strata, containing numerous species agreeing closely with members of the Rhætic and Jurassic floras of the northern hemisphere. These post-Permian floras, as represented by the Upper Gondwana beds of India and corresponding strata in Australia, South Africa, and South America, differ but slightly from the northern floras, and point to a uniformity in the Rhætic and Jurassic vegetation which is in contrast to the existence of two botanical provinces during the latter part of the Palæozoic period. A few plants recently described by Potonié from German and Portuguese East Africa demonstrate the occurrence of *Glossopteris* and a few other genera, referred to a Permo-Triassic horizon, in a region slightly to the north of Tete in the Zambezi district (Map A, I.), where typical European plants agreeing with Upper Carboniferous types were discovered several years ago, and described by Zeiller in 1882 and 1901. The existence of Upper Gondwana plants, resembling Jurassic species from the Rajmahal beds of India, has recently been demonstrated in the Argentine by Dr Kurtz.

FIG. 4.—*Neuropteridium validum.* From Lower Gondwana rocks, India. (*After Feistmantel.*)

Having seen how the Glossopteris flora of the south gradually spread to the north in the Permian period, we may now take a brief survey of the succession of floras in the northern hemisphere, which have left traces in Mesozoic rocks of North America, Europe, and Asia. Our knowledge of the Triassic vegetation is far from extensive; this is no doubt due in part to the fact that the conditions under which the Triassic rocks were deposited were not favourable to the existence of a luxuriant vegetation. Moreover, the Triassic rocks of southern Europe and other regions are typical marine sediments. The Bunter sandstones of the Vosges have afforded several species of Lower Triassic plants; these include the Equisetaceous genus *Schizoneura*—a member also of the Glossopteris flora — bipinnate fern fronds referred to the genus *Anomopteris*, another fern, described originally as *Neuropteris grandifolia*, which agrees very closely with a southern hemisphere type (*Neuropteridium validum*, Fig. 4), some large Equisetaceous stems apparently identical, except in size, with modern Horsetails. With these occur several Conifers, among others *Voltzia heterophylla* and some twigs referred to the genus *Albertia*, bearing large leaves like those of *Agathis australis* and some of the Araucarias, also a few representatives of the Cycadales. Among plants from Lower Triassic strata there are a few which form connecting links with the older Permo-Carboniferous flora; of these we have a species, described by Blankenhorn as *Sigillaria oculina*, which may be correctly referred to that genus, although an inspection of a plaster-cast of the type-specimen in the Berlin Bergakademie leaves a little doubt as to the sufficiency of the evidence for adopting the generic name *Sigillaria*. Another Triassic genus, *Pleuromeia*, is of interest as exhibiting, on the one hand, a striking resemblance to the recent genus *Isoetes*, from which it differs in its much larger stem, and on the other as agreeing fairly closely with the Palæozoic genera *Lepidodendron* and *Sigillaria*. There is, however, a marked difference, as regards the floras as a whole, between the uppermost Palæozoic flora of the northern hemisphere and such species as have been recorded from Lower Triassic beds. There is evidence of a distinct break in the succession of the northern floras which is not apparent between the Permian and Trias floras of the south. Passing over the few known species of plants from the middle Trias (Muschelkalk) to the more abundant and more widely-spread Upper Triassic species as recorded from Germany, Austria, Switzerland, North America, and elsewhere, we find a vegetation characterized chiefly by an abundance of Ferns and Cycads, exhibiting the same general facies as that of the succeeding Rhætic and Lower Jurassic floras. Among Cycads may be mentioned species of *Pterophyllum* (*e.g.*, *P. Jaegeri*), represented by large pinnate fronds not unlike those of existing species of *Zamia*, some Equisetaceous plants and numerous Ferns which may be referred to such families as Gleicheniaceæ, Dipteridinæ, and Matonineæ. Representatives of the Ginkgoales constitute characteristic members of the later Triassic floras, and these, with other types, carry us on without any break in continuity to the Rhætic floras of Scania, Germany, Asia, Chile, Tongking, and Honduras (Map A, VIII.), and to the Jurassic and Wealden floras of many regions in both the north and south hemispheres. A comparative view of the plants found in various parts of the world, in beds ranging from the Upper Trias to the top of the Jurassic system, reveals a striking uniformity in the vegetation both in northern and southern latitudes during this long succession of ages. The Palæozoic types are barely represented; the arborescent Vascular Cryptogams have been replaced by Cycads, Ginkgoales, and Conifers as the dominant classes, while Ferns continue to hold their own. No undoubted Angiosperms have yet been found below the Cretaceous system. From the close of the Permian period, which marks the limit of the Upper Palæozoic floras, to the period immediately preceding the apparently sudden appearance of Angiosperms, we have a succession of floras differing from one another in certain minor details, but linked together by the possession of many characters in common. It is impossible to consider in detail this long period in the history of plant-evolution, but we may briefly pass in review the most striking features of the vegetation as exhibited in the dominant types of the various classes of plants.

Mesozoic floras.

Under the head of Algæ there is little of primary importance to record, but it is of interest to notice the occurrence of certain forms which throw light on the antiquity of existing families of Algæ. Species referred on good evidence to the Charophyta are represented by a few casts of oögonia and stem fragments, found in Jurassic and Wealden beds, which bear a striking resemblance to existing species. There is some evidence for the occurrence of similar *Chara* "fruits" in middle Triassic rocks; some doubtful fossils from the much older Devonian rocks have also been quoted as possible examples of the Charophyta. The oldest known Diatoms are represented by some specimens found entangled in the spicules of a Liassic sponge, and identified by Rothpletz as species of the recent genus *Pyxidicula*. The calcareous Siphoneæ are represented by several forms, identified

Algæ.

as species of *Diplopora, Triploporella, Neomeris*, and other genera, from strata ranging from the Lower Trias limestones of Tirol to the Cretaceous rocks of Mexico and elsewhere. It is probable that the Jurassic *Goniolina*, described from French localities, and other genera which need not be mentioned, may also be reckoned among the Mesozoic Siphoneæ. A genus *Zonatrichites*, compared with species of Cyanophyceæ, has been described as a Calcareous alga from Liassic limestones of Silesia.

The geological history of Mosses and Liverworts is at present very incomplete, and founded on few and generally unsatisfactory fragments. It is hardly too much to say, that no absolutely trustworthy examples of Mosses have so far been found in Mesozoic strata. Of Liverworts there are a few species, such as *Palæohepatica Rostafinskii* from the Lower Jurassic rocks of Cracow, *Marchantites erectus* from the Interior Oolite rocks of Yorkshire, and *M. Zeilleri* from the Wealden beds of Sussex. These fossil Hepaticæ are unfortunately founded only on sterile fragments, and placed in the Liverworts on the strength of their resemblance to the thallus of *Marchantia* and other recent genera.

Bryophyta.

The Palæozoic Calamites were succeeded in the Triassic period by large *Equisetites*, differing, so far as we know, in no essential respect from existing Equisetums. The large stems represented by casts of Triassic age, *Equisetites arenaceus* and other species, probably possessed the power of secondary growth in thickness; the cones were of the modern type, and the rhizomes occasionally formed large underground tubers like those frequently met with in *Equisetum arvense, E. sylvaticum*, and other species. *Equisetites Muensteri* is a characteristic and fairly widely spread Rhætic and Liassic species, having a comparatively slender stem, with leaf-sheaths consisting of a few broad and short leaf-segments. *Equisetites columnaris*, a common fossil in the Jurassic plant-beds of the Yorkshire coast, represents another type with relatively stout and occasionally branched vegetative shoots, bearing leaf-sheaths very like those of *Equisetum maximum* and other Horsetails. In the Wealden strata more slender forms have been found—*e.g.*, *Equisetites Burchardti* and *E. Lyelli*—in England, Germany, Portugal, Japan, and elsewhere, differing still less in dimensions from modern species. Of other Equisetales there are *Schizoneura* and *Phyllotheca*; the former first appears in Lower Gondwana rocks as a member of the Glossopteris flora, migrating at a later epoch into Europe, where it is represented by a Triassic species. The latter genus ranges from Upper Carboniferous to Jurassic rocks; it occurs in India, Australia, and elsewhere in the "Gondwana Land" vegetation, as well as in Palæozoic rocks of Asia Minor, in Permian rocks of Siberia, and in Jurassic plant-beds of Italy. This genus, like the allied *Calamites*, appears to have possessed cones of more than one type; but we know little of the structure of these Mesozoic Equisetaceous genera as compared with our much more complete knowledge of *Calamites* and *Archæocalamites*. (See section I., PALÆOZOIC.)

Equisetaceæ.

Reference has already been made to *Sigillaria oculina* and to the genus *Pleuromeia*. Of other Mesozoic representatives of the Lycopodiales, there are practically none of botanical interest. Palæobotanical literature contains several records of species of *Lycopodites* and *Selaginellites*; nearly all of them are sterile fragments, bearing a more or less close resemblance to living Club-Mosses and Selaginellas, but lacking the more important reproductive organs. A recent investigation of a plant long known from Rhætic rocks in the Severn valley as *Naiadita acuminata* has shown that this genus is in all probability a small Lycopodiaceous plant, and neither a Moss nor a Monocotyledon, as some writers have supposed. One of the most satisfactory species from European rocks is *Lycopodites falcatus*, originally described by Lindley and Hutton in 1831 from the Inferior Oolite of Yorkshire.

Lycopodiales.

Among the large number of Mesozoic Ferns there are several species founded on sterile fronds which possess but little interest from a botanical standpoint. Some plants, again, have been referred by certain authors to Ferns, while others have relegated them to the Cycads. As examples of these doubtful forms may be mentioned *Thinnfeldia*, characteristic of Rhætic and Lower Jurassic rocks; *Dichopteris*, represented by some exceptionally fine Jurassic specimens, described by Zigno, from Italy; and *Ctenis*, a genus chiefly from Jurassic beds, founded on pinnate fronds like those of *Zamia* and other Cycads, with linear pinnæ characterized by anastomosing veins. Plants referred to Schimper's genus *Lomatopteris* and to *Cycadopteris* of Zigno afford other instances of the difficulty of distinguishing between the foliage of Ferns and Cycads. The close resemblance between specimens from Jurassic rocks placed in one or other of the genera *Thinnfeldia, Dichopteris, Cycadopteris*, &c., illustrates the unsatisfactory custom of founding new names on imperfect fronds. It is of interest to note that some leaf-fragments recently found in Permian rocks of Kansas, and placed in a new genus *Glenopteris*, are hardly distinguishable from specimens of Jurassic and Rhætic age referred to *Thinnfeldia* and other Mesozoic genera. The difficulty of distinguishing between Ferns and Cycads is a necessary consequence of the common origin of these two classes; in Palæozoic times the Cycadofilices [see section I., PALÆOZOIC] played a prominent part, and even among recent Cycads and Ferns we still see a few indications of their close relationship. There is reason to believe that compound or synthetic types—partly Ferns and partly Cycads—persisted into the Mesozoic era; but without more anatomical knowledge than we at present possess, it is impossible to do more than to point to a few indications afforded by external, and to a slight extent by internal structure, of the survival of Cycadofilicinean types. The genus *Otozamites*, which it is customary and probably correct to include in the Cycadales, is represented by certain species, such as *Otozamites Beani* (Fig. 5, A), a characteristic Yorkshire fossil of Jurassic age, which in the form of the frond, bearing broad and relatively short pinnæ, exhibits a striking agreement with the sterile portions of the fronds of *Ancimia rotundifolia*. Again, another species of the same genus, *O. Bunburyanus* (Fig. 5, B), suggests a comparison with fern fronds like that of the recent species *Nephrolepis Duffi*. The scaly ramenta which occur in abundance on the leaf-stalk bases of fossil Cycads constitute another fern-character surviving in Mesozoic Cycadales. Without a fuller knowledge of internal structure and of the reproductive organs, we are compelled to speak of some of the Mesozoic plants as possibly Ferns or possibly Cycads, and not referable with certainty to one or other class. It has been found useful in some cases to examine microscopically the thin film of coal that often covers the pinnæ of fossil fronds, in order to determine the form of the epidermal cells which may be preserved in the carbonized cuticle; rectilinear epidermal cell-walls are usually considered characteristic of Cycads, while cells with undulating walls are more likely to belong to ferns. This distinction does not, however, afford a safe guide; the epidermal cells of some ferns, *e.g.*, *Angiopteris*, have straight walls, and occasionally the surface cells of a cycadean leaf-segment exhibit a fern-like character. Leaving out of account the numerous sterile fronds which cannot be certainly referred to particular families of Ferns, there are several genera which bear evidence in their sori, and to some extent in the form of the leaf, of their relationship to existing types.

Filicales.

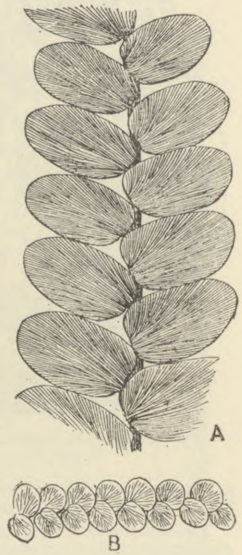


FIG. 5.—A, *Otazamites Beani.* B, *O. Bunburyanus.* Inferior Oolite, England.

The abundance of Palæozoic ferns with sporangia and sori of the Marattiaceous type is in striking contrast to the scarcity of Mesozoic species which can be reasonably included in the Marattiaceæ. One of the few forms so far recorded is that known as *Marattia Muensteri* from Rhætic localities in Europe and Asia. Some species included in the genus *Danæites* or *Danæopsis* from Jurassic rocks of Poland, Austria, and Switzerland may possibly be closely allied to the recent tropical genus *Danæa*. Of the Ophioglossaceæ there are no satisfactory examples; one of the few fossils compared with a recent species, *Ophioglossum palmatum*, was described several years ago from Triassic rocks under the name *Cheiropteris*, but the resemblance is one of external form only, and practically valueless as a taxonomic criterion. It would appear that the eusporangiate Ferns suddenly sank to a very subordinate position after the Palæozoic era.

Marattiaceæ.

The Osmundaceæ, represented by a few forms of Palæozoic age, played a more prominent part in the Mesozoic floras. A species described by Schenk from Rhætic rocks of Franconia as *Acrostichites princeps* is hardly distinguishable from *Todites Williamsoni*, a widely-distributed species in Inferior Oolite strata. This Jurassic species bore bipinnate fronds not unlike those of the South African, Australian, and New Zealand Fern *Todea barbara*, which were characterized by a stout rachis and short broad pinnules bearing numerous large sporangia covering the under surface of the lamina. Specimens of *Todites* have been obtained from England, Poland, and elsewhere, sufficiently well preserved to afford good evidence of a correspondence in the structure of their sporangia with those of recent Osmundaceæ. This Jurassic and Rhætic type occurs in England, Germany, Poland, Italy, East Greenland, North America, Japan, China, and Persia (Map A, X.). Bipinnate sterile fronds of *Todites* have in some instances been described under the designation *Pecopteris Whitbiensis*. This and other names, such as *Asplenium Whitbiense, A. nebbense, Asplenites Roesserti*, &c., have been given to bipinnate fronds of a type frequently met with in different genera and

Osmundaceæ.

families of recent Ferns, *e.g.*, *Onoclea struthiopteris*, species of *Cyathea*, *Asplenium*, *Gymnogramme*, &c. In most cases the Rhætic, Jurassic, and Wealden Ferns included under one or other of these names are sterile, and cannot be assigned to a particular family, but some are undoubtedly the leaves of *Todites*, a genus which may often be recognized by the broad and relatively short bluntly-terminated pinnules. The Jurassic species *Cladophlebis denticulata* (Fig. 6), recorded from several European localities, including Bornholm and the Arctic regions, as well as from North America, Japan, China, Australia, India, and Persia, affords an instance of a common type of bipinnate frond similar to *Todites Williamsoni*, which has been included in the Polypodiaceæ; but such meagre evidence of the soral characters as we possess also points to a comparison with the recent Osmundaceous fern *Todea barbara*. The systematic position of this Jurassic form is still undetermined.

FIG. 6.—*Cladophlebis denticulata*. Inferior Oolite, England.

Schizæaceæ.

The Schizæaceæ include a widely spread species, originally named *Pecopteris exilis*, and recently placed in a new genus, *Klukia* (Fig. 7), which is characterized by tripinnate fronds with short linear ultimate segments, bearing a single row of sporangia with an apical annulus ("monangic sori" of Prantl) on either side of the midrib. This type occurs in Rhætic and Lower Jurassic rocks of England, Poland, the Arctic regions, and Japan. *Ruffordia Gœpperti*, a Wealden type, and probably a member of the Schizæaceæ, has been recorded from England (Yorkshire and Sussex), Belgium, other European countries, and Japan.

FIG. 7.—*Klukia exilis*. 1–3, sporangia enlarged; 4, single fertile pinnule slightly enlarged; 5, fragment of pinna. Inferior Oolite, England.

Gleicheniaceæ.

The Gleicheniaceæ appear to have been represented by Triassic species in North America and Europe, and more abundantly in Jurassic, Wealden, or Lower Cretaceous rocks in Belgium, Greenland, Poland, and elsewhere. Some exceptionally perfect fragments of rhizomes have been found by Dr C. Bommer of Brussels in some Wealden deposits at Bracquegnies (not far from Baume) in Belgium; but these are not yet described. The dichotomously-branched fronds of the type represented by several recent species of *Gleichenia*, *e.g.*, *G. dichotoma*, &c., are abundant in Lower Cretaceous plant-beds of Greenland, and suggest that in the latter part of the Mesozoic period the Gleicheniaceæ held a position in the vegetation of the far north similar to that which they now occupy in the southern tropics of India and other regions.

Matonineæ.

The recent Malayan genus *Matonia* (Map B, Matonia), represented by two species, *M. pectinata* and *M. sarmentosa*, is clearly a survival in tropical latitudes of a family which occupied an important place in the vegetation of the Rhætic, Jurassic, and Wealden periods. The genera *Laccopteris* and *Matonidium* (Fig. 8) may be cited as the two most important types, both as regards geographical and geological range, of this Mesozoic family; these Ferns are recorded from England, France, Belgium, Germany, Austria, Portugal, Poland, and Italy (Map B, M_1), also from Greenland (Map B, M_2), Spitsbergen (Map B, M_3), and Persia (Map B, M_4). From the southern hemisphere, on the other hand, we know of one or two fragments only which can reasonably be referred to the Matonineæ (Map B, M_5), a fact which may point to a northern origin for this family, with its two surviving species almost confined to the Malayan region.

FIG. 8.—*Matonidium Gœpperti*. A, summit of petiole; B, fertile pinnules. Inferior Oolite, England.

Dipteridinæ.

The recent genus, *Dipteris*, with its four existing species, occurring chiefly in the Indo-Malayan region (Map B, Dipteris), is also a modern survival of several Mesozoic types represented by such genera as *Dictyophyllum* (Fig. 9), *Prothorhipis*, and *Camptopteris*, which were abundant during the Rhætic and Jurassic periods in England, Germany, Sweden, and elsewhere in Europe (Map B, D_1). The Dipteridinæ are represented also by species from Mesozoic rocks of Persia (Map B, D_2), Greenland (Map B, D_3), North America (D_4), South America (D_5), and China (D_6).

FIG. 9.—*Dictyophyllum*. Rhætic rocks of Europe. (*After Schenk.*)

Cyatheaceæ.

The Cyatheaceæ constitute another family of leptosporangiate Ferns which had several representatives in Mesozoic floras. The numerous species of fronds from Jurassic and Wealden rocks of North America and Europe referred to *Thyrsopteris*, a recent monotypic genus confined to Juan Fernandez, are in the majority of cases founded on sterile leaves, and of little or no botanical value. On the other hand, there are several fossil Ferns of Jurassic age possessing cup-like sori like those of *Thyrsopteris* and other Cyatheaceous Ferns, which indicate a wide Mesozoic distribution for this family. Among Jurassic species which should probably be classed as Cyatheaceæ, *Coniopteris hymenophylloides* is recorded from England, France, Poland, Bornholm, Italy, the Arctic regions, North America, Japan, China, Australia, and India. A few tree-ferns which may be included in this family, such as *Protopteris*, have been described from Wealden and Lower Cretaceous rocks of England, Germany, and Austria. It is by no means easy in dealing with fossil Ferns to distinguish between certain Polypodiaceæ—such as species of *Davallia*—and members of the Cyatheaceæ.

Polypodiaceæ.

It is a striking fact that among the numerous Mesozoic Ferns there are comparatively few that can with good reason be referred to the Polypodiaceæ, a family which plays so dominant a rôle at the present day. The frequent occurrence of such names as *Asplenium*, *Adiantum*, *Davallia*, and other Polypodiaceous genera in lists of fossil Ferns is thoroughly misleading. There are, indeed, a certain number of species which show traces of sori like those of modern species of *Asplenium* and other genera, but in most cases the names of recent Ferns have been used on insufficient grounds. The Wealden and Jurassic genus, *Onychiopsis* of England, Portugal, Belgium, Germany, Japan, and Australia, bears a close resemblance to the recent *Onychium* (*Cryptogamme*). Other Jurassic Ferns described by Raciborski from Poland suggest a comparison with *Davallia*. Supposed fertile fronds of *Glossopteris* have been described by several authors and referred to the Polypodiaceæ, but in no instance is the evidence enough to warrant more than the suggestion that this abundant southern Fern is a Polypodiaceous genus. The majority of the specimens included in the genus *Cladophlebis*, the Mesozoic representative of the Palæozoic *Pecopteris* type of frond, are known only in a sterile condition, and cannot be assigned to their family position. A Wealden plant, *Weichselia Mantelli*, is worthy of mention as a species of very wide geographical distribution, and one of the most characteristic members of the Wealden flora. This type is distinguished by its large bipinnate fronds bearing long and narrow pinnæ with close-set pinnules, characterized by the anastomosing secondary veins. No traces of sori have so far been found in the fronds. Similarly, the genus *Sagenopteris*, characterized by a habit like that of *Marsilia*, and represented by fronds consisting of a few spreading broadly oval or narrow segments, with anastomosing veins, borne on the apex of a common petiole, is abundant in rocks ranging from

MAP B.—M_1–M_5, Distribution of the *Matonineæ*. D_1–D_6, Distribution of the *Dipteridinæ*. G_1–G_{17}, Distribution of the *Ginkgoales* during the Mesozoic and Tertiary Periods. G_1 (Trias–Tertiary); G_2, G_3 (Rhætic–Jurassic); G_4 (Tertiary, Sakhalin I.); G_5 (Jurassic); G_6 (Jurassic and Tertiary); G_7 (Jurassic); G_8 (Rhætic–Jurassic); G_9 (Trias–Rhætic); G_{10} (Rhætic, Chile); G_{11} (Trias); G_{12} (Cretaceous–Tertiary); G_{13} (Tertiary, Alaska); G_{14} (Cretaceous–Tertiary); G_{15} (Jurassic); G_{16} (Jurassic, Spitsbergen); G_{17} (Jurassic, Franz Josef Land).

the Rhætic to the Wealden, but has not so far been satisfactorily placed. The evidence which led Nathorst and some other writers to refer this plant to the Marsiliaceæ is not convincing, and until we find well-preserved sporocarps we incline to the opinion that *Sagenopteris* is probably a genus of Ferns.

Cycadales.

The abundance of Cycadean plants is one of the most striking features of Mesozoic floras. In most cases we have only the evidence of sterile fronds, and this is necessarily unsatisfactory; but the occurrence of numerous stems and fertile shoots demonstrates the wealth of Cycadean plants in many parts of the world, more particularly during the Jurassic and Wealden periods. From Palæozoic rocks a few fronds have been described, such as *Pterophyllum Fayoli*, *P. Cambrayi*, *Plagiozamites*, and *Sphenozamites*, chiefly from French localities, which are referred to the Cycads because of their similarity to the pinnate fronds of modern Cycadaceæ. In the succeeding Triassic system Cycadean plants become much more abundant, especially in the Keuper period; from Rhætic rocks a still greater number of types have been recorded, among which may be mentioned *Nilssonia* (Fig. 10), *Anomozamites*, *Pterophyllum*, *Otozamites*, *Cycadites* (Fig. 11). The species of *Nilssonia* shown in Fig. 10 (*N. compta*) is a characteristic member of the Jurassic flora, practically identical with a form from Rhætic rocks described as *Nilssonia polymorpha*. The large frond of *Cycadites* represented in Fig. 11 (*C. Saportæ*) is from the Wealden strata of Sussex, and possibly identical with *Cycadites tenuisectus* from Portugal. In addition to these genera there are others, such as *Ctenozamites*, *Ctenis*, and *Podozamites*, the position of which is less certain. *Ctenozamites* occurs chiefly in the Rhætic coal-bearing beds of Scania, and has been found also in the Liassic clays of Dorsetshire and in the Inferior Oolite beds of Yorkshire, as well as in Rhætic strata in Persia and elsewhere; it is characterized by its bipinnate fronds, and may be compared with the recent Australian genus *Bowenia*—peculiar among living Cycads in having bipinnate fronds. *Ctenis* has been placed among the ferns by more than one author, on account of the occurrence of supposed sporangia on its pinnæ; but there is reason to believe that these so-called sporangia are probably nothing more than prominent papillose cells of the epidermis. *Podozamites* (Fig. 12) is usually considered to be a Cycad, but the broad pinnæ (or leaves) and their arrangement on the axis suggests a possible relationship with the southern Coniferous genus *Agathis*, represented by the Kauri Pine and other recent species. The considerable variation in the size of the pinnæ of *Podozamites*, as represented by species from the Jurassic rocks in the Arctic regions and various European localities, recalls the variation in length and breadth of the leaves of *Agathis*. With regard to the distinguishing features and the distribution of the numerous Cycadean leaves of Mesozoic age, the most striking fact is the abundance of fronds, which there is good reason to refer to the Cycadales in Upper Triassic, Rhætic, Jurassic, and Wealden rocks in India, Australia, Japan, China, and elsewhere in the southern hemisphere, as well in North America, Greenland, and other Arctic

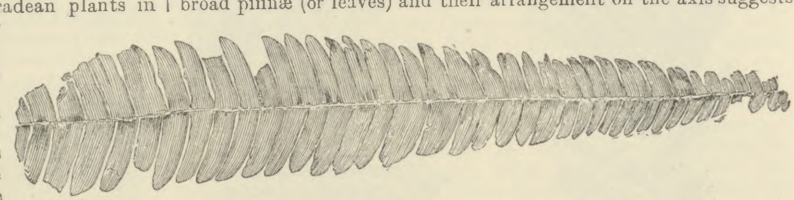


FIG. 10.—*Nilssonia compta*. Inferior Oolite, England.

lands and throughout Europe. It is noteworthy that Tertiary plant-beds have yielded hardly any specimens that can be recognized as Cycads.

A more important question is, What knowledge have we of the reproductive organs and stems of these fossil Cycads? Cycadean stems have recently been found in extraordinary abundance in Jurassic and possibly higher strata in Wyoming and other parts of the United States. Cycadean stems have been found also in the uppermost Jurassic, Wealden, and Lower Cretaceous rocks of England, India, and other parts of the world. An example of an Indian Cycadean stem from Upper Gondwana rocks is represented in Fig. 13; the surface of the trunk is covered with persistent bases (Fig. 13, A) of the fronds known as *Ptilophyllum Cutchense*, which are practically the same as the European species *Williamsonia pecten* (Fig. 17). In a section of the stem (Fig. 13, B) a large pith is seen to occupy the axial region, and this is surrounded by a zone of secondary wood, which appears to differ from the characteristic wood of modern Cycads (see GYMNOSPERMS) in having a more compact structure. The lozenge-shaped areas external to the axis of the stem represent the sections of petioles, some of which are shown in Fig. 13, A, attached to the stem. The majority of Mesozoic stems agree in external appearance with those of recent species of *Encephalartos*, *Macrozamia*, and some other genera; the trunk is encased in a mass of persistent petiole-bases separated from one another by a dense felt or packing of scaly ramenta. The structure of the leaf-stalks is like that of modern Cycads, but the

FIG. 11.—*Cycadites Saportæ*. Wealden, England.

FIG. 12.—*Podozamites lanceolatus*. Inferior Oolite, England.

FIG. 13.—Cycadean stem, from Upper Gondwana rocks, India. A, surface view: B, transverse section of stem.

ramenta, instead of having the form of long unicellular hairs like those on the petioles and bud-scales of existing species, are exactly like the paleæ or ramental scales characteristic of the majority of ferns. This fern-like character affords an interesting survival of the close relationship between Cycads and Ferns. Some recently discovered Jurassic Cycadean stems from Wyoming are characterized by an unusually rich development of ramental scales; the ramenta from the old leaf-bases form an almost complete covering over the surface of the trunk. Professor Lester Ward has instituted a new generic name, *Cycadella*, for these woolly forms. In a few cases the fossil stems show no trace of any lateral flowering shoots, and in that respect agree with modern forms: an instance of this is afforded by a large Cycadean trunk discovered a few years ago in one of the Portland quarries, and named *Cycadeoidea gigantea* (Fig. 14). In this stem the flowers may have been terminal, as in existing Cycads. As a rule, however, the fossil stems show a marked difference from modern forms in the possession of lateral shoots given off from the axils of leaves, and terminating in a flower of complex structure containing numerous orthotropous seeds. These reproductive shoots differ in many important respects from the flowers of recent Cycads, and, chiefly on this account, it is customary to include the plants in a separate genus, *Bennettites*, and in a family—the Bennettitaceæ—distinct from that of the Cycadaceæ as represented by existing Cycads. The best preserved specimens of the true *Bennettites* type so far described are from the Lower Greensand and Wealden of England, and from Upper Mesozoic strata in North America, Italy, and France. A study of the anatomical structure of the vegetative stem, which on the whole is very similar to that of recent Cycads (Fig. 15, 1 and 2), reveals certain characters which are not met with in modern Cycads. The chief distinguishing feature is afforded by the leaf-traces; in recent species (see GYMNOSPERMS) these pursue a somewhat complicated course as they pass from the petiole towards the vascular cylinder of the stem, but in *Bennettites* the vascular bundles from the leaves followed a more direct course through the cortex of the stem (Fig. 15, 3). Among existing types the genus *Macrozamia* appears to show the nearest approach to this simpler structure of the leaf-traces. The typical *Bennettites* female flower (Fig. 15, 4 and 7), as investigated in English, French, Italian, and American specimens, may be briefly described as a short lateral shoot or peduncle, arising in a leaf-axil and terminating in a bluntly rounded apex, bearing numerous linear bracts enclosing a central group of appendages, some of which consist of slender pedicels traversed by a vascular strand and bearing a single terminal ovule enclosed in an integument, which forms a distal canal or micropyle. Associated with these seminiferous pedicels occur sterile appendages consisting of slender stalks, terminating in distal expansions, which form a fleshy covering over the surface of the flower, leaving small apertures immediately above the micropyles for the entrance of the pollen-grains. The seeds have in some cases been preserved in wonderful perfection, enabling one to make out the structure of the embryo, with its bluntly conical radicle and two fleshy cotyledons filling the exalbuminous seed (Fig. 15, 11).

FIG. 14.—*Cycadeoidea gigantea*. Portland rocks, England.

Our knowledge of the reproductive organs of the Bennettitaceæ has until recently been confined to the female flowers, as described by Carruthers, Solms-Laubach, Lignier, and others. The fortunate discovery of several hundred Cycadean stems in the United States, of Lower Cretaceous and Upper Jurassic age, has supplied abundant material, which is now being examined by Mr Wieland. This investigator has already published several short accounts of his discoveries, which give valuable information as to the morphology of the male organs, and lead us to expect results in the future of the greatest importance and interest. On some of the American stems flowers have been found, borne at the apex of lateral shoots, which possess fully developed male organs consisting of sporangia with spores (pollen-grains), surrounding a conical central receptacle bearing numerous small and probably functionless or immature ovules (Fig. 15, 10). The structure of this type of flower may be briefly described as follows. In shape and size the flower is similar to that long known as the female flower of *Bennettites* and *Williamsonia*. A number of hairy linear bracts enclose the whole; internal to these occur 12 to 20 crowded pinnate leaves (sporophylls), with their apical portions bent over towards the axis of the flower, the bases of the petioles being fused laterally into a disc surrounding the base of the conical receptacle. Numerous pairs of pinnules are attached to the rachis of each sporophyll, and the larger pinnules bear 20 to 30 synangia (sori or plurilocular sporangia) (Fig. 15, 8 and 9). The synangia consist of a stout wall composed of thick-walled cells, succeeded by a layer of more delicate and smaller elements; and internal to the wall occur two rows of sporangial loculi containing microspores. When the synangia are ripe dehiscence takes place along a median line between the two rows of loculi. In size, position, arrangement, and manner of dehiscence the sporangia bear a striking resemblance to those of *Marattia* and *Danæa* among recent Marattiaceæ. The most important point elucidated by this discovery is the very close correspondence of the male organs of the *Bennettites* flower with the sporophylls and synangia of Marattiaceous Ferns—a further relic of the common origin of Cycads and Ferns. It remains to be seen if the ovuliferous cone in the centre of the flower represents simply a functionless gynœcium, as in *Welwitschia* and abnormal cones of certain Coniferæ, or if the flowers were hermaphrodite, with both male and female organs fully developed. We have a combination in the same flower of stalked ovules, the structure of which has already been described, and interseminal scales constituting a complex gynœcium, which exhibits in certain features an approach to the Angiospermous type, and differs in structure from other Gymnosperm flowers, associated with male organs constructed on a plan almost identical with that of the sporophylls in Marattiaceæ.

It is clear that *Bennettites* differed in many essential respects from the few modern survivors of the Cycadales. The flowers were more complex in structure, and in the case of the female flowers the almost complete covering of the ovule by sterile foliar organs offers a point of contact with the ovary of the Angiosperms, suggesting a foreshadowing in the Mesozoic Cycadales of the more efficient protection of the ovule characteristic of Monocotyledons and Dicotyledons. Fossil flowers of a type more like that of modern Cycads are few in number, and it is not by any means certain that all of those described as Cycadean flowers and seeds were borne by plants which should be included in the Cycadales; a few female flowers have been described from Rhætic rocks of Scania and elsewhere under the name *Zamiostrobus*—these consist of an axis with slender pedicels or carpophylls given off at a wide angle and bearing two ovules at the distal end; the structure is in fact similar to that of a *Zamia* female flower, in which the internodes of the peduncle have been elongated so as to give a looser arrangement to the carpels. It has been suggested that one at least of the flowers, that originally described by Mr Carruthers from the Inferior Oolite of Yorkshire as *Beania gracilis*, may have been borne by a member of the Ginkgoales. From Jurassic rocks of France and Italy a few imperfect specimens have been described as carpels of Cycads, like those of the recent genus *Cycas* (see GYMNOSPERMS); while a few of these may have been correctly identified, an inspection of some of the original examples in the Paris collections leads one to express the opinion that others are too imperfect to determine. Pinnate fronds of the *Cycas* type, characterized by the presence of a midrib and no lateral veins in the linear pinnæ, are recorded from Rhætic rocks of Germany, from Wealden strata in England (Fig. 11) and Portugal, and from Liassic beds in Dorsetshire. One large specimen is figured by Heer from Lower Cretaceous rocks of Greenland, and by the side of the frond is shown a carpel with lateral ovules, as in the female flower of *Cycas*; but an examination of the type-specimen in the Copenhagen Museum led the present writer to regard this supposed carpel as valueless. Another well-known Cycadean genus is *Williamsonia*, so named by Mr Carruthers in 1870, and now applied to certain pinnate fronds—*e.g.*, those previously described as *Zamites gigas* (Fig. 16), and others known under such names as *Pterophyllum* or *Ptilophyllum pecten*, &c., both common Jurassic species—as well as to stems bearing peduncles with terminal oval flowers, similar in form to those of *Bennettites*. There is good evidence for supporting Professor Williamson's conclusions as to the organic connexion between the flowers, originally described from Inferior Oolite rocks of Yorkshire and subsequently named *Williamsonia* (Fig. 15), and the fronds of *Zamites gigas*, now known as *Williamsonia gigas* (Fig. 16). There can be little doubt that the majority of the Cycadean fronds of Jurassic and Wealden age, which are nearly always found detached from the rest of the plant, were borne on stems of the *Bennettites* type. Williamson was the first to express the opinion that the Bennettitean flowers known as *Williamsonia* were borne on the trunks which terminated in a crown of pinnate fronds of the type long known as *Zamites gigas*;

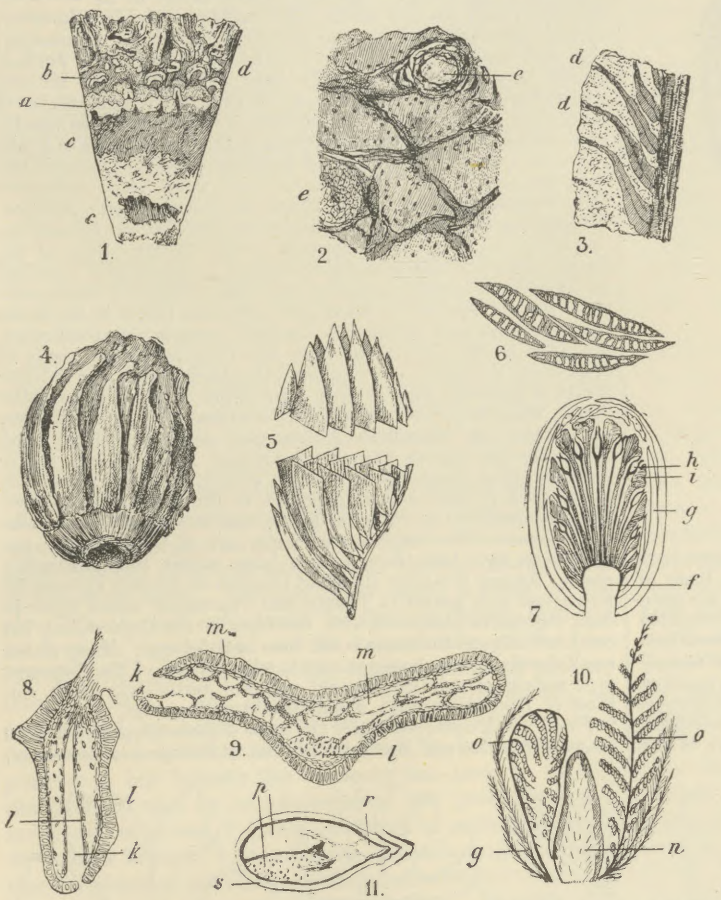


FIG. 15.—1, *Bennettites* stem: portion of transverse section of stem; *a*, vascular cylinder; *b*, leaf-traces; *c*, pith; *d*, cortex. 2, *Bennettites* stem, tangential section; *e*, flower-peduncles. 3, *Bennettites* stem, leaf-traces attached to the vascular cylinder and passing as simple strands through the cortex; *d*, cortex. 4, *Williamsonia*, Wealden, England. 5, Young leaf of *Bennettites*. 6, Ramenta of *Bennettites* in transverse section. 7, *Bennettites*, female flower in longitudinal section; *f*, apex of peduncle; *g*, bracts (shown in surface view in 4); *h*, seeds and seminiferous pedicels; *i*, interseminal scales. 8, *Bennettites*, synangium of male flower, showing line of dehiscence, *k*, and microspores, *l*. 9, Synangium, in transverse section, showing sporangial groups, *m*, and microspores, *l*. 10, *Bennettites* flower in vertical section, showing the central female portion, *n*, two sporophylls bearing synangia (male), *o*, and hairy bracts, *g*. 11, *Bennettites* seed in longitudinal section, showing the dicotyledonous embryo; *p*, cotyledons; *r*, radicle; *s*, testa. (1–3, *after Carruthers*; 5, 8, 9, and 10, *after Wieland*; 7, *after Scott*; 11, *after Solms-Laubach*.)

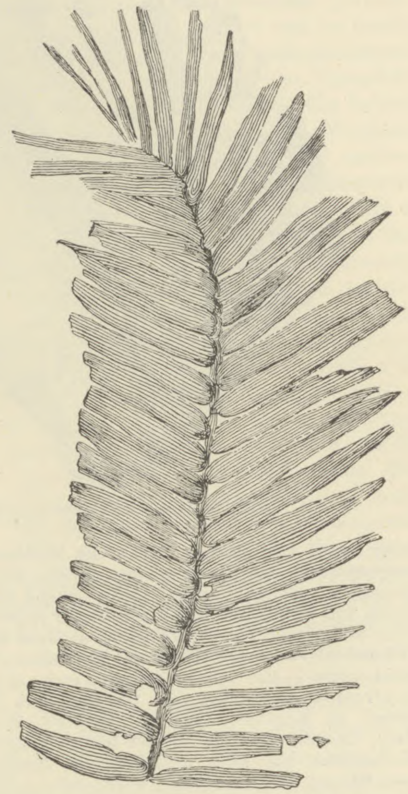


FIG. 16.—Frond of *Williamsonia gigas*. Inferior Oolite, England.

this view was regarded by Saporta and others as incorrect, and the nature of the Bennettitean foliage was left an open question. A recent re-examination of the English material in the museums of Paris and elsewhere has confirmed Williamson's conclusions. Mr Wieland of Yale has also described young bipinnate fronds, very like those of recent species of *Zamia* and *Encephalartos*, attached to a *Bennettites* stem, and exhibiting the vernation characters of

FIG. 17.—Fronds of *Williamsonia pecten.*

many recent Cycads (Fig. 15, 5). In *Williamsonia* the stem bore comparatively long fertile shoots, which, in contrast to those of *Bennettites*, projected several inches beyond the surface of the main trunk, and terminated in a flower which appears to have resembled those of the true *Bennettites*, so far at least as can be ascertained without the assistance of internal structure. The genus *Williamsonia* occurs in the Upper Gondwana rocks of India; it is recorded also from strata ranging from the Rhætic to the Lower Cretaceous period in England, Portugal, Sweden, Bornholm, Greenland, Italy, Canada, and the United States. Another member of the Bennettiteæ has been described by Nathorst from Rhætic beds in Scania, where certain Cycadean fronds, originally named by Brongniart *Anomozamites minor*, have been found in connexion with Bennettitean flowers; the specimens in the Stockholm Museum bear out Professor Nathorst's description. It would seem a safe statement to make, that the Cycadales, including both Cycadaceæ and Bennettiteæ, were represented during the Mesozoic period by a large number of species of almost world-wide distribution. These included some forms with flowers very similar to those of living genera, *e.g.*, *Androstrobus Balduini* from Bathonian rocks of France; *Zamites familiaris*, described many years ago by Corda, from Lower Cretaceous rocks of Bohemia, and *Androstrobus Nathorsti*, from Wealden beds in Sussex; but the majority of the species were characterized by flowers of a different type known as *Bennettites* and *Williamsonia*.

Ginkgoales. The living Maidenhair tree, *Ginkgo biloba* (see GYMNOSPERMS), remains, like *Matonia* and *Dipteris* among the ferns, as an isolated relic in the midst of recent vegetation. In Rhætic, Jurassic, and Wealden floras the Ginkgoales were exceedingly abundant (Map B, G_1–G_{17}); in addition to leaves agreeing almost exactly with those of the recent species (Fig. 18), there are others separated as a distinct genus, *Baiera* (Fig. 18, G), characterized by the greater number and narrower form of the segments, which may be best compared with such leaves as those of the recent fern *Actiniopteris* and of certain species of *Schizæa*. Male flowers, like those of *Ginkgo biloba*, but usually characterized by a rather larger number of oval pollen-sacs on the stamens, have been found in England, Germany, Siberia, and elsewhere in association with *Ginkgo* and *Baiera* foliage. The occasional occurrence of three or even four pollen-sacs on the stamens of the recent species affords a still closer agreement between the

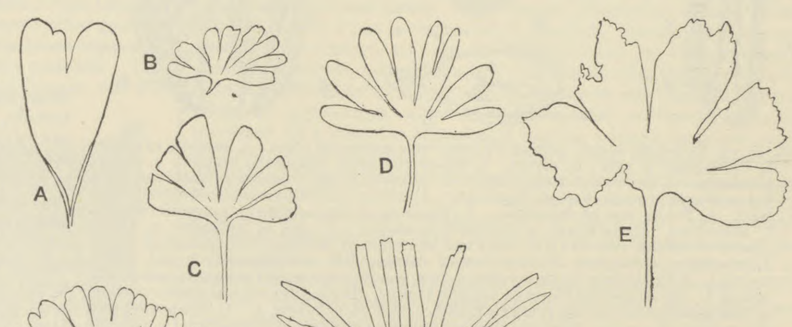


FIG. 18.—Leaves of Ginkgoales. A, *Ginkgodium*, Japan (Jurassic). B, C, D, E, F, H, *Ginkgo* leaves. B, from Franz Josef Land (Jurassic); C, Greenland (Lower Cretaceous); D, Siberia (Jurassic); E, Germany (Wealden); F, England (Jurassic); H, China (Rhætic); G, *Baiera* leaf, Inferior Oolite, England. (A, *after Yokoyama*; B, *after Nathorst*; C, D, *after Heer*; E, *after Schenk*; H, *after Krasser*. All the figures ½ nat. size.)

extinct and living types. Seeds like those of *Ginkgo biloba* have also been recorded as fossils in Jurassic rocks, and it is not improbable that the type of flower known as *Beania*, from the Inferior Oolite rocks of Yorkshire, may have been borne by *Ginkgo* or *Baiera*. The regions from which satisfactory examples of Ginkgoales (*Baiera* or *Ginkgo*) have been recorded are shown in Map B (G_1–G_{17}). Both Tertiary and Mesozoic localities are indicated in the map.

Coniferales. An adequate account of fossil Mesozoic Conifers is impossible within the limits of this article. Coniferous twigs are very common in Mesozoic strata, but in most cases we are compelled to refer them to provisional genera, as the evidence of vegetative shoots alone is not sufficient to enable us to determine their position within the Coniferæ. There are, however, several forms which it is reasonable to include in the Araucarieæ; that this family was to the fore in the vegetation of the Jurassic period is unquestionable. We have not merely the striking resemblance of vegetative shoots to those of recent species of *Araucaria* and *Agathis*, *e.g.*, species of *Nageiopsis*, abundantly represented in the upper Jurassic beds of the Potomac area in North America, species of *Pagiophyllum* and other genera of Jurassic and Wealden age, but an abundance of fossil wood (*Araucarioxylon*) from Jurassic and Cretaceous strata in Europe, North America, Madagascar, and elsewhere agreeing with that of recent Araucarieæ, in addition to several well-preserved female flowers. Some of the fossils referred to the genus *Kaidocarpon*, and originally described as monocotyledonous inflorescences, are undoubted Araucarian cones; other cones of the same type have been placed in the genus *Cycadeostrobus* and referred to Cycads. *Araucarites Hudlestoni*, described by Mr Carruthers from the Coralline Oolite rocks of Malton in Yorkshire, *Araucarites sphærocarpa* from the Inferior Oolite of Somerset, also another cone found in the Northampton Sands, which is probably specifically identical with *A. Hudlestoni*, and named by Carruthers *Kaidocarpon ooliticum*, afford good illustrations of British Araucarian flowers. A flower of a rather different type, *Pseudaraucaria major*, exhibiting in the occurrence of two seeds in each scale an approach to the cones of Abietineæ, has been described by Professor Fliche from Lower Cretaceous rocks of Argonne. The well-known Whitby jet of Upper Liassic age appears to have been formed to a large extent from Araucarian wood. Among the more abundant Conifers of Jurassic age may be mentioned such genera as *Thuytes* and *Cupressites*, which agree in their vegetative characters with members of the Cupressineæ, but our knowledge of the cones is far from satisfactory. Many of the small female flowers borne on shoots with foliage of the *Cupressus* type consist of spirally disposed and not verticillate scales, *e.g.* those of *Thuytes expansus*, a common Jurassic species.

Fossil wood, described under the name *Cupressinoxylon*, has been recorded from several Mesozoic horizons in Europe and elsewhere, but this term has been employed in a wide sense as a designation for a type of structure met with not only in the Cupressineæ, but in members of other families of Coniferæ. The Abietineæ do not appear to have played a prominent part before the Wealden period; various older species, *e.g.*, Rhætic specimens from Scania, are recorded, but it is not until we come to the Upper Jurassic and Wealden periods that this modern family was abundantly represented. Fossil wood of the *Pinites* type (*Pityoxylon*) has been described from England, France, Germany, Sweden, Spitsbergen, North America, and elsewhere; some of the best British examples have been obtained from the so-called Pine-raft, the remains of water-logged and petrified wood of Lower Greensand age, seen at low water near Brook Point in the Isle of Wight. Well-preserved Abietineous female flowers have been obtained from the Wealden rocks of England and Belgium, *e.g.*, *Pinites Dunkeri*, *P. Solmsi*, &c.; specimens of seeds and vegetative shoots are recorded also from Spitsbergen, Franz Josef Land, and other regions. Cones of Lower Cretaceous age have been described by Fliche from Argonne, which bear a close resemblance to the female flowers of recent species of *Cedrus*. The striking resemblance between such a fossil genus as *Brachyphyllum* and the Tasmanian Conifer *Athrotaxis* is striking enough to warrant a comparison; but in this case actual proof of close relationship is lacking. The two surviving species of *Sequoia* afford an illustration of the persistence of an old type, but unfortunately most of the Mesozoic species referred to this genus do not possess sufficiently perfect cones to confirm their identification as examples of *Sequoia*. Some of the best examples of cones and twigs which have been referred to *Sequoia* are those described by Heer from Cretaceous rocks of Greenland.

There are a few points suggested by a general survey of the Mesozoic floras, which may be briefly touched on in conclusion. In following the progress of plant-life through those periods in the history of the earth of which records are left in ancient sediments, seams of coal, or old land-surfaces, we recognize at certain stages a want of continuity between the floras of successive ages. The imperfection of the geological record, considered from the point of view of evolution, has been rendered familiar by Darwin's remarkable chapter in the *Origin of Species*. Breaks in the chain of life, as represented by gaps in the blurred and incomplete documents afforded by fragmentary fossils, are a necessary consequence of the general plan of geological evolution; they mark missing chapters rather than sudden breaks in an evolutionary series. On the other hand, a study of the plant-life of past ages tends to the conviction that too much stress may be laid on the imperfection of the geological record as a factor in the interpretation of palæontological data. The doctrine of Uniformitarianism, as propounded by Lyell, served to establish geology on a firmer and more rational basis than it had previously possessed; but latterly the tendency has been to modify the Lyellian view by an admission of the probability of a more intense action of groups of forces at certain stages of the earth's history. As a definite instance, a short review may be given of the evidence of palæobotanical records as regards their bearing on plant-evolution. Starting with the Permo-Carboniferous vegetation, and omitting for the moment the Glossopteris flora, we find a comparatively homogeneous flora of wide geographical range, consisting to a large extent of arborescent Lycopods, Calamites, and other Vascular Cryptogams, plants which occupied a place comparable with that of Gymnosperms and Angiosperms in our modern forests; with these were other types of the greatest phylogenetic importance, which serve as finger-posts pointing to lines of evolution of which we have but the faintest signs among existing plants. Other types, again, which may be referred to the Gymnosperms, played a not unimportant part in the Palæozoic vegetation. No conclusive proof has so far been adduced of the existence in those days of the Cycads, nor is there more than partial evidence of the occurrence of genera which can be placed with confidence in any of the existing families of Conifers. There are, moreover, no facts furnished by fossil plants in support of the view that Angiosperms were represented either in the low-lying forests or on the slopes of the mountains of the Coal period. Passing higher up the geological series, we find but scanty records of the vegetation that existed during the closing ages of the Permian period, and of the plants which witnessed the beginning of the Triassic period we have to be content with the most fragmentary relics. It is in rocks of Upper Triassic and Rhætic age that abundant remains of rich floras are met with, and an examination of the general features of the vegetation reveals a striking contrast between the Lower Mesozoic plants and those of the Palæozoic period. Arborescent Pteridophytes are barely represented, but such dominant types as *Lepidodendron*, *Sigillaria*, *Calamites*, and *Sphenophyllum* have practically ceased to exist; Cycads and Conifers have assumed the leading rôle, and the still luxuriant fern vegetation has put on a different aspect. This description applies almost equally to the floras of the succeeding Jurassic and Wealden periods. The change to this newer type of vegetation was no doubt less sudden than it appears as read from palæobotanical records, but the transition period between the Palæozoic type of vegetation and that which flourished in the Lower Mesozoic era, and continued to the close of the Wealden age, was probably characterized by rapid or almost sudden changes. In the southern hemisphere the Glossopteris flora succeeded a Lower Carboniferous vegetation with a rapidity similar to that which marked the passage in the north from Palæozoic to Mesozoic floras. This apparently rapid alteration in the character of the southern vegetation took place at an earlier period than that which witnessed the transformation in the northern hemisphere. The appearance of a new type of vegetation in India and the southern hemisphere was probably connected with a widespread lowering of temperature, to which reference has already been made. It was from this Glossopteris flora that several types gradually migrated across the equator, where they formed part of the vegetation of more northern regions. The difference between the Glossopteris flora and those which have left traces in the Upper Gondwana rocks of India, in the Wianamatta and Hawkesbury beds of Australia, and in the Stormberg series of South Africa is much less marked than that between the Permo-Carboniferous flora of the northern hemisphere and the succeeding Mesozoic vegetation. In other words, the change took place at an earlier period in the south than in the north. To return to the northern hemisphere, it is clear that the Wealden flora, as represented by plants recorded from England, France, Belgium, Portugal, Russia, Germany, and other European regions, as also from Japan and elsewhere, carries on, with minor differences, the facies of the older Jurassic floras. It was at the close of the Wealden period that a second evolutionary wave swept over the vegetation of the world. This change is most strikingly illustrated by the inrush of Angiosperms, in the equally marked decrease in the Cycads, and in the altered character of the Ferns. It would appear that in this case the new influence, supplied by the advent of Angiosperms, had its origin in the north. Unfortunately, our knowledge of the later floras in the southern hemisphere is very incomplete, but a similar transformation appears to have characterized the vegetation south of the equator. As to the nature of the chief factors concerned in the two revolutions in the vegetable kingdom, if it is admissible to use so strong a term, only a guess can be hazarded. Physical conditions no doubt played an important part, but whatever cause may have had the greatest share in disturbing the equilibrium of evolutionary forces, it would seem that the apparently sudden appearance of Cycads and other types at the close of the Palæozoic period made a widespread and sudden impression on the whole character of the vegetation. At a later stage—in post-Wealden days—it was the appearance of Angiosperms, probably in northern latitudes, that formed the chief motive power in accelerating the transition in the facies of plant-life from that which marked what we have called the Mesozoic floras, to the vegetation of the Upper Cretaceous and Tertiary periods. With the advent of Angiosperms began, as the late Marquis of Saporta expressed it, "Une révolution, ainsi rapide dans sa marche qu'universelle dans ses effets." From the floras of Tertiary age we pass by gradual stages to those which characterize the present phase of evolutionary progress. Among modern floras we find here and there isolated types, such as *Ginkgo*, *Sequoia*, *Matonia*, *Dipteris*, and the Cycads, persisting as more successful survivals which have held their own through the course of ages; these plants remain as vestiges from a remote past, and as links connecting the vegetation of to-day with that of the Mesozoic era.

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III. TERTIARY.

Lower Cretaceous.

After the Wealden period, and before the deposition of the lowest strata of the Chalk, so remarkable a change takes place in the character of the vegetation that this break must be taken as, botanically, the transition point from a Secondary to a Tertiary flora. A flora consisting entirely, with a single doubtful exception, of Gymnosperms and Cryptogams gives place to one containing many flowering plants; and these increase so rapidly that before long they seem to have crowded out many of the earlier types, and to have themselves become the dominant forms. Not only do Angiosperms suddenly become dominant in all known plant-bearing deposits of Upper Cretaceous age, but strangely enough the earliest found seem to belong to living orders, and commonly are referable to existing genera. From Cretaceous times onwards local distribution may change; yet the successive floras can be analysed in the same way as, and compared with, the living floras of different regions. World-wide floras, such as seem to characterize some of the older periods, have ceased to be, and plants are distributed more markedly according to geographical provinces and in climatic zones. This being the case, it will be most convenient to discuss the Tertiary floras in successive order of appearance, since the main interest no longer lies in the occurrence of strange extinct plants or of transitional forms connecting orders now completely isolated.

The accurate correlation in time of the various scattered plant-bearing deposits is a matter of considerable difficulty, for plant-remains are preserved principally in lacustrine strata laid down in separate basins of small extent. This it is obvious must commonly be the case, as most leaves and fruits are not calculated to drift far in the sea without injury or in abundance; nor are they likely as a rule to be associated with marine organisms. Deposits containing marine fossils can be compared even when widely separated, for the ocean is continuous and many marine species are world-wide. Plants, on the other hand, like land and fresh-water animals, occupied areas which may or may not have been continuous. Therefore, without a knowledge of the physical geography of any particular period, we cannot know whether like or unlike floras might be expected in neighbouring areas during that period. If, however, we discover plant-bearing strata interstratified with deposits containing marine fossils, we can fix the period to which the plants belong, and may be able to correlate them in distinct areas, even though the floras be unlike. This clear stratigraphical evidence is, however, so rarely found, that much uncertainty still remains as to the true age of several of the floras now to be described.

In rocks approximately equivalent to the Lower Greensand of England, or slightly earlier, Angiosperms make their first appearance; but as the only strata of this age in Britain are of marine origin, we have to turn to other countries for the evidence. The earliest Angiosperm yet found in Europe is a single monocotyledonous leaf of doubtful affinities, named by Saporta *Alismacites primævus* (Fig. 1) and found in the Valenginian strata of Portugal. These deposits seem to be equivalent to British Wealden rocks, though in the latter, even in their upper part, no trace of Angiosperms has been discovered. No other undoubted Angiosperm has yet been discovered in Europe in strata of this age, but Heer records a poplar-like leaf from Urgonian strata, a stage newer than the Valenginian, in Greenland, and Saporta has described from strata of the same date in Portugal a Euphorbiaceous plant apparently closely allied to the living *Phyllanthus* and named by him *Choffatia Francheti* (Fig. 2). We must turn to North America for a fuller knowledge of the earliest flowering plants.

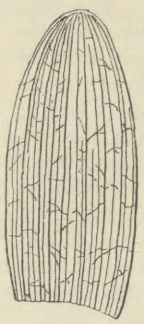

FIG. 1.—*Alismacites primævus.*

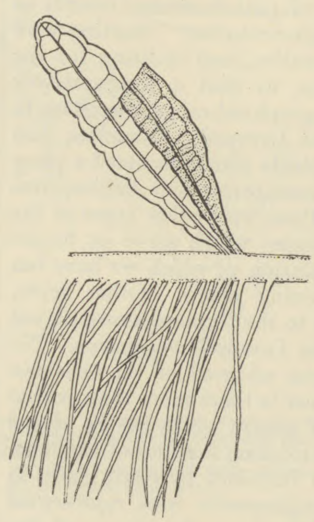

FIG. 2.—*Choffatia Francheti.*

American Cretaceous.

In Dakota a remarkable series has been discovered, lying unmistakably between marine Upper Jurassic rocks below and Upper Cretaceous above. There has been a certain amount of confusion as to the exact strata in which the plants occur, but this has now been cleared up by the researches of Lester Ward, who has shown how the Secondary flora gives place to one of Tertiary character. The lower strata—*i.e.*, those most allied to the Jurassic—contain only Gymnosperms and Cryptogams. The next division (Dakota No. 2 of Meek and Hayden) contains Gymnosperms and Ferns of Neocomian types, or even of Neocomian species; but mingled with these occur a few dicotyledonous leaves belonging to four genera. The specimens are very fragmentary, and all that can be said is that one of the forms may be allied to oak, another to fig, a third to *Sapindus*, and the fourth may perhaps be near to elm. The "Potomac Formation" of Virginia and Maryland is doubtless also mainly of Neocomian age, for though it rests unconformably on much older strata, the successive floras found in it are so allied to those of Dakota as to leave little doubt as to the general homotaxis of the series. Lester Ward records no fewer than 737 distinct forms, consisting chiefly of Ferns, Cycads, Conifers, and Dicotyledons, the Ferns and Cycads being confined mainly to the Older Potomac, while the Dicotyledons are principally represented in the Newer Potomac, though occurring more rarely even down to the base of the series. Six successive stages have been defined in the Potomac formation. The Mount Vernon beds, which occur about the middle of the series, have as yet yielded only a small number of species, though these include the most interesting early Angiosperms. Among them are recorded a *Casuarina*, a leaf of *Sagittaria* (which however, as observed by Zeiller, may belong to *Smilax*), two species of poplar-like leaves with remarkably cordate bases, *Menispermites* (possibly a water-lily), and *Celastrophyllum* (perhaps allied to *Celastrus*). *Proteophyllum*, found in the same bed, and also in the Infra-Cretaceous of Portugal, seems to have belonged to a Proteaceous plant, though only leaves without fruits have yet been discovered in deposits of this early date. Whatever doubt may be left as to the exact botanical position of these early Lower Cretaceous Angiosperms, it is clear that both Monocotyledons and Dicotyledons are represented by several types of leaves, and that the flora extended over wide areas in North America and Greenland, and is found again at a few points in Europe. There is as yet no clear evidence either of climatic zones or of the existence of geographical provinces during this period.

The next strata, the Aquila Creek series, contain a well-marked dicotyledonous flora, in which both the form and nervation of the leaves begin to approximate to those of recent times. The leading characteristic of this Middle Potomac flora is the proportion of Dicotyledons. Notwithstanding this apparent passage-bed, there is a marked difference between the Older and the Newer Potomac floras, very few species passing from the one to the other. Only 15 out of 405 plants in the older series occur in the beds above, though already more than 350 species have been determined from this newer series. The plants from the Amboy Clays, which form the most important division of the Newer Potomac series and were monographed in 1895 by Newberry, seem to belong to the commencement of the Upper Cretaceous period. It is remarkable that nearly 80 per cent. of the species are Dicotyledons, and that no Monocotyledons have been found. The mere enumeration of the genera will indicate how close the flowering plants are to living forms. Newberry records *Juglans*, *Myrica* (7 species), *Populus*, *Salix* (5 species), *Quercus*, *Planera*, *Ficus* (3 species), *Persoonia* and another extinct Proteaceous genus named *Proteoides*, Magnolia (7 species), *Liriodendron* (4 species), *Menispermites*, *Laurus*, and allied plants, *Sassafras* (3 species), *Cinnamomum*, *Prunus*, *Hymenœa*, *Dalbergia*, *Bauhinia*, *Caesalpinia*, *Fontainea*, *Colutea*, and other Leguminosæ, *Ilex*, *Celastrus*, *Celastrophyllum* (10 species), *Acer*, *Rhamnites*, *Paliurus*, *Cissites*, *Tiliœphyllum*, *Passiflora*, *Eucalyptus* (5 species), *Hedera*, *Aralia* (8 species), *Cornophyllum*, *Andromeda* (4 species), *Myrsine*, *Sapotacites*, *Diospyros*, *Acerates*, *Viburnum*, and various genera of uncertain affinities. The points that suggest themselves with regard to this flora are, that it includes a fair representation of the existing orders of warm-temperate deciduous trees; that the more primitive types, such as the *Amentaceæ*, do not appear to preponderate to a greater extent than they do in the existing temperate flora; that the assemblage somewhat suggests American affinities; and that when we take into account deficient collecting, local conditions, and the non-preservation of succulent plants, there is no reason for saying that certain other orders must have been absent. The great rarity of Monocotyledons is a common characteristic of fossil floras known only, as this one is, from leaves principally belonging to deciduous trees. With regard to suggested American affinities, it must be borne in mind that the Neocomian Angiosperms are little known except in America and in Greenland, and that we therefore cannot yet say whether families now mainly American were not formerly of world-wide distribution. We know that this was the case with some, such as *Liriodendron*; and in *Eucalyptus* we see the converse, where a genus formerly American is now confined to a far distant region. The Neocomian flora has been collected from an area extending over about 30° of latitude; but there is little evidence of any corresponding climatic change. We cannot yet say, however, that the deposits are exactly contemporaneous, and the great climatic variations that have taken place in the northern hemisphere during the existence of our living flora should make us hesitate to correlate too minutely from the evidence of plants alone.

The highest division of the Dakota series (known as Dakota No. 1) which lies immediately beneath Upper Cretaceous strata with marine fossils, contains a flora so like that of the Tertiary deposits that only the clearest geological evidence has been considered sufficient to prove that Heer was wrong when he spoke of the plants as Miocene. These highest plant-bearing strata rest, according to Lester Ward, somewhat unconformably on the Dakota No. 2; they show also a marked difference in the included plants. The genera of Dicotyledons represented are *Quercus*, *Sassafras*, *Platanus*, *Celastrophyllum*, *Cissites*, *Viburnites*.

In the central parts of North America the lacustrine plant-bearing deposits are of enormous thickness, the Dakota series being followed by marine Cretaceous strata known as the Colorado and Montana groups, and these being succeeded conformably by a thousand feet or more of lacustrine shales, sandstones, and coal-seams belonging to the Laramie series. This also contains occasional marine Upper Cretaceous fossils, as well as reptiles of Cretaceous types. An extensive literature has grown up relating to these Laramie strata, for owing to the Tertiary aspect of the contained plants, geologists were slow to recognize that they could be truly contemporaneous and interbedded with others yielding Cretaceous animals. In addition to this, the earlier writers included in the Laramie series many deposits now known to be of later date and truly Tertiary, and the process of separation is even now only partially completed. It will be safest in these circumstances to accept as our guide to the true Laramie flora the carefully compiled "Catalogue" of Mr Knowlton. According to this catalogue, the true Laramie flora includes about 250 species, more than half of which are deciduous forest trees, herbaceous Dicotyledons, Monocotyledons, and Cryptogams all being but poorly represented. Among the few Monocotyledons are leaves and fruits of palms, and traces of grasses and sedges. The Dicotyledons include several water-lilies, a somewhat doubtful *Trapa*, and many genera of forest trees still common in America. The genera best represented are *Ficus* (21 species), *Quercus* (16 species), *Populus* (11 species), *Rhamnus* (9 species), *Platanus* (8 species), *Viburnum* (7 species), *Magnolia*

(6 species), *Cornus* (5 species), *Cinnamomum* (5 species), *Juglans* (4 species), *Acer* (4 species), *Salix* (4 species), *Aralia* (3 species), *Rhus* (3 species), *Sequoia* (3 species). Of trees now extinct in America, *Eucalyptus* and *Ginkgo* are perhaps the most noticeable. So large a proportion of the trees still belongs to the flora of North America that one is apt to overlook the fact that among the more specialized plants some of the largest American orders, such as the *Compositæ*, are still missing from strata belonging to the Cretaceous period.

European Cretaceous. The imperfection and want of continuity of the records in Europe have made it necessary in dealing with the Cretaceous floras for us to give the first place to America. But it is now advisable to return to Europe, where Upper Cretaceous plants are not uncommon, and the position of the deposits in the Cretaceous series can often be fixed accurately by their close association with marine strata belonging to definite subdivisions. As these divisions of Cretaceous time will have to be referred to more than once, it will be useful to tabulate them, thus showing which plant-beds seem to be referable to each, and what are the British strata of like age. It has not yet been found possible so closely to correlate the strata of Europe with those of America, where distance has allowed geographical differences in both fauna and flora to come into play; therefore, beyond the references to Lower or Upper Cretaceous, no classification of the American Cretaceous strata has here been given. In Europe the most commonly accepted divisions of the Cretaceous period are as follows:—

England.	France, &c.
Wanting	Danian
Upper Chalk	Senonian
Middle Chalk	Turonian
Lower Chalk, Upper Greensand	Cenomanian
Gault	Albian·
	Aptian
Lower Greensand	Valenginian
	Urgonian
Wealden	Neocomian

In the Continental classification the deposits from the Gault downwards are grouped as Lower Cretaceous; but in Great Britain there is a strong break below the Gault and none above; and the Gault is therefore classed as Upper Cretaceous. The limits of the divisions in other places do not correspond, the British and Continental strata often being so unlike that it is almost impossible to compare them. The doubt as to the exact British equivalent of the Valenginian strata of Portugal, which yield the earliest Dicotyledon, has already been alluded to. The plant-bearing deposits next in age, which have yielded Angiosperms, appear to belong to the Cenomanian, though from Westphalia a few species belonging to the Cryptogams and Gymnosperms, found in deposits correlated with the Gault, have been described by Hosius and von der Marck.

In Great Britain the whole of the Upper Cretaceous strata are of marine origin, and have yielded no land-plants beyond a few fir-cones, drift-wood, and rare Dicotyledonous leaves in the Lower Chalk. Most of the deposits which have yielded Angiosperms of Cretaceous age in central Europe correspond in age with the English Upper Chalk (Senonian) but a small Cenomanian flora has been collected from the Unter Quader in Moravia. Heer described from this deposit at Moletein 13 genera, of which 7 are still living, containing 18 species, viz., 1 fern, 4 Conifers, 1 palm, 2 figs, 1 *Credneria*, 2 laurels, 1 *Aralia*, 1 *Chondrophyllum* (of uncertain affinities), 2 magnolias, 2 species of *Myrtaceæ*, and a species of walnut. Saxony yields from strata of this period at Niederschoena 42 species, described by Ettingshausen. This small flora is most remarkable, for no fewer than 6 genera, containing 8 species, are referred to the *Proteaceæ*. The Cenomanian flora of Bohemia is larger and equally peculiar. Among the Dicotyledons described by Velenovsky are the following:—*Credneria* (5 species), *Araliaceæ* (17 species), *Proteaceæ* (8 species), *Myrica* (2 species), *Ficus* (5 species), *Quercus* (2 species), *Magnoliaceæ* (5 species), *Bombaceæ* (3 species), *Laurineæ* (2 species), *Ebenaceæ* (2 species), *Verbenaceæ*, *Combretaceæ*, *Sapindaceæ* (2 species), *Camelliaceæ*, *Ampelideæ*, *Mimoseæ*, *Caesalpinieæ* (5 species), *Eucalyptus* (2 species), *Pisonia*, *Phillyrea*, *Rhus*, *Prunus*, *Bignonia*, *Laurus*, *Salix*, *Benthamia*. To this list Bayer adds *Aristolochia*. The Cenomanian flora of central Europe appears to be a subtropical one, with marked approaches to the living flora of Australia. The majority of its Dicotyledons belong to existing genera, but one of the most prolific and characteristic Cretaceous forms is *Credneria* (Fig. 3), a genus of doubtful affinities, which has been compared by different authors to the poplars, planes, limes, and other orders.

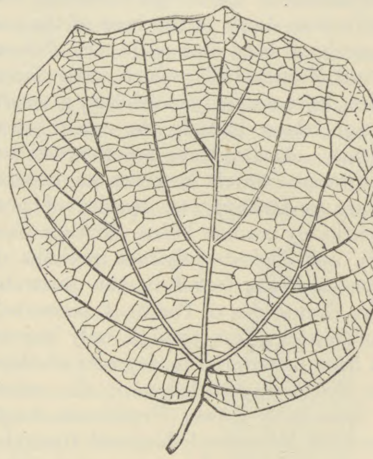

Fig. 3.—*Credneria triacuminata.*

The Cretaceous plant-beds of Westphalia include both Upper and Lower Senonian, the two floras being very distinct. Hosius and von der Marck describe, for instance, 12 species of oak from the Upper and 6 from the Lower strata, but no species is common to the two. The same occurs with the figs, with 3 species above and 8 below. The 6 species of *Credneria* are all confined to the older deposits. In fact, not a single Dicotyledon is common to these two closely allied divisions of the Cretaceous series; a circumstance not easy to explain, when we see how well the oaks and figs are represented in each. Four species of *Dewalquea*, a ranunculaceous genus allied to the hellebore, make their appearance in the Upper Senonian of Westphalia, other species occurring at Aix-la-Chapelle in deposits of about the same age. The Senonian flora of the last-named place, and that of Maestricht, are still only imperfectly known. It is unnecessary to trace the variations of the Upper Cretaceous flora from point to point; but the discoveries within the Arctic circle have been so surprising that attention must again be called to them. Besides the Lower Cretaceous plants already mentioned, Heer has described from Greenland a flora of Cenomanian age, and another belonging to the Senonian. The Cenomanian strata have yielded already 177 species, the different groups being represented in these proportions:—Cryptogams, 37, 30 of which are Ferns; Cycads, 8; Conifers, 27; Monocotyledons, 8; Apetalæ, 31; other Dicotyledons, 66. The Senonian strata have yielded 118 species, 21 of which are Cryptogams, 11 Conifers, 5 Monocotyledons, 75 Dicotyledons. Forest trees, especially oaks, are plentiful, and many of the species are identical with those found in Cretaceous deposits in more southern latitudes. Both of these floras suggest, however, that the climate of Greenland was somewhat colder than that of Westphalia, though scarcely colder than warm-temperate.

The Cretaceous deposits just described are followed by a series of Tertiary formations, but in Europe the continuity between Cretaceous and Tertiary is not quite complete. The Tertiary formations have been assigned to six periods; these are termed—Palæocene, Eocene, Oligocene, Miocene, Pliocene, Pleistocene, and each has its own botanical peculiarities. During the first period the plants were not markedly different from those of the Upper Cretaceous. Its flora is still but imperfectly known, for we are dependent on two or three localities for the plants. There is found at Sézanne, about 60 miles east of Paris, an isolated deposit of calcareous tufa full of leaves, which gives a curious insight into the vegetation which flourished in Palæocene times around a waterfall. Sézanne yields Ferns in profusion, mingled with other shade-loving plants such as would grow under the trees in a moist ravine; its vegetation is comparable to that of an island in the tropical seas. Monocotyledons are rare, the only ones of much interest being some fragments of pandanaceous leaves. The absence of Gymnosperms is noticeable. The Proteaceæ are also missing; but other Dicotyledons occur in profusion, many of them being remarkable for the large size of their deciduous leaves. Among the flowering plants are *Dewalquea*, a ranunculaceous genus already mentioned as occurring in the Upper Cretaceous, and numerous living genera of forest-trees, such as occur throughout the Tertiary period, and are readily comparable with living forms. Saporta has described about seventy Dicotyledons, most of which are peculiar to this locality. The plant-bearing marls of Gelinden, near Liége, contain the débris of a palæocene forest. The trees seemed to have flourished on neighbouring chalky heights. The most abundant species of this forest were the oaks and chestnuts, of which a dozen have been collected; laurels, *Viburnum*, ivy, several Aralias, *Dewalquea*, a *Thuja*, and several Ferns may be added. This flora is compared by Saporta and Marion with that of southern Japan. Other deposits of this age in France have furnished plants of a more varied aspect, including myrtles, araucarias, a bamboo, and several fan-leaved palms. Saporta points out the presence in these Palæocene deposits of certain types common, on the one hand, to the American Tertiary strata between the Missouri and the Rocky Mountains, and on the other, to the Tertiary flora of Greenland. The Palæocene deposits of Great Britain are of marine origin, and only yield pine-cones and fragments of *Osmunda*.

Palæocene plants.

The British Eocene and Oligocene strata yield so large a flora, and contain plant-beds belonging to so many different stages, that it is unfortunate we have still no monograph on the subject, the one commenced by Gardner and Ettingshausen in 1879 having reached no farther than the Ferns and Gymnosperms. This deficiency makes it impossible adequately to deal with the British Eocene plants, most of the material being either unpublished or needing re-examination. In the earliest Eocene plant-beds, in the Woolwich and Reading series, a small but interesting flora is found, which suggests a temperate climate less warm than that of earlier or of later periods. Leaves of planes are abundant, and among the plants recorded are two figs, a laurel, a *Robinia*, a *Grevillea*, and a palm. Ferns are scarce, Ettingshausen and Gardner recording only *Anemia subcretacea* and *Pteris* (?) *Prestwichii*. The only Gymnosperms determined are *Libocedrus adpressa*, which is close to *L. decurrens* of the Yosemite, and *Taxodium europæum*. A few plants have been found in the next stage, the Oldhaven beds, and among these are fig and cinnamon. Gardner considers the plants to point to subtropical conditions. The London Clay has yielded a large number of plants, but most of the species are represented by fruits alone, not by leaves. This circumstance makes it difficult to compare the flora with that of other formations, for not only is it uncertain which leaves and fruits belong to the same plant, but there is the additional source of doubt, that different elements of the same flora may be represented at different localities. Of some plants only the deciduous leaves are likely to be preserved, whilst other succulent-leaved forms will only be known from their woody fruits. Among the 200 plants of the London Clay are no Ferns, but 6 genera of Gymnosperms, viz., *Callitris* (2 species), *Sequoia*, *Athrotaxis* (?) *Ginkgo*, *Podocarpus*, *Pinus*; and several genera of palms, of which the tropical *Nipa* is the most abundant and most characteristic, among the others being fan-palms of the genera *Sabal* and *Chamærops*. The Dicotyledons need further study. Among the fruits Ettingshausen records *Quercus*, *Liquidambar*, *Laurus*, *Nyssa*, *Diospyros*, *Symplocos*, *Magnolia*, *Victoria*, *Hightea*, *Sapindus*, *Cupania*, *Eugenia*, *Eucalyptus*, *Amygdalus*; he suggests that the fruits of the London Clay of Sheppey may belong to the same plants as the leaves found at Alum Bay in the Isle of Wight.

Eocene and Oligocene of Great Britain.

The next stage is represented by the Lower Bagshot leaf-beds of Alum Bay. These pipeclays yield a varied flora, Ettingshausen recording 274 species, belonging to 116 genera and 63 families. Gardner, however, is unable to reconcile this estimated richness with our knowledge of the flora, and surmises that fossil plants from other localities must have been inadvertently included. He considers the flora to be the most tropical of any that has so far been studied in the northern hemisphere. Its most conspicuous plants are *Ficus Bowerbankii*, *Aralia primigenia*, *Comptonia acutiloba*, *Dryandra Bunburyi*, *Cassia Ungeri*, and the fruits of *Caesalpinia*. The floras which it chiefly resembles are first, that of Monte Bolca, and second, that of the Grès du Soissonais, which latter Gardner thinks may be of the same age, and not earlier, as is generally supposed. The total number of species found at Alum Bay, according to this author, is only about 50 or 60.

To the Bagshot Sand succeeds the thick mass of sands with intercalated plant-beds seen in Bournemouth cliffs. Each bed yields peculiar forms, the total number of species amounting to many hundred, most of them differing from those occurring in the strata below. The plants suggest a comparison of the climate and forests with those of the Malay Archipelago and tropical America. At one place we find drifted fruits of *Nipa*, *Hightea*, and *Anona*; at another perfect limbs of an American form of cactus, found also at Bovey Tracey. Other beds yield principally palms, willows, laurels, *Eucalyptus*, or Ferns; but there are no Cycads. As showing the richness of this flora, we may mention that in the only orders which have yet been monographed, Ferns are represented by 17 species and Gymnosperms by 10, though these are not the groups best represented. Gardner speaks of the Bournemouth flora as appearing to consist principally of trees or hard-wooded shrubs, comparatively few remains of the herbaceous vegetation being preserved. The lignite deposits and pipeclays of Bovey Tracey, in Devon, referred by Heer and Pengelly to the Miocene period, have now been shown by Gardner to be of the same age as the Bournemouth Beds; many of the species, including all the Dicotyledonous leaves of Bovey, occurring also at Bournemouth. One of the commonest Ferns at both localities, *Osmunda lignita*, is scarcely distinguishable from a species found in the Philippines. The higher Eocene strata of England—those above the Bournemouth Beds—are of marine origin, and yield only drifted fruits, principally fir-cones

In the volcanic districts of the south-west of Scotland

and the north-east of Ireland plant-beds are found intercalated between the lava-flows. These also, like the lignites of Bovey Tracey, have been referred to the Miocene period, on the supposed evidence of the plants; but more recent discoveries by Gardner tend to throw doubt on this allocation, and suggest that, though of various ages, the first-formed of these deposits may date back to early Eocene times. The flora found in Mull points distinctly to temperate conditions; but it is not yet clear whether this indicates a different period from the sub-tropical flora of the south of England, or whether the difference depends on latitude or local conditions. The plants include a Fern, *Onoclea hebridica*, close to a living American form; four Gymnosperms belonging to the genera *Cryptomeria*, *Ginkgo*, *Taxus* and *Podocarpus*; Dicotyledons of about 30 species, several of which have been figured. Among the Dicotyledons may be mentioned *Platanus*, *Acer* (?), *Quercus* (?), *Viburnum*, *Alnus*, *Magnolia*, *Corylus* (?), *Castanea* (?), *Zizyphus*, *Populus*, and the nettle-like *Bœhmeria antiqua*. The absence of the so-called cinnamon-leaves and the *Smilaceæ*, which always enter into the composition of Middle Eocene and Oligocene floras, is noticeable. The Irish strata yield two Ferns; 7 Gymnosperms, *Cupressus*, *Cryptomeria*, *Taxus*, *Podocarpus*, *Pinus* (2 species), *Tsuga*; and leaves of about 25 Dicotyledons. The most abundant leaf, according to Gardner, does not seem distinct from *Celastrophyllum Benedeni*, of the Palæocene strata of Gelinden; a water-lily, *Nelumbium Buchii*, occurs also in Oligocene beds on the Continent; the species of *MacClintockia* (Fig. 4) is found both in the Arctic floras and at Gelinden. Among the other plants are an alder, an oak, and a doubtful cinnamon.

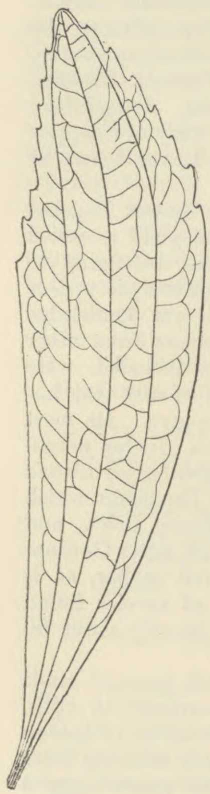

Fig. 4.—*MacClintockia trinervata.*

Leaving these Scottish and Irish deposits of doubtful age, we find in the Hampshire Basin a thick series of fluviatile, lacustrine, and marine deposits undoubtedly of Lower and Middle Oligocene date. Their flora is still a singularly poor one, though plants have been obtained at many different levels; they perhaps indicate a somewhat cooler climate than that of the Bournemouth series. Among the more abundant plants are nucules of several species of *Chara*, and drifted fruits and seeds of water-lilies, of *Folliculites* (a genus probably close to *Stratiotes*) and of *Limnocarpus* (allied to *Potamogeton*); there is little else mixed with these. Other seams are full of the twigs and cones of *Athrotaxis*, a Conifer now confined to Tasmania. Ferns are represented by *Gleichenia*, *Lygodium*, and *Chrysodium Lanzæanum*, which last has a very wide range in time; Monocotyledons, by a Sabal and a feather-palm, as well as by the two aquatic genera above mentioned; Gymnosperms, by the extinct araucarian genus *Doliostrobus*, by rare pine-cones, and by *Athrotaxis*. Dicotyledonous leaves are not plentiful, the genera recorded being *Andromeda*, *Cinnamomum*, *Zizyphus*, *Rhus*, *Viburnum*. Above the Oligocene strata in Great Britain there is a complete break, no species of plant ranging upwards into the next fossiliferous division.

Space will not allow us to deal with the numerous scattered deposits which have yielded Tertiary plants. It will be more to the purpose to take distant areas, where the order of the strata is clear, and compare the succession of the floras with that met with in other geographical regions and in other latitudes. For this study it will be most convenient to take next south and central France, for in that area can be found a series of plant-bearing strata in which is preserved a nearly continuous history of the vegetation from Upper Eocene down to Pliocene. The account is taken mainly from the writings of Saporta.

Central and southern France.

The gypsum-deposit of Upper Eocene date at Aix in Provence commences this series, and is remarkable for the variety and perfect preservation of its organic remains. Among its Gymnosperms are numerous *Cupressineæ* of African affinity belonging to the genera *Callitris* and *Widdringtonia*, and a juniper close to one indigenous in Greece. Fan-palms, several species of dragon-tree, and a banana like one living in Abyssinia represent the more peculiar Monocotyledons. Among the noticeable Dicotyledons are the *Myricaceæ*, *Proteaceæ*, *Laurineæ*, *Bombax*, the Judas-tree, *Acacia*, *Ailanthus*, while the most plentiful forms are the *Araliaceæ*. Willows and poplars, with a few other plants of more temperate regions, are found rarely at Aix, and seemingly point to casual introduction from surrounding mountains. In a general way, spiny plants, with stiff branches and dry and coriaceous leaves, dominate the flora, as they now do in Central Africa, to which region on the whole Saporta considers the flora to be most allied.

The succeeding Oligocene flora appears to be more characterized by a gradual replacement of the Eocene species by allied forms, than by any marked change in the assemblage or in the climatic conditions. It forms a perfectly gradual transition to the still newer Miocene period, the newer species slowly appearing and increasing in number. Saporta considers that in central and southern Europe the alternate dry and moist heat of the Eocene period gave place to a climate more equally and more universally humid, and that these conditions continued without material change into the succeeding Miocene stage. Among the types of vegetation which make their appearance in Europe during the Oligocene period may be mentioned the Conifers *Libocedrus salicornioides*, several species of *Chamæcyparis* and *Sequoia*, *Taxodium distichum*, and *Glyptostrobus europæus*. The palms include *Sabal hæringiana*, *S. major* and *Flabellaria*. Among the *Myricaceæ* several species of *Comptonia* are common. These new-comers are all of American type. Aquatic plants, especially water-lilies, are abundant and varied; the dry-soil *Callitris* and *Widdringtonia* become scarce.

Though we do not propose to deal with the other European localities for Eocene and Oligocene plants, there is one district to which attention should be drawn, on account of the exceptional state of preservation of the specimens. On the Baltic shores of Prussia there is found a quantity of amber, containing remains of insects and plants. This is derived from strata of Oligocene age, and is particularly valuable because it preserves perfectly various soft parts of the plants, which are usually lost in fossil specimens.

Plants in amber.

The tissues, in fact, are preserved just as they would be in Canada balsam. The amber yields such things as fallen flowers, perfect catkins of oak, pollen grains, and fungi. It enables us to determine accurately orders and genera which otherwise are unknown in the fossil state, and it thus aids us in forming a truer idea of the flora of the period than can be formed at any locality where the harder parts alone are recognizable. No doubt this amber flora is still imperfectly known, but it is valuable as giving a good idea of the vegetation, during Oligocene times, of a mixed wood of pine and oak, in which there is a mixture of herbaceous and woody plants, such as would now be found under similar conditions. The plants of which the floral organs or perfect fruits are preserved include the amber-bearing *Pinus succinifera*, *Smilax*, *Phœnix*, the spike of an aroid, 11 species of oak, 2 of chestnut, a beech, *Urticaceæ*, 2 cinnamons and *Trianthera* among the *Lauraceæ*, representatives of the *Cistaceæ*, *Ternstrœmiaceæ*, *Dilleniaceæ* (3 species of *Hibbertia*), *Geraniaceæ* (*Geranium* and *Erodium*), *Oxalidaceæ*, *Acer*, *Celastraceæ*, *Olacaceæ*, *Pittesporaceæ*, *Ilex* (2 species), *Euphorbiaceæ*, *Umbelliferæ* (*Chærophyllum*), *Saxifragaceæ* (3 genera), *Hamamelidaceæ*, *Rosaceæ*, *Connaraceæ*, *Ericaceæ* (*Andromeda* and *Clethra*), *Myrsinaceæ* (3 species) *Rubiaceæ*, *Sambucus* (2 species), *Santalaceæ*, *Loranthaceæ* (3 species). We here discover for the first time various living families and genera, but there is still a noticeable absence of many of our most prolific existing groups. Whether this deficiency is accidental or real time will show.

Miocene.

The Miocene flora, which succeeds to that just described, is well represented in Europe; but till recently there has been an unfortunate tendency to refer Tertiary floras of all dates to the Miocene period, unless the geological position of the strata was so clear as obviously to forbid this assignment. Thus the Eocene lignites of Devon and the plant-beds in the basalt of Scotland and Ireland were called Miocene; and in the Arctic regions and in North America even plant-beds of Upper Cretaceous age were referred to the same period. The reason for this was that some of the first Tertiary floras to be examined were certainly Miocene, and, when these plants had been studied, it was considered that somewhat similar assemblages found elsewhere in deposits of doubtful geological age must also be Miocene. For a long time it was not recognized that changes in the marine fauna, on which our geological classification mainly depends, correspond scarcely at all with changes in the land plants. It was not suspected, or the fact was ignored, that the break between Cretaceous and Tertiary—made so conspicuous by striking changes in the aquatic animals—had little or no importance in botanical history. It was not realized that an Upper Cretaceous flora needed critical examination to distinguish it from one of Miocene age, and that the two periods were not characterized by a sweeping change of generic type, such as took place among the marine invertebrates. It may appear absurd to a geologist that any one could mistake a Cretaceous flora for one of Miocene date, since the marine animals are completely different and the differences are striking. In the case of the plants, however, the Tertiary generic types in large part appeared in Upper Cretaceous times. Few or no extinct types are to be found in these older strata—there is nothing among the plants equivalent to the unmistakably extinct *Ammonites*, *Belemnites*, and a hundred other groups, and we only meet with constant variations in the same genus or family, these variations having seldom any obvious relation to phylogeny.

The Miocene period is unrepresented by any deposits in Great Britain; we will therefore commence with the best known region—that of central Europe and especially of Switzerland, whence a prolific flora has been collected and described by Oswald Heer. The Miocene lacustrine deposits are contained in a number of silted-up lake-basins, which were successively formed and obliterated during the uprise of the Alps and the continuous folding and bending of the earth's crust which was so striking a feature of the period. These undulations tended to transform valleys into chains of lakes, into which the plants and animals of the surrounding area fell or were washed. We thus find preserved in the Upper Miocene lacustrine deposits of Switzerland a larger flora than is known from any other period of similar length; in fact, an analysis of its composition suggests that the Miocene flora of Switzerland must have been both larger and more varied than that now living in the same country. The best known locality for the Upper Miocene plants is Oeningen, on the Lake of Constance, where have been collected nearly 500 species of plants, the total number of Miocene plants found in Switzerland being stated to be now over 900. Among the characteristics of this Miocene flora are the large number of families represented, the marked increase in the deciduous-leaved plants, the gradual decrease in the number of palms and of tropical plants, and the replacement of these latter by Mediterranean or North American forms. According to Heer, the tropical forms in the Swiss Miocene agree rather with Asiatic types, while the subtropical and temperate plants are allied to forms now living in the temperate zone in North America. Of the 920 species described by Heer, 114 are Cryptogams and 806 flowering plants. Mosses are extremely rare, Heer only describing 3 species. Vascular Cryptogams still include one or two large Horsetails with stems over an inch thick, and also 37 species of Fern, amongst the most interesting of which are 5 species belonging to the climbing *Lygodium*, a genus now living in Java. The number of Ferns is just equal to that now found in Switzerland. Cycads are only represented by fragments of two species, and this seems to be the last appearance of Cycads in Europe. The Coniferæ include no fewer than 94 species of *Cupressineæ* and 17 of *Abietineæ*, including several species of *Sequoia*. Monocotyledons form one-sixth of the known Miocene flora, 25 of them being grasses and 39 sedges; but most of these need further study, and are very insufficiently characterized. Heer records one species of rice and four of millet. Most of the other Monocotyledons call for little remark, though among them is an *Iris*, a *Bromelia*, and a ginger. *Smilax*, as in earlier times, was common. Palms, referred to 11 species, are found, though they seem to have decreased in abundance; of them 7 are fan-palms, the others including *Phœnicites*—a form allied to the date—and a trailing palm, *Calamopsis*, allied to the canes and rattans. Among the Dicotyledons, the Leguminosæ take the first place with 131 species, including *Acacia*, *Cæsalpinia*, and *Cassia*, each represented by several forms. The occurrence of 90 species of Amentaceæ shows that, as the climate became less tropical, the relative proportion of this group to the total flora increased. Evergreen oaks are a marked characteristic of the period, more than half the Swiss species being allied to living American forms. Fig-trees referred to 17 species occur, all with undivided leathery leaves; one is close to the banyan, another to the indiarubber tree. The Laurineæ were plentiful, and include various true laurels, camphor-trees, cinnamon, *Persea*, and *Sassafras*. The Proteaceæ, according to Heer, are still common, the Australian genera *Hakea*, *Dryandra*, *Grevillea*, and *Banksia* being represented. Amongst gamopetalous plants several of our largest living families, including Campanulaceæ, Labiatæ, Solanaceæ and Primulaceæ, are still missing; and of Boragineæ, Scrophularineæ, Gentianeæ, and Caprifoliaceæ there are only faint and doubtful indications. The Compositæ are represented by isolated fruits of various species. Twining lianas are met with in a species of *Bignonia*: Umbelliferæ, Ranunculaceæ, and Cruciferæ are represented by a few fruits. These families, however, do not appear to have had anything like their present importance in the temperate flora, though, as they are mainly herbaceous plants with fruits of moderate hardness, they may have decayed and left no trace. The American *Liriodendron* still flourished in Europe. Water-lilies of the genera *Nymphæa* and *Nelumbium* occur. Maples were still plentiful, 20 species having been described.

Rosaceæ are rare, *Cratægus*, *Prunus*, and *Amygdalus* being the only genera recorded. It is obvious that many of these Swiss Miocene plants will need more close study before their specific characters, or even their generic position, can be accepted as thoroughly made out; still, this will not affect the general composition of the flora, with its large proportion of deciduous trees and evergreens, and its noticeable deficiency in many of our largest living families.

From Europe it will be convenient to pass to a distant region of similar latitude, so that we may see to what extent botanical provinces existed in Eocene and Oligocene times. It so happens that the interior of temperate North America is almost the only region outside Europe in which a series of plant-bearing strata give a connected history of these periods, and in which the plants have been collected and studied. It is unfortunately still very difficult to correlate even approximately the strata on the two sides of the Atlantic, and there is great doubt as to what strata belong to each division of the Tertiary period even in different parts of North America. This difficulty will disappear as the strata become better known, but at present each of the silted-up lakes has to be studied separately, for we cannot expect so close a correspondence in their faunas and floras as is found in the more crowded and smaller basins in central Europe.

Tertiary of North America.

Perhaps the most striking characteristic of the Tertiary floras of North America, as distinguished from those of Europe, is the greater continuity in their history and greater connexion with the existing flora of the same regions. This difference is readily explained when we remember that in Europe the main barriers which stop migration, such as the Alps and the Mediterranean, run east and west, while in America the only barriers of any importance run north and south. In consequence of this peculiarity, climatic or orographic changes in Europe tend to drive animals and plants into a *cul de sac*, from which there is no escape; but in America similar climatic waves merely cause the species alternately to retreat and advance. This difficulty in migration is probably the reason why the existing European flora is so poor in large-fruited trees compared with what it was in Miocene times or with the existing flora of North America. In America the contrast between the Eocene forests and those now living is much less striking, and this fact has led to the wrong assumption that the present American flora had its origin in the American continent. Such a conclusion is by no means warranted by the facts, for in Tertiary times, as we have seen, the European flora had a distinctly "American" facies. Therefore the so-called American forms may have originated in the Old World, or more probably, as Saporta suggests, in the polar regions, whence they were driven by the increase of cold southwards into Europe and into America. The American Tertiary flora is so large, and the geology of the deposits is so intricate, that it is out of the question to discuss them more fully within the limits of this article. We may point out, however, that the early Tertiary floras seem to indicate a much closer connexion and a greater community of species than is found between the existing plants of Europe and America. Or, rather, we should perhaps say that ancient floras suggest recent dispersal from the place of origin, and less time in which to vary and become modified by the loss of different groups in the two continents. Geographical provinces are certainly indicated by the Eocene flora of Europe and America, but these are less marked than those now existing.

If we turn to a more isolated region, like Australia, we find a Lower Eocene flora distinctly related to the existing flora of Australia and not to that of other continents. Australasia had then as now a peculiar flora of its own, though the former wide dispersal of the Proteaceæ and Myrtaceæ, and also the large number of Amentaceæ then found in Australia, make the Eocene plants of Europe and Australia much less unlike than are the present floras.

Australia.

Within the Arctic circle a large number of Tertiary plants have been collected. These were described by Heer, who referred them to the Miocene period; he recognized, in fact, two periods during which Angiosperms flourished within the Arctic regions, the one Upper Cretaceous, the other Miocene. To this view of the Miocene age of the plant-bearing strata in Greenland and Spitsbergen there are serious objections, which we will again refer to when the flora has been described.

Arctic regions.

The Tertiary flora of Greenland is of great interest, from the extremely high latitude at which the plants flourished, thirty of the species having been collected so far north as lat. 81°. Taking first this most northerly locality, in Grinnell Land, we find the flora to comprise 2 horsetails, 11 Conifers (including the living *Pinus Abies*), 2 grasses, a sedge, 2 poplars, a willow, 2 birches, 2 hazels, an elm, a *Viburnum*, a water-lily, and a lime. Such an assemblage at the present day would suggest a latitude quite 25° farther south; but it shows decidedly colder conditions than any of the European Eocene, Oligocene, or Miocene strata. From lat. 78° in Spitsbergen Heer records 136 species of fossil plants. More to the south, at Disco Island in lat. 70°, the Tertiary wood seem to have been principally composed of planes and Sequoias; but a large number of other genera occur, the total number of plants already recorded being 137. From various parts of Greenland they now amount to at least 280. Among the plants from Disco, more than a quarter are also found in the Miocene of central Europe. The plants of Disco include, besides the plane and Sequoia, such warm-temperate trees as *Ginkgo*, oak, beech, poplar, maple, walnut, lime, and magnolia. If these different deposits are contemporaneous, as is not improbable, there is a distinct change in the flora as we move farther from the pole, which suggests that difference of latitude then as now was accompanied by a difference in the flora. But if this process is continuous from latitude to latitude, then we ought not to look for a flora of equivalent age in the warm-temperate Miocene deposits of central Europe, but should rather expect to find that the temperate plants of Greenland were contemporaneous with a tropical flora in central Europe. As Mr Starkie Gardner has pointed out, it does not seem reasonable to assume that the same flora could have ranged then through 40° of latitude; it is more probable that an Eocene temperate flora found in the Arctic regions travelled southwards as the climate became cooler, till it became the Miocene temperate flora of central Europe. Mr Gardner suggests, therefore, that the plant-beds of Greenland and Spitsbergen represent the period of greatest heat, and are therefore wrongly referred to the Miocene. At present the evidence is scarcely sufficient to decide the question, for if this view is right, we ought to find within the Arctic circle truly Arctic floras equivalent to the cool Lower Eocene and Miocene periods; but these have not yet been met with.

Pliocene.

A steady decrease of temperature marked the Pliocene period throughout Europe, and gradually brought the climatic conditions into correspondence with those now existing, till towards the end of the period neither climate nor physical geography differed greatly from those now existing. Concurrently with this change, the tropical and extinct forms disappeared, and the flora approached more and more nearly to that now existing in the districts where the fossil plants are found, though in the older deposits, at any rate, the geographical distribution still differed considerably from that now met with. At last, in the latest Pliocene strata (often called "pre-Glacial") we find a flora consisting almost entirely of existing species belonging to the Palæarctic regions, and nearly all still living in the country where the fossils are found. This flora, however, is associated with a fauna of large mammals, the majority of which are extinct.

The plants of the Older Pliocene period are unknown in Great Britain, and little known throughout Europe except in central France and the Mediterranean region. The forests of central France during this epoch showed, according to Saporta, a singular admixture of living European species, with trees now characteristic of the Canary Isles and of North America. For instance, of the living species found at Meximieux, near Lyons, one is American, eight at least belong to the Canaries (six being characteristic of those islands), two are Asiatic, and ten still live in Europe. Taking into account, however, the closest living allies of the fossil plants, we find about equal affinities with the floras of Europe, America, and Asia. There is also a decided resemblance to the earlier Miocene flora. Among the more interesting plants of this deposit may be mentioned *Torreya nucifera*, now Japanese; an evergreen oak close to the common *Quercus ilex*; *Laurus canariensis*, *Apollonias canariensis*, *Persea carolinensis*, and *Ilex canariensis*; *Daphne pontica* (a plant of Asia Minor); a species of box scarcely differing from the English, and a bamboo. To this epoch, or perhaps to a stage slightly later, and not to the Newer Pliocene period, as is generally supposed, should probably be referred the lignite deposits of the Val d'Arno. This lignite and the accompanying leaf-bearing clays underlie and are apparently older than the strata with Newer Pliocene mammals and mollusca. The only mammal actually associated with the plants appears to be a species of tapir, a genus which in Europe seems to be characteristically Miocene and Older Pliocene. The plants of the Val d'Arno have been described by Ristori; they consist mainly of deciduous trees, a large proportion of which are known Miocene and early Pliocene forms, nearly all of them being extinct. A markedly upland character is given to the flora of this valley through the abundance of pines (9 species) and oaks (16 species) which it contains; but this peculiarity is readily accounted for by the steep slopes of the Apennines, which everywhere surround and dominate the old lake-basin. Among the other noticeable plants may be mentioned *Betula* (3 species), *Alnus* (2 species), *Carpinus*, *Fagus* (4 species), *Salix* (4 species), *Populus* (2 species), *Platanus*, *Liquidambar*, *Planera*, *Ulmus* (2 species), *Ficus* (2 species), *Persoonia*, *Laurus* (5 species), *Persea*, *Sassafras*, *Cinnamomum* (5 species), *Oreodaphne*, *Diospyros* (2 species), *Andromeda*, *Magnolia*, *Acer* (3 species), *Sapindus*, *Celastrus* (2 species), *Ilex* (4 species), *Rhamnus* (3 species), *Juglans* (5 species), *Carya* (2 species), *Rhus*, *Myrtus*, *Cratægus*, *Prunus*, *Cassia* (3 species). These plants suggest a colder climate than that indicated by the plants of Meximieux—they might, therefore, be thought to belong to a later period. The difference, however, is probably fully accounted for when we take into consideration the biting winds still felt in spring in the valley of the Arno, and the probable large admixture of plants washed down from the mountains above. Somewhat later Pliocene deposits in the Val d'Arno, as well as the tuffs associated with the Pliocene volcanoes in central France, yield plants of a more familiar type, a considerable proportion of them still living in the Mediterranean region, though some are only now found at distant localities, and others are extinct. The flora, however, is essentially Palæarctic, American and Australian types having disappeared.

The latest Pliocene, or pre-Glacial, flora of northern Europe is best known from the Cromer Forest-bed of Norfolk and Suffolk, a fluvio-marine deposit which lies beneath the whole of the Glacial deposits of these counties, and passes downwards into the Crag, many of the animals actually associated with the plants being characteristic Pliocene species which seem immediately afterwards to have been exterminated by the increasing cold. The plants contained in the Cromer Forest-bed fall into two groups—the forest-trees, and the marsh and aquatic plants. We know little or nothing at present of the upland plants, or of those of dry or chalky soils. Forest trees are well represented; they are, in fact, better known than in any of the later English deposits. We find the living British species of maple, sloe, hawthorn, white-beam, cornel, elm, birch, alder, hornbeam, hazel, oak, beech, willow, yew, and pine, and also the spruce. This is an assemblage that could not well be found under conditions differing greatly from those now holding in Norfolk; there is an absence of both Arctic and south European plants. The variety of trees shows that the climate was mild and moist. Among the aquatic and marsh plants we find, mingled with a number that still live in Norfolk, the water-chestnut (*Trapa natans*) and *Najas minor*, neither of which is now British. On the Norfolk coast another thin plant-bed occurs locally above the Forest-bed and immediately beneath the Boulder Clay. This deposit shows no trace of forest-trees, but it is full of remains of Arctic mosses, and of the dwarf willow, and birch; in short, it yields the flora now found within the Arctic circle. The incoming of the Glacial epoch does not appear to have been accompanied by any acclimatization of the plants—the species belonging to temperate Europe were locally exterminated, and Arctic forms took their places. The same Arctic flora reappears in deposits immediately above the highest Boulder-Clay, deposits formed after the ice had passed away. These fossil Arctic plants have now been found as far south as Bovey Tracey in Devonshire, where Pengelly and Heer discovered the bear-berry and dwarf birch; London, where also *Betula nana* occurs; and at Deuben in Saxony, which lies nearly as far south as lat. 50°, but has yielded to Professor Nathorst's researches several Arctic species of willow and saxifrage. The cold period, however, was not continuous, for both in Great Britain and on the continent of Europe, as well as in Canada, it was broken by the recurrence of a milder climate and the reappearance of a flora almost identical with that now living in the same regions. This "inter-Glacial" flora, though so like that now found in the district, has interesting peculiarities. In England, for instance, it includes *Acer monspessulanum*, a southern maple which does not now extend nearer than central Europe; also *Najas graminea* and *N. minor*, both southern forms not now native of Britain. *Brassenia peltata*, a water-lily found in the warmer regions almost throughout the world, except in Europe, occurs abundantly in north Germany, but not in Great Britain. Similar inter-Glacial deposits in Tirol contain leaves of *Rhododendron ponticum*.

Pleistocene.

Space will not permit us to enter into any full discussion of the recurrence of Glacial and inter-Glacial periods, and the influence they may have had on the flora. It is evident, however, that if climatic alternations such as those just described are part of the normal routine that has gone on through all geological periods, and are not merely confined to the latest, then such changes must evidently have had great influence on the evolution and geographical distribution both of species and of floras. Whether this was so, is a question still to be decided, for in dealing with extinct floras it is difficult to decide, except in the most general way, to what climatic conditions they point. We seem to find indications of long-period climatic oscillations in Tertiary times, but none of the sudden invasion of an Arctic flora, like that which occurred during more recent times. It should not be forgotten, however, that an Arctic flora is mainly distinguishable from a temperate one by its poverty and dwarfed vegetation, its deciduous leaves and small fruits, rather than by the occurrence of any characteristic genera or families. Careful and long-continued study would therefore be needed before we could say of any extinct dwarfed flora that it included only plants which could withstand Arctic conditions.

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(C. R.)

PALÆOGRAPHY.

THE principal discoveries made during recent years in the field of Palæography concern the history of Greek writing. At the time when the article on Palæography appeared in vol. xviii. (ninth edition) of this Encyclopædia, the anterior limit of our knowledge of the forms of writing to be found in documents of Greek origin was the 2nd century B.C. We are now in a position to carry back our investigations a century earlier. It is true that a few documents which have since been shown to be of the 3rd century B.C. were extant in European libraries, but they were undated, and their value as specimens of early writing was not recognized. But now the very large number of Greek papyri recovered in Egypt since 1880 have furnished material which not only extends our knowledge, but also enables us to confirm or modify views formerly held. In the history of Latin Palæography little has been added to the material already known. Comparatively few Latin documents have been found among the papyri of Egypt; still, such as they are, they are not without interest in providing us with specimens of writing of the time of the early Roman occupation of the country. It follows, then, that this supplement must mainly be a survey of the history and palæography of Greek papyri, a subject which has been most ably dealt with by Mr F. G. Kenyon in *The Palæography of Greek Papyri*, to which the student may be referred for fuller details than can be given in these pages.

The history of Greek writing on papyrus can now be followed with more or less fulness of material for more than nine hundred years. Actual dated examples range from 270 B.C. to A.D. 680. We have a fair knowledge of the leading features of the writing of the 3rd and 2nd centuries B.C.; a less perfect acquaintance with those of the 1st century B.C. For the first two centuries of the Christian era and to the middle of the 3rd century there is an almost uninterrupted series of documents; then again for two centuries there is a decline, only to be followed by abundance of material for the 6th and early 7th centuries. Thus it will be seen that, while for some periods we may be justified in drawing certain conclusions and laying down certain rules, for others we are still in a very imperfect condition of knowledge. But our knowledge will no doubt almost yearly become more exact, as fresh material is brought to light from the excavations which are now continually proceeding; and those periods in which the lack of papyri breaks the chain of evidence will sooner or later be as fully represented as the rest. The material certainly lies buried in the sands; it is our misfortune that the exact sites have not yet been struck.

The first discovery of Greek papyri was made in Europe, in 1752, when the excavations on the site of Herculaneum yielded a number of charred rolls which proved to be of a literary character. All subsequent discoveries we owe to Egypt; and it is to be observed that the papyri which are found in that country have come down to us under different conditions. Some, generally of a literary nature, were carefully deposited with the bodies of their owners in the tomb with the express intention of being preserved; hence such MSS. in several instances have come to our hands in fairly perfect condition. On the other hand, by far the larger number of those recently brought to light have been found on the sites of towns and villages, particularly in the district of the Fayûm, where they had been either accidentally lost or purposely thrown aside as of no value, or had even been used up as material for other purposes besides their original one. These are consequently for the most part in an imperfect and even fragmentary condition, although not a few of them have proved to be of the highest palæographical and literary importance.

The date of the first find of Greek papyri in Egypt was in 1778, when some forty or fifty rolls were discovered by some native diggers, who, however, kept only one of them. After this, scarcely anything appeared until the year 1820, when was found on the site of the Serapeum at Memphis, as it was reported, the group of documents of the 2nd century B.C. which have been referred to in the article PALÆOGRAPHY (*Ency. Brit.* vol. xviii. p. 149). Then followed a fruitful period when several important literary papyri were secured: in 1821, the Bankes Homer, containing the last book of the *Iliad;* in 1847, the roll containing the Lycophron and other orations of Hyperides; in 1849 and 1850, the Harris Homer, book xviii. of the *Iliad*, and a MS. of books ii.–iv.; and in 1856, the Funeral Oration of Hyperides.

But the great bulk of the Greek papyri from Egypt is the result of excavations undertaken during the last quarter of the 19th century. Within this time three very important discoveries of documents in large quantities have taken place. In 1877 a great mass of papyri was found on the site of Arsinoë in the Fayûm, being chiefly of a non-literary nature and unfortunately in a very fragmentary state; they are also late in date, being of the Byzantine period. The greater number passed into the possession of the Archduke Rainer, and are now at Vienna; the rest are divided between London, Oxford, Paris, and Berlin. After an interval, this find was followed by the recovery in 1892, in the same neighbourhood, and chiefly on the site of a village named Socnopæi Nesus, of an extensive series of documents of the Roman period, ranging from the 1st century to the middle of the 3rd century. These papyri, being of an earlier date and in better condition than the Arsinoite collection, are consequently of greater palæographical value. Most of them are now in Berlin; many are in the British Museum; and some are at Vienna, Geneva, and elsewhere. The third great find, and the most important of all, was made by Messrs Grenfell and Hunt, when excavating, in the season 1896–97, for the Egypt Exploration Fund, at Behnesa, the ancient Oxyrhynchus. Thousands of papyri were here recovered, including, among the non-literary material, a number of rolls in good condition, and comprising also a great store of fragments of literary works, among which occur the now well-known "Logia" or "Sayings of Our Lord," and fragments of the Gospel of St Matthew and of writings of various classical authors. This great collection ranges in date over the first seven hundred years of the Christian era; but in what proportion the documents fall to the several centuries cannot be determined until the series of volumes in which they are to be described for the Græco-Roman branch of the Egypt Exploration Fund shall have made some substantial progress.

These three great collections of miscellaneous documents have been supplemented by finds of other smaller groups, which fit into them and serve to make more complete the chronological series. Such are the correspondence of a Roman officer named Abinnæus of the middle of the 4th century, shared between the British Museum and the library of Geneva in the year 1892; and a miscellaneous collection, ranging from the 2nd century B.C. to the 3rd or 4th century A.D., acquired for the Egypt Exploration Fund and published by that society (*Fayûm Towns and their Papyri*, 1900). But of these smaller groups by far the most interesting is that which Mr Flinders Petrie extracted, in 1889–90, from a set of mummy-cases found in the necropolis of the village of Gurob in the Fayûm. In the manufacture of these coffins numbers of inscribed papyri had been employed, being cut into pieces and pasted together in order to form the cartonnage. The fragments thus recovered proved to be the most valuable documents for the history of Greek palæography hitherto found, supplying us with examples of writing of the 3rd century B.C. in fairly ample numbers, and thus carrying back our knowledge of the subject to a period which up to that time had remained a blank. Besides miscellaneous documents, there are included the remains of registers of wills entered up from time to time by different scribes, and thus affording a variety of handwritings for study; and, further, the value of the collection is enhanced by the presence of fragments of the *Phædo* and *Laches* of Plato and of the lost *Antiope* of Euripides and of other classical works.

The last decade of the 19th century has also been distinguished by the recovery of several literary works of the first importance, inscribed on papyri which had been deposited with the dead, and had thus remained in a fairly perfect condition. In 1889 the Trustees of the British Museum acquired a copy of the lost Ἀθηναίων Πολιτεία of Aristotle, a papyrus of the Mimes of the poet Herodas, and a portion of the oration of Hyperides against Philippides; and in 1896 they had the further good fortune to secure a papyrus containing considerable portions of the odes of Bacchylides, the contemporary of Pindar. And to the series of the orations of Hyperides the Louvre was enabled to add, in 1892, a MS. of the greater part of the oration against Athenogenes. The recovery of so many great classical works within a few years may be accepted as an earnest of further finds of the same nature, now that excavations are being carried on systematically in Egypt.

From a study of the material thus placed at our disposal, certain conclusions have been arrived at which satisfy us that the periodical changes which passed over the character of Greek writing as practised in Egypt coincide pretty nearly with the changes in the political administration of the country. The period of the rule of the Ptolemies from 323 to 30 B.C. has, in general, its own style of writing, which we recognize as the *Ptolemaic;* the period of Roman supremacy, beginning with the conquest by Augustus and ending with the reorganization of the empire by Diocletian in A.D. 284, is accompanied by a characteristic *Roman* hand; and with the change of administration which placed Egypt under the Byzantine division of the empire, and lasted down to the time of the Arab conquest in A.D. 640, there is a corresponding change to the *Byzantine* class of writing. These changes must obviously be attributed to the influence of the official handwritings of the time. A change of government naturally led to a change of the officials employed, and with the change of officials would naturally follow a change in the style of production of official documents. In illustration of this view, it is enough to call to mind the instances of such variations to be met with in the history of the palæography of mediæval Europe, due in the same way to political causes. It is interesting, too, to observe that in our own time the teaching in schools of a particular type of handwriting which finds favour in clerical examinations for the public service has not been without its influence on the general handwriting of the people.

Classifying, then, the writing of the papyri into the three groups, the Ptolemaic, the Roman, and the Byzantine, the next step is to determine, by a closer examination of the documents, the changes which characterize the several centuries traversed by those groups. In doing this, we cannot apply the exact terms which are employed in describing the MSS. of the Middle Ages. We have to do with writing which has not yet been cast into the formal literary moulds of the later times; and it has therefore been found necessary, as well as convenient, to divide the papyri simply into two series, representative of their contents and not of their style of production, namely, literary papyri and non-literary papyri. Neither series, however, it is to be remembered, has a style of writing peculiar to itself. While the literary works are, as a rule, written with more or less formality, not a few of even the more valuable of them are copies in the ordinary cursive hands of the day. Conversely, while we find non-literary documents generally written in ordinary cursive hands, whether by official scribes or by private individuals, yet occasionally we meet with one produced in the formal style more common to literary examples. Again, while applying to particular letters in papyri such technical terms as capitals, or uncials, or minuscules, we cannot convey by those terms the exact ideas which we convey when thus describing the individual letters of mediæval manuscripts. For the letters of the papyrus period were not cast in finished moulds, while the uncial writing and the minuscule writing of the Middle Ages were settled literary hands. As will presently be seen, the mediæval uncial developed directly from the literary writing of the papyri; the minuscule was a new type moulded from the cursive into a fixed literary style.

Necessarily, the non-literary papyri are much more numerous than the literary documents, and present a much greater variety of handwriting, being in fact the result of the daily transactions of ordinary life; and how very widespread was the knowledge of writing among the Greek-speaking population of Egypt is sufficiently testified by the surviving examples, coming as they do from the hands of all sorts and conditions of men. We will first examine these specimens of the current handwriting of the day before passing to the review of the more or less artificial book-writing of the literary papyri.

As already stated, the oldest material is chiefly contributed by the papyri discovered at Gurob. Among them are not only the fragments of official registers which have been mentioned, but also a variety of miscellaneous documents relating to private affairs, and in various hands of the 3rd century and early 2nd century B.C. The series of non-literary papyri bears actual dates ranging from 270 to 186 B.C. The leading characteristic of Greek writing of the 3rd century B.C. is its strength and facility. While it may not compare with some later styles in the precise formation of particular letters, yet its freedom and spontaneous air lend it a particular charm and please the eye, very much in the same way that a scholar's practised and unconscious handwriting of a good type is more attractive than the more exact formality of a clerk's hand. The letters generally are widely spread and shallow, and, particularly in the official hands, they are linked together with horizontal connecting strokes to such an extent that the text has almost the appearance of depending from a continuous horizontal line. The extreme shallowness or flatness of many of the letters is very striking, especially in the case of *delta*, *mu*, *nu*, *pi*, and *omega*. A significant indication of the antiquity of Greek cursive writing is found in connexion with one of the forms of the letter *alpha*, which is reduced to a mere angle or wedge.

A few lines from an official order of the year 250 B.C. will serve to convey an idea of the trained cursive style of this century:—

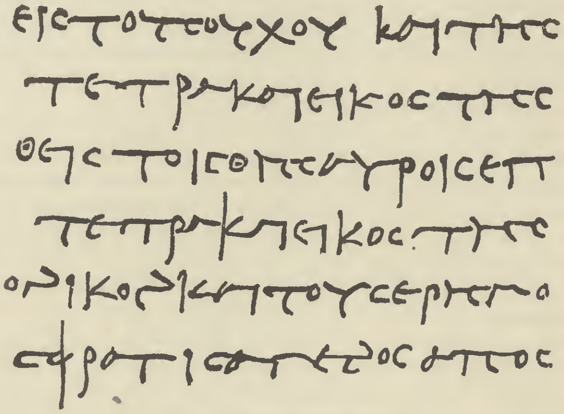

Fig. 1.—Official Order, 250 B.C.

(—εις τοπουχου και της—
—τετρα και εικοστης—
—θεις τοις θησαυροις επ—
—τετρα και εικοστης—
—ονικον και τους ερημο—
—σφραγισαμενος αποσ—)

As a contrast to this excellent hand, we give a facsimile of a section from a roughly written letter from a land steward to his employer, of about the same date:—

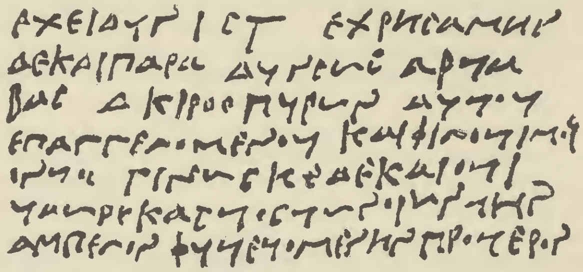

Fig 2.—Letter of a Land Steward, 3rd century B.C.

(εχει δυνις γ εχρησαμην
δε και παρα δυνεως αρτα
βας δ κριθοπυρων αυτου
επαγγελομενου και φιλοτιμου
οντος γινωσκε δε και οτι
υδωρ εκαστος των ορων την
αμπελον φυτευομενην προτερον)

Here there is none of the linking of the letters which is seen in the other example: every letter stands distinct. But while the individual letters are clumsily written, the same laws govern their formation as in the other document. The shallow, wide-spread *mu*, the cursive *nu*, the small *theta*, *omikron*, and *rho*, are repeated. Here also is seen the *tau*, with its horizontal stroke confined to the left of the vertical instead of crossing it, and the undeveloped *omega*, which has the appearance of being clipped—both forms being characteristic of the 3rd century B.C.

The trained clerical hands of the 2nd century B.C., if we may form a judgment from the evidence of such documents as those connected with the Serapeum at Memphis, already referred to, differ generally from those of the earlier century in the larger size of the lettering, and in a more perfect and less cursive formation, the older shallow type gradually disappearing, and the linking of letters by horizontal strokes being less continuous. But the Ptolemaic character marks the handwriting well through the century; and it is only towards the close of that period and as the next century is entered, that the hand begins to give way and to lose altogether its linked style and the peculiar crispness of the strokes which give it its distinctive appearance.

With the Roman period comes roundness of style, in strong contrast to the stiffness and rigid linking of the Ptolemaic hand. Curves take the place of straight strokes in the individual letters, and even ligatures are formed in pliant sweeps of the pen. This transition from the stiff to the flexible finds something of a parallel in the development of the curving and flexible English charter-hand of the 14th century from the rigid hand of the 13th century; following, it would seem, the natural law of relaxation. Roundness of style, then, is characteristic of Greek cursive writing in the papyri of the first three centuries of the Christian era, however much individual hands, or groups of hands, might vary among themselves. After that time, if we may judge from the meagre material that has been recovered, there appears to have been a reform of the Roman hand which marks the entry of Greek writing into the new phase of the Byzantine period, the characteristic features of the new style being its large scale and its formality—a deliberate calligraphic effort which culminated in the bold but artificial hand of the 6th and 7th centuries.

A specimen of cursive writing of the Roman type is selected from a papyrus (Brit. Mus. No. cxxxi.) which is of more than usual interest, as it is on the verso side of the rolls of which it is composed that the text of Aristotle's *Constitution of Athens* has been transcribed. It contains the farming accounts of the bailiff of Epimachus, son of Polydeuces, the owner of an estate in the nome of Hermopolis in the 9th and 10th years of the reign of Vespasian, that is, A.D. 78–79:—

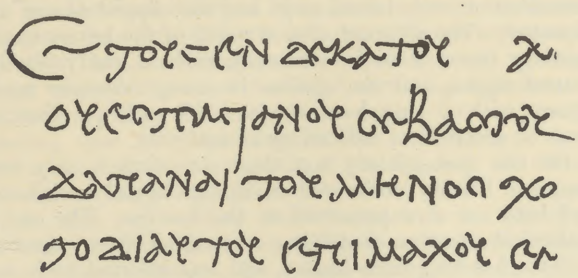

FIG. 3.—Farm Accounts, A.D. 78-79.

(ετους ενδεκατου α—
ουεσπασιανου σεβαστου—
δαπαναι του μηνος χ—
το δι αυτου επιμαχου ε—)

The fully developed Byzantine hand of the legal type is shown in a few lines from a fragmentary lease of a farm (Fig. 4) in the 6th century (Brit. Mus. pap. cxiii. 3).

In the long range covered by the Greek papyri under our hands, the formation of individual letters necessarily varied under different influences; but in not a few instances the original shapes were remarkably maintained. From those which thus remained conservative it is rash to attempt to draw conclusions as to the precise age of the several documents in which they occur. On the other hand, there are some which at certain periods adopted shapes which were in vogue for a limited time and then disappeared, never to be resumed. Such forms can very properly be regarded as sure guides to the palæographer in assigning dates. We may take a brief survey of the Greek cursive alphabet of the papyri and note some of the peculiarities of individual letters. The incipient form of the *alpha*, which gradually developed into the minuscule letter of the Middle Ages, may be traced back to the Ptolemaic documents of the 2nd century B.C.; but the more cursive letter, which was a simple acute angle, representing only two of the three strokes of which the

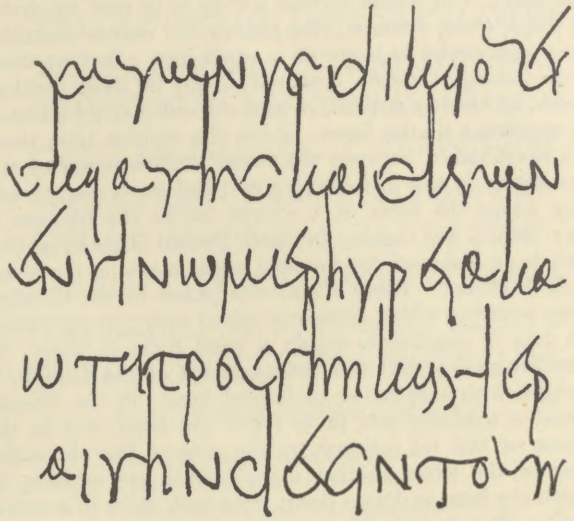

FIG. 4.—Lease of a Farm, 6th Century.

(—ς αυτων του δικαιου ε—
—ς και αυτης και εκ των—
—εντινω μερη τρεια κα—
—ω τα προς την καλλιερ—
—αι την δεσιν του π—)

primitive letter was composed, was characteristic of the 3rd century B.C., and seems to have gone out of use within the Ptolemaic period. The development of the cursive *beta* is interesting. At the very beginning we find two forms in use: the primitive capital letter and a cursive shape somewhat resembling a small *n*, being in fact an imperfectly written *B* in which the lower bow is disregarded. This form lasted through the Ptolemaic period. Then arose the natural tendency to reverse the strokes and to form the letter on the principle of *u*; but still the capital letter also continued in use, so that through the Roman and Byzantine periods the *u*-shape and the *B*-shape run on side by side. Analogously the letter *kappa*, formed on somewhat the same lines as the *beta*, runs a similar course in developing a cursive *u*-shaped form by the side of the primitive capital. *Delta* remained fairly true to its primitive form until the Byzantine period, when the elongation of the head into a flourish led on to the minuscule letter which is familiar to us in the mediæval and modern alphabet. *Epsilon*, the most frequently recurring letter in Greek texts, departs less from its original rounded uncial form than might have been expected. Frequent and varied as its cursive formations are, yet the original shape is seldom quite disguised, the variations almost in all instances arising from the devices of the scribe to dispose swiftly and conveniently of the cross-bar by incorporating it with the rest of the letter. The tendency to curtail the second vertical limb of *eta*, leading eventually to the *h*-shape, is in evidence from the first. But in the development of this letter we have one of the instances of temporary forms which lasted only within a fixed period. In the 1st century, side by side with the more usual form, there appears a modification of it, somewhat resembling the contemporary *upsilon*, consisting of a shallow horizontal curve with a vertical limb slightly turned in at the foot, Ɂ. Its development from the original H is evident: the first vertical limb is slurred, and survives only in the beginning of the horizontal curve, while the cross-bar and the second vertical are combined in the rest of the letter. This form was in general use from the middle of the 1st to the middle of the 2nd century, becoming less common after about A.D. 160, and practically disappearing about A.D. 200. The letters formed wholly or in part by circles or loops, *theta*, *omikron*, *rho*, *phi*, in the earlier centuries have such circles or loops of a small size. Just as there is an analogy between *beta* and *kappa* in their developments, as already noticed, so also do *mu* and *pi* advance on somewhat similar lines. From the earliest time there is a resemblance between the broad shallow forms of the two letters in the 3rd century B.C., and particularly when they adopt the form of a convex stroke the likeness is very close; and again, in both Roman and Byzantine periods an *n*-shaped development appears among the forms of both letters. There is also one phase in the development of *sigma* which affords a useful criterion for fixing the date of documents within a fixed limit of time. In the Ptolemaic period the letter, always of the C-form, is upright, with a flattened horizontal head; in the Roman period a tendency sets in to curve the head, and in the course of the 1st century, by the side of the old stiffer form of the letter another more cursive one appears, in which the head is drawn down more and more in a curve, C C. This form is in common use from the latter part of the 1st century to the beginning of the 3rd century. The cursive form of *tau*, in which the horizontal stroke is kept to the left of the vertical limb, without crossing it, is one of the early shapes of the letter. Lastly, the early Ptolemaic form of the *w*-shaped *omega* is noticeable from having its second curve undeveloped, the letter having the appearance of being clipped.

Before taking leave of the non-literary hands, we may briefly notice certain literary papyri which are written in cursive writing. The most important are: the astronomical treatise derived from Eudoxus, of the 2nd century B.C., among the collections of the Louvre; an anonymous work on diseases, with extracts from Menon's *Iatrica*, of the 1st or 2nd century, now in the British Museum; and, above all, Aristotle's *Constitution of Athens*, written at the end of the 1st century, also in the British Museum. To these are to be added: a papyrus containing a small portion of the eleventh book of the *Iliad*, of the 2nd century B.C., now at Geneva; an erotic fragment of the same time, in the British Museum; and the fragment of the lyric poet Alcman, of the 1st century, in the Louvre.

Literary papyri written in book-hands, distinct from the cursive writing which has been under consideration, may be divided into two classes: those which were produced by skilled scribes, and therefore presumably for the market, and those which were written less elegantly, but still in a literary hand, and were probably copied by or for scholars for their own use. By rare good fortune important literary fragments were recovered in the Gurob collection, which yielded the most ancient dated cursive documents of the 3rd century B.C., so that, from the beginning, we start with coeval specimens of both the cursive and of the book-hand, and we are in a position to compare the two styles on equal terms, and thus approximately to date the literary papyri. Palæographically, this is a matter of the first importance; for while cursive documents, from their nature, in most instances bear actual dates, the periods of literary examples have chiefly to be decided by comparison, and often by conjecture.

The literary fragments from Gurob fall into the two groups just indicated, MSS. written for sale, and scholars' copies. Of the former are some considerable portions of two works, the *Phædo* of Plato and the lost *Antiope* of Euripides. Both are written in carefully formed characters of a small type, but of the two the *Phædo* is the better executed. As the cursive fragments among which they were found date back to before the middle of the 3rd century B.C., it is reasonable to place these literary remains also about the middle of that century. Their survival is a particularly interesting fact in the history of Greek palæography, for in them we have specimens of literary rolls which may be fairly assumed to differ very little in appearance from the manuscripts of the great classical authors of Greece. Indeed, the *Phædo* was probably written within a hundred years of the death of the author.

In the facsimile of a few lines from this papyrus here placed before the reader, the characteristics of the cursive hand are also to some extent to be observed in the formal book-hand:—

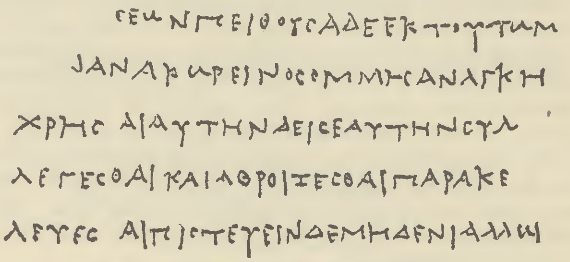

FIG. 5.—The *Phædo* of Plato, 3rd century B.C.

(—σεων πειθουσα δε εκ τουτωμ
—ανακωρειν οσομ μη αναγκη
χρησ[θ]αι αυτην δ εις εαυτην συλ
λεγεσθαι και αθροιζεσθαι παρακε
λευεσ[θ]αι πιστευειν δε μηδενι αλλωι)

The general breadth of the square letters, the smallness of the letters formed of circles and loops, and the particular formation of such letters as *pi* and the clipped *omega*, are repeated. The approach also of many of the letters to the lapidary forms is to be remarked, such as the precisely-shaped *alpha*, and the *epsilon* in many instances made square with a long head stroke. All such peculiarities must be accepted as indications of antiquity.

Of the 2nd century B.C. there are extant only two papyri of literary works written in the formal book-hand, and both are now preserved in the Louvre. The one, a dialectical treatise containing quotations from classical authors, has long been known, and was referred to in the article in the ninth edition of this work. The other is the oration of Hyperides against Athenogenes, which is an acquisition of recent date. The dialectical treatise must belong to the first half of the century, as there is on the verso side of the papyrus writing subsequently added in the year 160 B.C. The period of the Hyperides cannot be so closely defined; but the existence on the verso of later demotic writing, said to be of the Ptolemaic time, affords a limit, and the MS. has been accordingly placed in the second half of the century. While the writing of the earlier papyrus is of a light and rather sloping character, that of the Hyperides is particularly firm and square and upright.

Passing to the 1st century B.C., the papyri which have been recovered from the ashes of Herculaneum come into account. Many of them, the texts of which are of a philosophical nature, are written in literary hands, and are conjectured to have actually formed part of the library of their author, the philosopher Philodemus; they are therefore placed about the middle of the century. To the same time are assigned the remains of a roll containing the oration of Hyperides against Philippides and the third Epistle of Demosthenes (Brit. Mus. papp. cxxxiii., cxxxiv.). But the most important addition to the period is the handsomely written papyrus containing the poems of Bacchylides, which retains in the forms of the letters much of the character of the Ptolemaic style, although for other reasons it can hardly be placed earlier than about the middle of the century :—

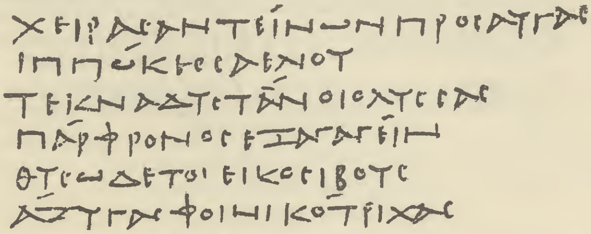

Fig. 6.—Bacchylides, 1st century B.C.

(χειρας αντεινων προς αυγας
ιππωκεος αελιου
τεκνα δυστανοιο λυσσας
παρφρονος εξαγαγειν
θυσω δε τοι εικοσι βους
αζυγας φοινικοτριχας)

With the latter half of the 1st century B.C. we quit the Ptolemaic period and pass to the consideration of the literary papyri of the Roman period; and it is especially in this latter period that our extended knowledge, acquired from recent discoveries, has led to the modification of views formerly held with regard to the dates to be attributed to certain important literary MSS. As in the case of non-literary documents, the literary writing of the Roman period differs from that of the Ptolemaic in adopting rounded forms and greater uniformity in the size of the letters.

Just on the threshold of the Roman period, near the end of the 1st century B.C., stands a fragmentary papyrus of the last two books of the *Iliad*, now in the British Museum (pap. cxxviii.), which is of sufficient extent to be noted. Then, emerging on the Christian era, we come upon one of the most beautiful surviving specimens of literary writing, which we have satisfactory reason for placing near the beginning of the 1st century. It is a fragment of the third book of the *Odyssey*, the writing of which closely resembles that of an official document (Brit. Mus. pap. cccliv.) which happens to be written in a formal literary hand, and which from internal evidence can be dated within a few years of the close of the 1st century B.C. There can be no hesitation, therefore, in grouping the *Odyssey* with that document. The contrast between the round Roman style and the stiff and firm Ptolemaic hands is here well shown in the facsimiles from this papyrus (Fig. 7) and the *Phædo* and *Bacchylides*.

In a similar style of beautiful writing are two fragments of Hesiodic poems recently published, with facsimiles, in the *Sitzungsberichte* (1900, p. 839) of the Berlin Academy. The earliest of the two, now at Strasburg, may be assigned to the first half of the 1st century; the other, at Berlin, appears to be of the 2nd century.

At this point two MSS. come into the series, in regard to which there is now held to be reason for revising views formerly entertained. The papyrus known as the Harris Homer (Brit. Mus. pap. cvii.), containing portions of the eighteenth book of the *Iliad*, which was formerly placed in the 1st century B.C., it is thought should be now brought down to a later date, and should be rather assigned to the 1st century of the Christian era. The great papyrus, too, of Hyperides, containing his orations against Demosthenes and for Lycophron and Euxenippus, which has been commonly placed also in the 1st century B.C., and by some even earlier, is now adjudged to belong to the latter part of the 1st century A.D.

At the end of the 1st or early in the 2nd century is placed a papyrus of great literary interest, containing the Mimes of the Alexandrian writer Herodas, which was discovered a few years ago and is now in the British

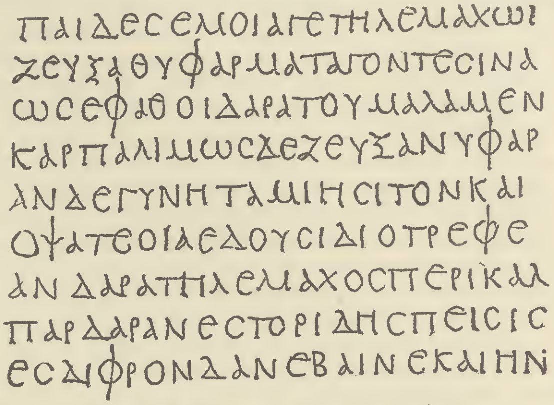

Fig. 7.—The *Odyssey*, beginning of 1st century.

(παιδες εμοι αγε τηλεμαχωι—
ζευξαθ υφ αρματ αγοντες ινα—
ως εφαθ οι δ αρα του μαλα μεν—
καρπαλιμως δ εζευξαν υφ αρ—
αν δε γυνη ταμιη σιτον και—
οψα τε οια εδουσι διοτρεφε—
αν δ αρα τηλεμαχος περικαλ—
παρ δ αρα νεστοριδης πεισισ—
ες διφρον δ ανεβαινε και ην—

Museum. The writing of this MS. differs from the usual type of literary hand, being a rough and ill-formed uncial, inscribed on narrow, and therefore inexpensive, papyrus; and if the roll were written for the market, it was a cheap copy, if indeed it was not made for private use. Of the same period is a papyrus of Isocrates, *de Pace* (Brit. Mus. pap. cxxxii.), written in two hands, the one more clerical than the other; and two papyri of Homer, *Iliad* iii.–iv. (Brit. Mus. pap. cxxxvi.), and *Iliad*, xiii.–xiv. (Brit. Mus. pap. dccxxxii.), the first in a rough uneducated hand, but the latter a fine specimen of uncial writing. Then follows another famous papyrus, the Bankes Homer, containing the last book of the *Iliad*, which belongs to the 2nd century and is also written in a careful style of uncial writing.

With regard to the later literary works on papyrus that have been recovered, the period which they occupy is somewhat uncertain. The following are, however, placed in the 3rd century, during which a sloping literary hand seems to have been developed, curiously anticipating a similar change which took place in the course of development of the uncial writing of the vellum MSS., the upright hand of the 4th to 6th centuries being followed by a sloping hand in the 7th and 8th centuries:—A MS., now in the British Museum, of portions of books ii.–iv. of the *Iliad*, written on eighteen leaves of papyrus, put together in book-form, but inscribed on only one side; on the verso of some of the leaves is a short grammatical treatise attributed to Tryphon: portion of *Iliad* v., among the Oxyrhynchus papyri (No. ccxxiii.): a fragment of Plato's *Laws* (Ox. pap. xxiii.): a papyrus of Isocrates, *in Nicoclem*, now at Marseilles: a fragment of Ezekiel, in book form, in the Bodleian Library: and a fragment of the "Shepherd" of Hermas, at Berlin.

Of the 3rd century also are some fragments which are palæographically of interest, as they are written neither in the recognized literary hand nor in simple cursive, but in cursive characters moulded and adapted in a set form for literary use—thus anticipating the early stages of the development of the minuscule book-hand of the 9th century from the cursive writing of that time.

With the 3rd century the literary hand on papyrus appears to lose most of its importance. We are within measurable distance of the age of vellum, and of the formal uncial writing of the vellum MSS. which is found in some existing examples of the 4th century and in more abundant numbers of the 5th century. We have now to see how the connexion can be established between the literary handwriting of the papyri and the firmer and heavier literary uncial writing of the vellum codices. The literary hands on papyrus which have been reviewed above are distinctly of the style inscribed with a light touch most suitable to the comparatively frail material of papyrus. Only in the Bankes Homer may one detect some indication of the fulness that characterizes the vellum uncial writing. But it now appears that a larger and rounder hand was also employed on papyrus at least as early as the 1st century. In proof of this we are able to cite a non-literary document bearing an actual date, which happens to be written in characters that, exclusive of certain less formally-made letters, are of a large uncial literary type. This writing, though not actually of the finished style familiar to us in the early vellum MSS., yet resembles it so generally that it may be assumed, almost as a certainty, that there was in the 1st century a full literary uncial hand formed on this pattern, which was the direct ancestor of the vellum uncial. The tendency to employ at this period a calligraphic style, as seen in the fragments of the *Odyssey* and one of the Hesiodic poems mentioned above, supports this assumption. The document now referred to is a deed of sale written in the seventh year of Domitian, A.D. 88 (Brit. Mus. pap. cxli.). The letters still retaining a cursive element are *alpha*, *upsilon*, and in some instances *epsilon*.

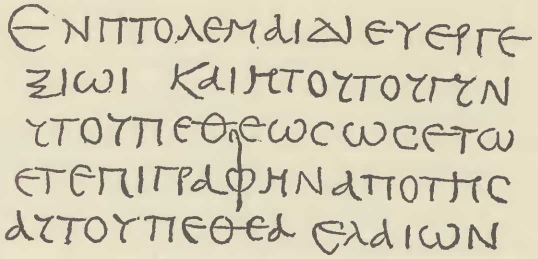

Fig. 8.—Deed of Sale, A.D. 88.

(—εν πτολεμαιδι ευεργε—
—ξιωι και η τουτου γυν—
—υ του πεθεως ως ετω—
—ετεπιγραφην απο της—
—αυτου πεθεα ελαιων—)

As evidence in support of this view that the uncial hand of the vellum MSS. is to be traced back to the period of the document just quoted, we have the important papyrus found by Mr Flinders Petrie at Hawara in Egypt, and now in the Bodleian Library, which contains a portion of the second book of the *Iliad*. The writing is of the large uncial type under consideration; and there is now full reason for assigning it to the 2nd century at latest. Before the discovery of the document of the year 88 there was nothing to give a clue to the real period of the Homer; and now the date which has been suggested is corroborated by a fragment of papyrus from Oxyrhynchus inscribed with some lines from the same book of the *Iliad* (Fig. 9) in the same large uncial type (*Ox. Pap.* vol. i. no. 20, pl. v.). In this latter instance there can be no question of the early date of the writing, as on the verso of the papyrus accounts of the end of the 2nd century or of the beginning of the 3rd century have been subsequently added.

Thus, then, in the 1st and 2nd centuries there was in use a large uncial hand which was evidently the fore-

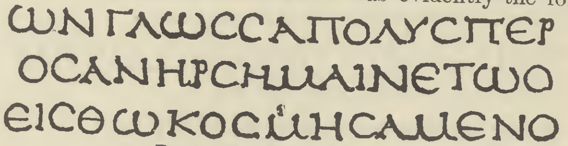

Fig. 9.—The *Iliad*, 2nd century.

(—ων γλωσσα πολυσπερ—
—ος ανηρ σημαινετω ο—
—εισθω κοσμησαμενο—)

runner of the literary uncial hand of the early vellum codices. It is also to be noted that the two literary examples just mentioned are MSS. of Homer; and hence one is tempted to suggest that, as in the production of sumptuous copies on papyrus of a work of such universal popularity and veneration as the *Iliad* this large and handsome uncial was specially employed, so also the use of a similar type for the early vellum copies of the sacred text of the Scriptures naturally followed.

While such large results in Greek papyri have rewarded recent researches in Egypt, we have to record the discovery of only a very small number of papyri inscribed in Latin, and of those very few are in perfect condition. Among the Archduke Rainer's collection at Vienna, for example, and among the large mass of documents found at Oxyrhynchus for the Egypt Exploration Fund, here and there a letter, or fragment, or military document is found. But it is hardly to be expected that any very extensive series of Latin documents should come to light in Egypt, unless by chance the archives of some Roman military station should be recovered.

We may briefly enumerate the few more important documents recently found. Among Lord Amherst's papyri is a fragment containing three of the fables of Babrius, each accompanied with a Latin version, of the 3rd or 4th century (*Amherst Papyri*, pt. ii. no. xxvi.). At Berlin are the remains of an Imperial edict, suggested to be of the time of Tiberius, which are published, with a photograph, in *Aegyptische Urkunden aus den königl. Museen*, No. 628. At Geneva is a papyrus containing Roman military money accounts, published by Nicole and Morel, *Archives Militaires du premier siècle.* A papyrus of a similar nature, of the 2nd century, is printed by Grenfell and Hunt, *Fayûm Towns* (Eg. Expl. Fund), No. cv. And a roll, now at Berlin, of the First Augustan Cohort of Spain, quartered at Apollinopolis Major in Egypt, in A.D. 156, is given in facsimile in the series of the *Palæographical Society*, ii. 165. The most perfect Latin document on papyrus, as yet recovered, is in the British

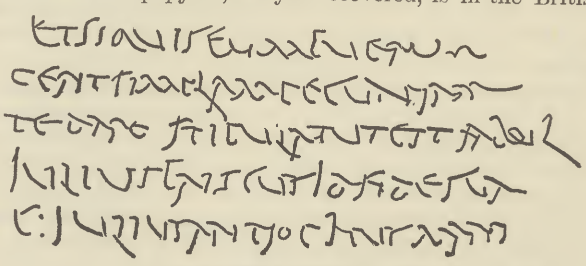

Fig. 10.—Sale of a Slave, A.D. 166.

(—et si quis eum puerum
—ccrit simplam pecuniam
—te dare stipulatus est Fabul
—Julius Priscus id fide sua
—C. Julius Antiochus mani—)

Museum, and records the purchase of a slave-boy by an officer in the Roman fleet of Misenum stationed on the

Syrian coast, A.D. 166 (*Pal. Soc.* i. 190; *Archæologia*, liv. p. 433). The writing of the body of the document is in a formal cursive, generally of the same formation as the inscriptions on the Dacian waxen tablets of the 2nd century, as will be seen from the accompanying facsimile of a few lines (Fig. 10).

With this example of legal handwriting of the 2nd century it is interesting to compare two specimens of more ordinary cursive in different styles found in private letters of about the same time. The first is taken from a fragmentary letter of the year 167, published by Grenfell and Hunt, *Greek Papyri*, series ii. No. cviii.:—

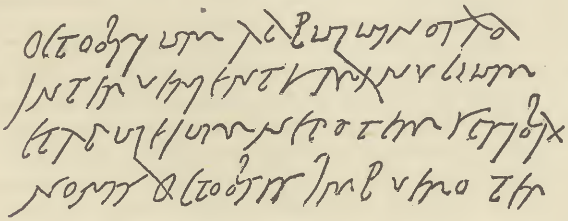

FIG. 11.—Letter, A.D. 167.

(Octobrium ad Puluinos ad—
interueniente Minucium—
et Apuleium nepotem scrib*am*—
nonis Octobris imp. Uero ter—)

The second (Fig. 12) is from a letter written by one Aurelius Archelaus to Julius Domitius, *tribunus militum*, recommending a friend named Theon, of the 2nd century. (Printed by Grenfell and Hunt, *Oxyrhynchus Papyri* (Eg. Expl. Fund), i. No. xxxii.)

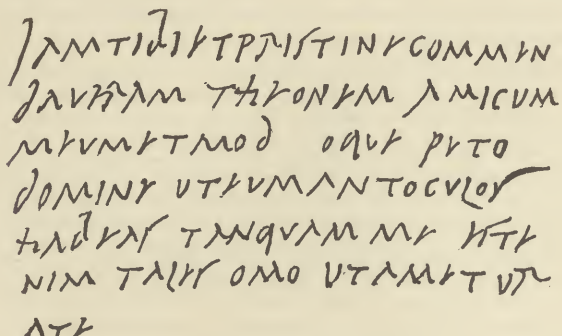

FIG. 12.—Letter, 2nd century.

(Jam tibi et pristine commen
daueram Theonem amicum
meum et mod[o qu]oque puto
domine ut eum ant oculos
habeas tanquam me est e
nim tales omo ut ametur
a te)

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Palamau, a district of British India, in the Chota Nagpur division of Bengal. It was formed out of Lohardaga, and takes its name from a former state or chiefship. The administrative headquarters are at Daltonganj. It consists of the lower spurs of the Chota Nagpur plateau, sloping north to the valley of the Sone. Area, 4905 square miles; population (1881), 551,075; (1891), 596,770; (1901), 619,421; showing an increase of 8 per cent. between 1881 and 1891, and of 3·8 per cent. between 1891 and 1901; average density, 126 persons per square mile, being the lowest in all Bengal. Classified according to religion, Hindus in 1891 numbered 496,426; Mahommedans, 50,445; Christians, 6676; aborigines, 43,223. The land revenue and rates in 1897–98 were Rs.1,23,780; number of police, 256; boys at school (1896–1897), 6860, being 15·5 per cent. of the male population of school-going age; registered death-rate (1897), 39·4 per thousand. Palamau suffered severely from drought in 1897–98. Sanction has been given for a branch of the East Indian Railway from the Sone valley, which will open up the valuable coalfield near Daltonganj; and other lines have been surveyed to afford a shorter route to Calcutta. The only articles of export are jungle produce, such as lac and *tasar* silk. The forests are unprofitable.

Palamcottah, a town of British India, in the Tinnevelly district of Madras, situated on the opposite bank of the Tambraparni river to Tinnevelly town, with which it shares a station on the South Indian Railway, 444 miles south of Madras. Population (1891), 18,612; municipal income (1897–98), Rs.25,360. It is the residence of the officials of the district. The Sarah Tucker college for women was founded in 1895; the two high schools (Church Mission and Jesuit) have nearly 600 pupils. There are three printing-presses, besides a library and reading-room.

Palanpur, a native state of India, in the Gujarat division of Bombay, on the southern border of Rajputana. Area, 3177 square miles; population (1881), 234,402; (1891), 274,864; (1901), 222,627.

The estimated gross revenue is Rs.6,59,530, of which Rs.48,680 was expended on public works in 1897–98; tribute to the Gaekwar of Baroda, Rs.50,000. The chief, whose title is diwan, is an Afghan by descent. The state is traversed by the main line of the Rajputana–Malwa railway, and contains the British cantonment of Deesa. The state suffered severely from the plague, the number of deaths to July 1898 having been 1119. The town of PALANPUR is a railway junction for Deesa, 18 miles distant. Population (1881), 17,547; (1891), 21,092; (1901), 17,799. There are a high school, with 138 pupils in 1896–97; the Jackson town hall; the Scott Hospital, opened in 1898; and a printing-press. Palanpur also gives its name to a political agency, or collection of native states; total area, 4775 square miles; population (1891), 645,526; (1901), 467,691, showing a decrease of 28 per cent., due to the effects of famine.

Palêan. See MALAY PENINSULA.

Palencia, an inland province of Spain; area, 3127 square miles. Population, 188,845 in 1887, and 193,668 in 1897. It is divided into seven districts and 250 parishes. The birth-rate is 4·43 per cent., the death-rate 3·76 per cent., and the proportion of illegitimate births 2·03 per cent. The climate is cold and damp in the northern mountainous and well-wooded part, but temperate and dry in the vast plain of the Tierra de Campos, which is rich in agricultural products.

In 1897 wheat was grown on 269,687 acres; rye, oats, barley, maize on 314,217 acres; pod fruit on 99,930 acres; vines on 57,370 acres. The province is rich in live stock. Besides all its breadstuffs, Palencia produces good, strongly alcoholic wines, much hemp, fruit, and vegetables. The most important industry is flour-milling. There are manufactures of oil, porcelain, leather, paper, cloths, and especially of rugs (in great demand in the whole peninsula). The mining interests have been chiefly developed by the opening of narrow-gauge railways, putting the province in communication with Bilbao *viâ* Robla, and very advantageous for the coal-mines near the rivers Carrion, Pisuera, and Rubagon. There are one copper and ninety coal mines, and the output is 500 tons of copper and 106,666 tons of coal a year.

Palencia, capital of the above province, on the left bank of the river Carrion and of the canal of Castilla, in a fertile country. Population, 15,050 in 1887, and 16,118 in 1897. The streets of the old town are narrow and irregular, but studded with more modern houses and public buildings. The Puente Mayer, Puente Nuevo, and Puentecillos span the river, and communicate with some new suburbs. Much has been done for education; besides an institute, there are many primary schools, a school for teachers of both sexes, a municipal academy of fine arts, a school of arts and handicrafts, and a meteorological observatory. The town is well provided with hospitals, a foundling refuge, barracks, and a bull-ring for 8000 sightseers. Local industries include the making of rugs, alcohol, leather, soap, porcelain, linen, cotton, wool, foundries, machinery, and matches.

Palermo, a city of Italy, capital of the former kingdom of Sicily, standing on a bay of the same name situated on the northern coast of the island. It is surrounded by a plain about 70 square miles in extent, bounded at a distance of from 4 to 6 miles by a semicircular mountain chain which terminates in the two promontories of Zaffarano and Monte Pellegrino. Until a century ago the form of the city was perfectly rectangular. It occupied an area of about 1 square mile. This more ancient part of the town is intersected by the two great streets, Toledo and Macqueda, which, cutting each other at right angles in the centre of the city, terminate at the four old gates called Porta Telice, Porta Nuova, Porta di S. Antonino, and Porta Macqueda. At the point where the two streets cross is the little Piazza of the Four Corners (Quattro Cantoni), which is still the centre of Palermitan life. With the increase of the population vast new quarters have grown up, especially outside Porta Nuova and Porta Macqueda. These quarters are characterized by fine squares, large straight streets planted with trees, several public gardens, and numerous villas in the English style surrounded by gardens. Among the modern edifices are the two theatres, called the Politeama and the Teatro Massimo, which are two of the most gorgeous in Italy. The city is the commercial centre of western Sicily. The climate in winter is extremely mild, the sky usually clear, and the atmosphere always free from fog. The plain is planted with orange and lemon groves and with abundance of palm-trees, which, though their fruit does not attain maturity, give to the landscape an Oriental aspect—an aspect further enhanced by the numerous acanthus, cactus, stone-pine, and gigantic plane trees. The interior of the city—now well supplied with good water—does not wear that neglected and dirty aspect often noticeable in southern cities. Shops and streets are extremely clean, and the bearing of the population is reserved and dignified. The inhabitants, indeed, present the appearance of an economic well-being possibly out of keeping with their financial condition. Industrial development is as yet slight, although a large shipbuilding yard has been established. But owing to the university, the libraries, the museum, and the scientific institutions, Palermo remains the centre of Sicilian culture and exerts great moral and intellectual influence over the rest of the island. Population, 291,000.

Like most other Italian universities, the university is subject to the general laws upon higher education, namely, the fundamental Casati Law of 1859, the Matteucci Law of 1860, and the Baccelli Law of 1881. It was given first-class status in 1860, and since then has possessed the four faculties which exist in all Italian universities of the first class—jurisprudence, medicine and surgery, letters and philosophy, natural sciences and mathematics. A school of pharmacy and a school of practical engineering have been added. The ordinary and extraordinary professors in all the faculties numbered seventy-one in 1899. The number of *liberi docenti* or free chairs (corresponding to the *agrégation* of French universities, or, more exactly, to the *Privat-docenten* of German universities) was almost equal to that of the official professors. The institution known as a Consorzio Universitario arranges for the payment by the communal and provincial authorities of a part of the cost of the scientific laboratories annexed to the chairs of experimental science, and of the training school connected with the faculty of philosophy and letters. The number of students grew from 300 in 1872 to 1495 in 1897, but the number has since somewhat decreased, having been 1225 in 1898, 1148 in 1899, and 1161 in 1900. The chief cause of this diminution is the increasing emigration of Sicilian students —especially those who intend to study electricity, for which no provision exists at Palermo—to the better-equipped universities of Naples, Rome, or Turin. A number of professors have also migrated from Sicily to the northern Italian universities.

The number of entrances and clearances at the port in 1896 was 7192 vessels of 3,164,465 tons, unloading and loading 681,014 tons of goods; in 1898 the figures were 6921 vessels of 3,266,833 tons, unloading and loading 677,932 tons of goods.

Palestine, or the HOLY LAND, the southern third of Syria, bounded on the W. by the Mediterranean, on the S. by a line somewhat indeterminately drawn from the southern end of the Dead Sea westwards, on the E. by the desert of Syria and Arabia, and on the N., rather indefinitely, by the Lebanon and Anti-Lebanon, between 31° and 34° N. and 34° and 37° W.

Geology.—The physical features closely conform to its geological structure. Proceeding from west to east, they are: (1) A maritime district, of varying width, that extends along the coast of the Mediterranean, and is formed of raised beaches and sea-beds which range from the Pliocene period downwards, and rest upon calcareous sandstones of Upper Eocene age. (2) The hill-country which stretches southwards from Lebanon through Galilee, Samaria, and Judæa, to the desert tableland called Badiet et-Tíh. It is composed of cretaceous limestone, with beds and bands of marl and flint, which is covered here and there by outlying patches of nummulitic limestone. Westwards the limestone passes under the calcareous sandstone; eastwards, though concealed by more recent deposits, it underlies nearly the whole of the Jordan valley, and is broken off, along the line of the great fault, against older formations. (3) The Jordan-ʿAraba depression, which follows the line of a fault, or fracture of the earth's crust that has produced a vertical displacement of the strata, those on the west side of the depression being lowered, and those on the east side elevated. In the valley itself there are remains of lake-deposits which reach to a height of 1200 feet, and indicate the varying levels of the great inland sea of the Pliocene period (see DEAD SEA). (4) The hill-country of Gilead and the table-land of Moab, formed of cretaceous limestone resting, in descending order, upon variegated "Nubian" sandstone of Lower Cretaceous age, limestone of the Carboniferous period, red sandstone, conglomerates, and crystalline rocks of great geological antiquity. East of the Dead Sea and the Jordan the limestone is overlaid in places by sheets of basalt of post-Tertiary date, most conspicuous in the north, where they form the surface of the Haurán, Jaulán, and Lejá districts. West of Jordan volcanic lavas are found round the Sea of Galilee, in the plain of Jezreel, and in a few other localities.

Political Geography. — Considerable light has been thrown upon the condition of Palestine in the 14th century B.C. by the discovery of the Tell el-ʿAmarna letters, which describe the breaking up of the Egyptian empire in that country during the last years of Amenhotep III. and the reign of Akhenaten, and the extension southwards of the Amorite and Hittite power prior to the Hebrew invasion. Palestine, except for the independent sanjak of el-Khuds (Jerusalem), now forms part of the vilayets of Beirút and Suríya (Damascus), including the sanjaks of ʿAkka, Náblus, Haurán, Belka, and Kerak.

Recent History.—Since 1880 great changes have taken place. The effective occupation, by Turkish troops, of the country east of Jordan, from Damascus to Máán and the Gulf of ʿAkabah, has secured both sides of the river from the incursions of the Bedawín, and given security to life and property. New villages have been built, and large areas of rich land which were formerly waste have been brought under cultivation. A railway now connects Jaffa with Jerusalem; another runs through the Haurán from Mezeiríb to Damascus, where it joins the line to Beirút; and a third, intended to connect Haifa with Damascus, is in course of construction.[1] Metalled roads have been made, and upon these wheeled transport has largely taken the place of the mule and camel. But the most interesting changes are those due to the efforts that have been made to establish European and Jewish agricultural colonies in the land. The first attempts, by Germans at Urtás in 1850, and by Americans at the same place in 1851, and near Jaffa in 1853 and 1866, failed. But in 1868 the German community of the "Temple" successfully founded colonies at Haifa and Jaffa, and afterwards at Sarona, north-east of Jaffa, and at Jerusalem. The community now numbers about 1200, and has its own schools and hospitals. Its members are engaged in trade, or in agricultural pursuits and the production of wine, or work as artisans. They have done much to promote the agricultural development of the country, and have introduced a higher standard of life, which is slowly but surely influencing the native peasantry. The Christian attempts at colonization attracted the attention of the Jews. In 1853 Sir Moses Montefiore purchased land near Jaffa for the use of the American colony; in 1870 the Alliance Israélite Universelle established an agricultural school for Jews near Jaffa; and in 1878 an abortive attempt was made to settle a colony of Jerusalem Jews at Mulebbis on the Jaffa–Náblus road. In 1881 and the following years the persecution of the Jews in Rumania and Russia led to emigration on a large scale, and many of the emigrants selected Palestine as their future home. Land was purchased, not always in suitable localities, and there was much suffering amongst the settlers from fever and ignorance of the country. Many died, and failure was almost certain, when Baron Edmond de Rothschild intervened with that financial assistance and intelligent direction without which there could be no measure of success.[2] His example was followed by the Alliance Israélite, the Jewish Colonization Association, the Chovevi Zion, and other societies, and numerous settlements had been established before the movement was checked by the action of the Porte in forbidding further immigration and the sale of land to Jews. At present there are more than twenty colonies, with about 5000 colonists, scattered over the country from the Merj ʿAyún to the vicinity of Ashdod. The land held exceeds 40,000 acres, and the whole of this has been brought under cultivation. In the face of obstacles created by local officials, crushing taxation, and the opposition of France and Russia, the colonization has been on the whole successful. The land has proved to be highly productive, and to respond readily to improved methods of agriculture; and under a better system of government the financial success of the colonies, which thus far has not been complete, would be assured. The influence of the colonies on the aspect and well-being of the country is marked. Forests of eucalyptus, extensive orchards, olive groves, vineyards, and cornfields have taken the place of arid waste lands; clusters of well-built houses are frequently seen; roads have been made; native landowners have adopted the agricultural methods of the Jews; industries have sprung up to meet the requirements of the colonies, and a great impetus has been given to the culture of silk, the manufacture of wine and perfumes, and the re-cultivation of the soil. How far the next generation will be able to resist the enervating tendency of the climate, and avoid the danger of assimilation with the natives, are questions that cannot be discussed here. Circassian colonies have been planted at Jerash, ʿAmmán, Kaisaríeh, and other places, where the colonists, although they have done irreparable damage to the ruins of the ancient cities, have introduced wheeled transport and improved methods of cultivation.

The Sultan, in pursuance of a scheme which had its origin about 1885, has taken up waste lands and purchased landed property throughout the Asiatic provinces of his empire. In Palestine he now holds as his private property (*arázi-i-seníye*) the whole of the Jordan valley south of the Sea of Galilee, and large estates in Wádi es-Surár and other places. These Crown properties, which are under an independent administration managed from Constantinople, serve as model farms, and have in some respects an influence for good. But they pay

[1] The construction of this line was suspended in 1901.

[2] In 1900 the Rothschild interest in the colonies was handed over to the Jewish Colonization Association.

no taxes to the State, and the officials attached to them act not only in the name but in the personal interests of the head of the State.

Accompanying, and partly consequent upon, the process of colonization there has been a change in the position of the peasantry who were formerly freeholders of the soil. In most of the fertile districts capitalists, to whom the peasant proprietors were hopelessly in debt, have foreclosed their mortgages, and the owners, obliged to give up their title-deeds, are now working as tenants at will (*sherík el-hawa*) on lands that had been handed down to them through many generations.

An interesting feature is the great increase in the number of monastic, missionary, educational, and philanthropic establishments. The scene of nearly every event connected with New Testament history has been localized, the site purchased, and a commemorative chapel and monastery erected. There has also been great missionary activity on the part of all the Churches, and latterly the Russians have sought to gain influence by subsidizing Greek Orthodox schools in which Russian is taught, by opening schools in the villages and seminaries in the towns, and by sending promising students to complete their education in Russia. The object of this propaganda is, apparently, to form a national Arab Church, looking to Russia for protection, and to weaken the position now held in Turkey by the Greek Orthodox Church. Amongst the philanthropic establishments none are more worthy of notice than the hospitals founded at Jerusalem, Nazareth, Tiberias, and other places by English and Scottish societies. As a result of this activity on the part of the Greek, Protestant, Roman Catholic, and Russian Churches, Palestine is now covered with churches, chapels, monasteries, nunneries, hospices, and hospitals, and filled with clergy, monks, nuns, and pilgrims, as it has not been since the fall of the Latin kingdom. The old theory that all Roman Catholic institutions in the Levant should be under French protection has been abandoned. In Egypt they are now under Austrian protection, and in Palestine, since the German emperor's visit in 1898, all German Roman Catholic subjects and institutions are under German protection.

The trade and prosperity are to a large extent derived from the various religious interests centred in the land. There has been a large import of building material, and general trade has increased; but although this has benefited Europeans and the upper and educated classes amongst the natives, the condition of the peasants is perhaps worse than it was before the inrush of Europeans commenced. There are no trustworthy statistics of the population. There has been a large increase since 1880 in the number of Europeans and Jews, but the native population apparently has been stationary, and in some districts even seems to have decreased.

Exploration.—Since 1885 important surveys, covering Jaulán and parts of Haurán, and Gilead, have been made by Schumacher; excavations have been carried out for the Palestine Exploration Fund by Petrie, Bliss, and Macalister at Tell el-Hesi (Lachish), Jerusalem, Tell es-Safi, and other sites; the Sea of Galilee has been examined by Barrois; and Petra, with parts of Moab and Edom, has been surveyed by Brünnow. The results of the excavations show generally that an advanced state of civilization, sometimes under Mycenaean, sometimes under Egyptian influence, existed in the country during the pre-Israelite period.

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Palestine, a city of Texas, U.S.A., capital of Anderson county. It is on the International and Great Northern Railroad, in the eastern part of the state, at an altitude of 495 feet. It is in an agricultural and forested region, and has varied manufactures. Population (1880), 2997; (1890), 5838; (1900), 8297, of whom 356 were foreign-born and 2872 were negroes.

Palfrey, John Gorham (1796–1881), American historian, was born in Boston, Massachusetts, 2nd May 1796. He graduated at Harvard, 1815, and became a Unitarian minister, being pastor of the Brattle Square church, Boston, 1818–31. He was professor of sacred literature in the Harvard divinity school, 1831–39. Entering political life, he was secretary of state of Massachusetts, 1844–47; member of Congress, 1847–49; and postmaster of Boston, 1861–67. During his public career he was an earnest abolitionist. As a writer he edited the *North American Review*, 1836–43, and produced Biblical, sermonic, apologetic, and grammatical works now forgotten; but he is best known by a solid, rather than rhetorically interesting, *History of New England* to the revolutionary war, in five volumes, of which the first appeared in 1859 and the last posthumously in 1890. He died at Cambridge, Massachusetts, 26th April 1881.

Palghat, a town of British India, in the Malabar district of Madras, on the Madras Railway, 74 miles east of Beypur. Population (1881), 36,339; (1891), 39,367; municipal income (1897–98), Rs.65,850. It is a busy centre of trade with the western coast. The Basel Protestant mission has quarters here. The municipality manages the Victoria Jubilee College, with 67 students in 1896–97. There are two high schools with 481 pupils, two printing-presses, a reading-room, and a law library.

Palgrave, Francis Turner (1824–1897), English critic and poet, eldest son of Sir Francis Palgrave, the historian, was born at Great Yarmouth, 28th September 1824. His brothers, WILLIAM GIFFORD, traveller, author, and colonial official (1826–1888), and Sir REGINALD F. D. (1829– ——), who was Clerk of the House of Commons from 1886 to 1900, also had distinguished careers. At fourteen Francis was sent to Charterhouse; and in 1843, having in the meanwhile travelled extensively in Italy and other parts of the Continent, he proceeded to Oxford, having won a scholarship at Balliol. In 1846 he interrupted his university career to serve as assistant private secretary to Gladstone, but returned to Oxford the next year, and took a first-class in Literæ Humaniores. From 1847 to 1862 he was fellow of Exeter College, and in 1849, in which year began his long friendship with Tennyson, was appointed examiner in the Education Department at Whitehall, afterwards becoming assistant secretary. In 1850 he accepted the vice-principalship of Kneller Hall Training College. He married, in 1862, Cecil Grenville Milnes, daughter of James Milnes-Gaskell. In 1884 he resigned his position at the Education Department, and in the following year was elected professor of poetry at Oxford. He died in London, 24th October 1897, and was buried in the cemetery on Barnes Common. Palgrave published both criticism and poetry, but his work as a critic was by far the more important. Indeed, considering his admirable sense of the qualities and differentiations of true poetry, it is strange that he should have been content with the cold formality of much of his own verse. His *Visions of England* (1880–81) contains the last of his work in metre; it has dignity and lucidity, but little of the "natural magic" which the greatest of his predecessors in the Oxford chair considered rightly to be the test of inspiration. His lyrics were mildly delicate, but quite without lyrical fervour. On the other hand, his criticism was always marked by fine and sensitive tact, quick intuitive perception, and generally sound judgment. His *Handbook to the Fine Arts Collection, International Exhibition, 1862*, and his *Essays on Art* (1866), though not free from dogmatism and over-emphasis, were sincere contributions to art criticism, full of striking judgments strikingly expressed. His *Landscape in Poetry* (1897) showed wide knowledge and critical appreciation of one of the most attractive aspects of poetic interpretation. But Palgrave's principal contribution to the development of literary taste was contained in his *Golden Treasury of English Songs and Lyrics* (1861), an anthology of the best poetry in the language constructed upon a plan sound and spacious, and followed out with a delicacy of feeling which could scarcely be surpassed. The influence of this treasure-house of poetry, with the standards which it set up to taste and selection, has been incalculable. Palgrave followed it with a *Treasury of Sacred Song* (1889), and a second series of the *Golden Treasury* (1897); but in neither of these was quite the same exquisiteness of judgment preserved. (A. WA.)

Palit. See MALAY PENINSULA.

Pallanza, an industrial town and summer and winter resort of the province of Novara, Piedmont, Italy, occupying a position of great natural beauty, on a promontory on the west side of Lago Maggiore, with a semicircle of mountains behind and the lake and Borromean Islands in front, 62 miles north of Novara (56 by rail to Gravellona on the Simplon Railway). The annual mean temperature is 55° Fahr.; January, 37·1°; July, 74°. There is a fine botanical garden. There are cotton, silk, and jute manufactures, saw-mills and turnery shops, and a school of design. Population (1900), 3500.

Palma, capital of the province of Baleares, in the island of Majorca, the largest of the Balearic Isles, in the most northern part of the bay of the same name. It has a seminary founded in 1700, a depot of archives since the 14th century, schools of fine arts and museums of paintings, a nautical school, an institute, many primary schools, and a school for training teachers of both sexes. There are fine public buildings, and most of the streets have been improved with new houses in striking contrast with interesting old residences and palaces of the local nobility. Palma has a thriving trade in agricultural products, wine, oil, almonds, fruit, vegetables, silk, and food-stuffs, as well as live stock. There are manufactures of alcohol, liqueurs, chocolate, starch, sugar, preserves, flour, soap, leather, earthenware, glass, matches, paper, linen, woollen goods, and rugs. The port has been so much improved that large merchant steamers can enter and remain in even rough weather, and foreign war-vessels often visit the port. Population (1887), 61,052; (1897), 62,525.

Palmer, a town of Hampden county, Massachusetts, U.S.A. It has an area of 25 square miles of hill country, and is situated south-west of the centre of the state. The village of Palmer is on the Chicopee river, and on the Boston and Albany and the Central Vermont railways, at an altitude of 332 feet. It is irregular in plan, and has varied manufactures, consisting in part of cotton and woollen goods, iron and steel goods of various sorts, and carpets. Population (1880), 5504; (1890), 6520; (1900), 7801, of whom 2780 were foreign-born.

Palmer, John McCauley (1817–1900), American politician, was born at Eagle Creek, Ky., on 13th September 1817. In 1831 his family removed to Illinois, where he rose to some prominence as a Democrat. On the slavery question he joined the Republican party at its foundation. During the war he served in the Western armies, and rose to the rank of major-general. From 1868 to 1872 he was governor of Illinois, but joined the Liberal Republican movement in the latter year. As governor he resented strongly the assumption of police authority by General Sheridan and the federal troops at the time of the great Chicago fire (October 1872). In 1891 he was elected to the United States Senate by the Democrats, and served one term. Upon the adoption of the free-silver platform, and the nomination of Bryan by the Democratic Convention in 1896, General Palmer was nominated for the Presidency by the "Gold Democrats," but failed to receive any electoral votes. He then lived in retirement till his death, 25th September 1900.

Palmi, a town of the province of Reggio, Calabria, Italy, 26 miles north by east of Reggio on the west coast railway to Naples, standing halfway up the slope of Mount Elia, 450 feet above sea-level. It has olive-oil presses, and fishing for tunny and sword-fish. The town was almost entirely rebuilt after the earthquake of 1783. Population (1881), 9705; (1899), 15,500.

Palmyra Island. See POLYNESIA.

Palo Alto, a town of Santa Clara county, California, U.S.A., on the west side of Santa Clara valley, between two of the coast ranges, on the coast division of the Southern Pacific Railway, 34 miles nearly south of San Francisco. Its site is perfectly level and plan strictly regular. It has a water-supply pumped from artesian wells, and a good sewer system. It is the railway station for Leland Stanford Jr. University, which is $1\frac{1}{2}$ miles south-west. The name of the town was derived from a solitary redwood, standing near the railway track on the outskirts of the town. Population (1900), 1658.

Paludan-Müller, Frederik (1809–1876), the most distinguished of the recent poets of Denmark, was the third son of Jens Paludan-Müller, from 1830 to 1845 bishop of Aarhus. He was born at Kjerteminde in Fünen, on the 7th of February 1809. In 1819 his father was transferred to Odense, and the future poet began to attend the Latin school there. He went to Copenhagen as a student in 1828. After several efforts, he attracted general attention in 1833 by *The Dancing Girl*, a poetical narrative embroidered with charming melody and colour. Paludan-Müller was accepted by criticism without a struggle, and few writers have ever excited less hostility than he. He was, however, not entirely well inspired in his lyrical drama of *Amor and Psyche* in 1834, and his next productions were too vividly influenced by Byron. From 1838 to 1840 Paludan-Müller was making the grand tour in Europe, and his genius greatly expanded. In Italy he wrote *Venus*, a lyrical poem of extreme beauty, a hymn to the majesty of Eros. In 1841 he began to publish a great work on which he had long been engaged, and which he did not conclude until 1848; this was *Adam Homo*, a narrative epic, satirical, modern, and descriptive, into which Paludan-Müller wove all his variegated impressions of Denmark and of love. This remains the typical classic of Danish poetical literature. While this virile work was in slow progress the poet was engaged in shorter and more exquisite productions. In 1844 he was absolutely in flower, for he completed three enchanting idyls, *The Dryad's Wedding*, *Tithonus*, and *The Death of Abel*, each separate, and each one of the poet's most characteristic and most highly finished compositions. In *Tithonus*, perhaps, the genius of Paludan-Müller reaches its most personal expression. From 1850 a certain decline in the poet's physical powers became manifest, and he wrote less. His majestic drama of *Kalanus* belongs to 1854. Then for seven years he kept silence. *Paradise* (1861) bears evidence of malady, both physical and mental. Paludan-Müller wrote considerably after this, but never recovered his early raptures, except in the very latest of all his poems, the enchanting welcome to death, called *Adonis* (1874). After long ill-health, he died at Copenhagen on the 27th of December 1876. He was a poetic artist of the finest order, perhaps the greatest purely plastic poet that the North has seen. (E. G.)

Pamiers, chief town of arrondissement, department of Ariège, France, 12 miles north of Foix, on the railway from Toulouse to Ax-les-Thermes. It has a communal college, consultative chamber of arts and manufactures, and a hospital. Iron and steel of excellent quality, sheet-iron, iron-ware, chains, and carriage springs are among the products of its important metallurgical industries. It has also paper and saw mills and tanneries, and commerce in grain, flour, fodder, fruit, and vegetables. Population (1891), 8166; (1901), 9409.

Pamirs.—Since 1875 the Pamirs have probably been the best explored region in High Asia. Not only have many travellers of many nationalities directed their steps towards the Bam-i-dunya ("the Roof the World") in search of adventure or of scientific information, but the Government surveys of Russia and India have met in these high altitudes, and there effected a connexion which will help to solve many of the geodetic problems which surround the superficial survey of Asia. Since Wood first discovered a source of the Oxus in Lake Victoria in 1837, and left us a somewhat erroneous conception of the physiography of the Pamirs, with a legacy of political dispute arising therefrom, the gradual approach of Russia from the north has stimulated the processes of exploration from the side of India, until conflicting political interests have been set at rest by the discovery that no serious dispute is worth maintaining about those bleak, wind-swept, glacial regions, which are blocked by snow for half the year, and offer no right of way to more than the passing traveller at any time. Native explorers from India first began to be busy in the Pamirs about 1860, and continued their investigations for the following fifteen years. In 1874 the mission of Sir D. Forsyth to Yarkand led to the first systematic geographical exploitation of the Pamir country, and native attachés of the mission subsequently extended their researches into Turkestan. In 1885 Ney Elias made his famous journey across the Pamirs from east to west, identifying the Rang Kul as the Dragon Lake of Chinese geographers—a distinction which has also been claimed by some geographers for Lake Victoria. Then Lockhart and Woodthorpe, in 1886, passed along the Wakhan tributary of the Oxus from its head to Ishkashim in Badakshan, and completed an enduring record of most excellent geographical research. Bonvalot in 1887, Littledale in 1888, Cumberland, Bower, and Dauvergne, followed by Younghusband in succeeding years, extending to 1890; Dunmore in 1892, and Sven Hedin in 1894–95, have all contributed more or less to Pamir geography; but the honours of successful inquiry in those high altitudes still fall to Curzon, whose researches in 1894 led to a singularly clear and comprehensive description of Pamir physiography, as well as to the best map compilation that till then had existed. Meanwhile Russian explorers and Russian topographers had been equally busy from the north. The great soldier Skobeleff was probably the first European to visit the great Kara Kul. He was followed by scientific missions systematically organized by the Russian Government. In 1883 Putiata's mission started south. Grombchefski was hard at work from 1888 to 1892. Yanoff began again in 1891, after a short spell of rest, and has left his mark as a permanent record in the valley of Sarhad (or Wakhan), between the Baroghel pass and Bozai Gumbaz. Finally, in 1895, the Russian mission under General Schveikofski met the British mission under General Gerard on the banks of Victoria Lake, and from that point to the Chinese frontier eastward demarcated the line which thereafter was to divide Russian from British interests in highest Asia. Since then other travellers have visited the Pamirs, but the junction of the Russian and British surveys (the latter based on triangulation carried across the Hindu Kush from India) disposes of any further claim to the honours of geographical exploration (see Asia).

Pamir conformation.

Our estimate of the extent of Pamir conformation depends much on the significance of the word Pamir. If we accept the Persian derivation of the term (which is advanced by Curzon as being perhaps the most plausible), *pai-mir*, or "the foot of mountain peaks," we have a definition which is by no means an inapt illustration of the actual facts of configuration. It has been too often assumed that the plateau of Tibet and the uplands of the Pamirs are analogous in physiography, and that they merge into each other. This is hardly the case. Littledale points out (vol. vii., *R.G.S. Journal*) that the high-level valleys of glacial formation which distinguish the Pamirs, which are never very wide, and which are separated from each other by bands of mountain formation, with crests rounded by the action of the ice-cap and troughs filled with beds of detritus and alluvium, have no real counterpart in the Chang or plains of Tibet. The latter are 2000 feet higher; they are intersected by narrow ranges, and are drained by no rivers of importance. They form a region of salt lakes and stagnant marshes, relieved by wide flat spaces of open plateau country. The absence of any vegetation beyond grass or scrub is a striking feature common to both Pamir and Chang, and it is a remarkable fact that, from the Pamirs to eastern Tibet, a traveller may pass through 30 degrees of longitude without meeting with any vegetable growth "higher than an umbrella"; but there the resemblance ceases, and the physical conformation of mountain and valley to the east and to the west of the upper sources of the Zarafshan is radically distinct.

The axis, or backbone, of Pamir formation is the great meridional mountain chain of Sarikol—the ancient Taurus of tradition and history—on which stands the highest peak north of the Himalaya, the Muztagh Ata (25,000 feet). This chain divides off the high-level sources of the Oxus on the west from the streams which sweep downwards into the Turkestan depression of Kashgar on the east. There are the true Pamirs (*i.e.*, valleys reaching up in long slopes to the foot of mountain peaks) on either side, and the Pamirs on the west differ in some essential respects from those of the east. On the west the following are generally recognized as distinct Pamirs: (1) the Great Pamir, of which the dominant feature is Lake Victoria; (2) the Little Pamir, separated from the Great Pamir on the north by what is now known as the Nicolas range; (3) the Pamir-i-Wakhan, which is the narrow trough of the Wakhan tributary of the Oxus, the term Pamir applying to its upper reaches only; (4) the Alichur—the Pamir of the Yeshil Kul and Gund-dara—immediately to the north of the Great Pamir; (5) the Sarez Pamir, which forms the valley of the Murghab river, which has here found its way round the eastern head of the Great Pamir, and the Alichur from the Little Pamir, and now makes westwards for the Oxus. This branch was considered by many geographers as the main Oxus stream, and Lake Chakmaktin, at its head, was by them regarded as the Oxus source. At the foot of the Sarez Pamir stands the most advanced Russian outpost of Murghabi. To the north-east of the Alichur are the Rang Kul and the Kara Kul (or Kargosh) Pamirs. Rang Kul Lake occupies a central basin or depression; but the Kara Kul drains away north-eastwards through the Sarikol (as the latter, bending westwards, merges into the Trans-Alai) to Kashgar and the Turkestan plains. Similar characteristics distinguish all these Pamirs. They are hemmed in and separated by snow-capped mountain peaks and ridges, which are seamed with glaciers terminating in moraines and shingle slopes at the base of the foot-hills. Long sweeps of grassy upland bestrewn with boulders lead from the stream beds up to the snow-fields, yellow, grey, or vivid green, according to the season and the measure of sunlight, fold upon fold in interminable succession, their bleak monotony being only relieved by the grace of flowers for a short space during the summer months.

The Pamirs.

To the east of the Sarikol chain is the Taghdumbash Pamir, which claims many of the characteristics of the western Pamirs at its upper or western extremity, where the Karachukar, which drains it, is a comparatively small stream. But where the Karachukar, joining forces with the Khunjerab, stretches out northwards for a comparatively straight run to Tashkurghan, dividing asunder the two parallel ranges of Sarikol and Kandar, which together form the Sarikol chain, the appellation Pamir can hardly be maintained. This is the richest portion of the Sarikol province. Here are stone-built houses collected in scattered detachments, with a spread of cultivation reaching down to the river. Here are watermills and many permanent appliances of civilization suited to the lower altitude (11,500 feet, the average height of the upper Pamirs being about 13,000), and here we are no longer near the sources of the river at the foot of the mountain peaks. One other so-called Pamir exists to the east of Sarikol, separated therefrom by the eastern range (the Kandar) of the Sarikol, which is known as Mariom or Mariong. But this Pamir is situated nowhere near the sources of the Zarafshan or Raskam river, which it borders, and possesses little in common with the Pamirs of the west. The Mariom Pamir defines the western extremity of the Kuen Lun, which stretches eastwards for 250 miles before it becomes the political boundary of northern Tibet.

The Muztagh chain and Karakoram extension.

The Muztagh chain, which holds within its grasp the mightiest system of glaciers in the world, forms a junction with the Sarikol at the head of the Taghdumbash, where also another great system (that of the Hindu Kush) has its eastern roots. The political boundary between the extreme north of the Kashmir dependencies and the extreme south of Chinese Turkestan is carried by the Zarafshan or Raskam river, which runs parallel to the Muztagh at its northern foot (its valley dividing the Muztagh from the Kuen Lun) to a point in about 79° 20′ E., where it is transferred to the watershed of the Kuen Lun. Within the limits of these partially explored highlands, lying between the Pamirs and the Tibetan table-land, exact geographical definition is impossible. But we may follow Godwin-Austen in accepting the main drain of the Muztagh as merging into the central mountain system of the Tibetan Chang, its axis being defined and divided by the transverse stream of the Shyok at its westward bend, whilst the Karakoram range, in which the Shyok rises, is a subsidiary northern branch. The pass over the Karakoram (18,500 feet) is the most formidable obstacle on the main trade route between Leh and Kashgar.

The Taghdumbash Pamir.

The Taghdumbash Pamir occupies a geographical position of some political significance. One important pass (the Beyik, 15,100 feet) leads from the Russian Pamirs into Sarikol across its northern border. A second pass (the Wakhjir, 16,150 feet) connects the head of the Wakhan valley of Afghanistan with the Sarikol province across its western head, whilst a third (the Kilik, 15,600 feet) leads into the head of the Hunza river and opens a difficult and dangerous route to Gilgit. The Taghdumbash is claimed both by China and Kunjut (or Hunza), and there is consequently an open boundary question at this corner of the Pamirs.

Boundary between Russia and Afghanistan.

From Lake Victoria of the Great Pamir the northern boundary of that extended strip of Afghanistan which reaches out to the head of the Taghdumbash from Badakshan north of the Hindu Kush is to be traced, westwards, in the Victoria Lake affluent of the Oxus; and eastwards, on the Nicolas range, dividing the Great and Little Pamirs, till it overlooks a point on the Aksu (or Murghab) river in about 74° 40′ E. Here it diverges southwards to the Sarikol chain, north of Taghdumbash. This eastward extension was laid down by the Pamir Boundary Commission of 1895. All the head of the Little Pamir with the Wakhan valley is consequently Afghan territory, but no military posts have been established so far. The Alichur, Rang Kul, Kargosh (Kara Kul), and Sarez are Russian Pamirs. The Mariom Pamir is Chinese.

Glacial sources of the Oxus.

The Wakhan glaciers under the Wakhjir water-parting, Lake Chakmaktin near the sources of the Aksu, and Victoria Lake of the Great Pamir have all been claimed as indicating the true source of the Oxus. But detailed examination of their hydrographical conditions proves that neither of the two lakes, Victoria (13,400 feet) or Chakmaktin (13,020 feet), can justly be regarded as sources, both of them being derived from the same mighty system of glacial snow-fields on the summit of the Nicolas range. Both may be regarded as incidents in the course of glacial streams (incidents which are diminishing in volume day by day), rather than original springs or sources. The same glacial beds of the Nicolas range send down tributary waters to the Panja or Wakhan river, below its junction with the ice stream from Wakhjir, and thus it becomes impossible to decide whether the glaciers of the Wakhjir or the glaciers of Nicolas should be regarded as effecting the most important contribution to the main stream. There is evidence also that glacial moraine formations from time to time may have largely affected the catchment area of these tributary streams. It would be as rash to assert that from Victoria Lake no waters could ever have issued with an eastward flow as it would be to state that from Chakmaktin none ever flow westwards. The measure of the veracity of Chines pilgrims and geographers in the early centuries of our era must not be balanced on such points as these.

Population and ethnography.

There is no evidence that the Pamirs were ever the support of permanent settlements. The few mud-built buildings which once existed at Chakmaktin and at Lungar only decide recent occupation which could hardly have possessed a permanent character, and the few shrines and domed tombs which are scattered here and there about the empty desolation of the Pamir slopes are all of them of recent construction. The nomadic population which seeks pasturage during the summer months in these dreary altitudes is entirely Kirghiz, and we may take it for granted that it will soon be entirely Russian. The non-Russian population during the summer of 1895 could not have amounted to more than a few hundred souls—occupying a few encampments in the Little Pamir and in the Taghdumbash. The total population of the Russian Pamirs has been reckoned at 250 "kibitkas," or 1500 souls. There is no ethnographical distinction to be traced between the Kirghiz of the Alichur Pamir and the Kirghiz of the Taghdumbash.

The Kirghiz are Sunni Mahommedans by faith, but amongst them there are curious survivals of an ancient ritual of which the origin is to be traced to those Nestorian Christian communities of Central Asia which existed in the Middle Ages. A Christian bishopric existed at Yarkand in Marco Polo's time, and is supposed to have survived for another century (1350). The last Gurkhan of the Kara Khitay empire in the early part of the 13th century (the legendary Prester John) was a member of a Christian tribe called Naiman, which is one of the four chief tribal divisions mentioned by Ney Elias. The Naiman tribe claim kinship with the Kipchaks. It is curious that the same survival of Christian ceremonial should be found amongst the Sarikoli, a Shiah people of Aryan descent akin to the Tajiks of Badakshan, as may be traced amongst the Kirghiz. The discoveries of Christian symbols in the southern towns of Chinese Turkestan by Sven Hedin may throw further light upon this interesting question.

Evidences of the survival of Christian symbols.

The total area of the Pamir country may be estimated as about 150 miles long by 150 miles broad, of which about one-tenth is grass pasture land and the rest mountainous. All of it once formed part of the ancient kingdom of Bolor, itself a survival of the yet more ancient empire of the Yuchi, Tokharistan; and across it, in spite of its bleak inhospitality, there have been one or two recognized trade routes from east to west throughout all ages. The most important commercially was that which passed north-west *viâ* Tashkurghan and Rang Kul, from Chinese Turkestan to the khanates north of the Oxus; but the route *viâ* Tashkurghan and Lake Victoria to Badakshan was also well trodden. The great pilgrim route of Buddhist days was that which connects the ancient Buddhist cities of the Takla Makan in Chinese Turkestan with Chitral (Kashkar), by the Baroghel Pass across the Hindu Kush. This was but one link in a chain of devout peregrination which stretched from China to India, and which included every intervening Buddhist centre of note which existed in the early centuries of our era.

Area of the Pamirs.

Trade routes.

For six or seven months of the year (November to April) the Pamirs are covered with snow, the lakes are frozen, and the passes nearly impracticable. The mean temperature during the month of January recorded by Russian observers at the Murghabi—or Pamirski—post is $-13°$ F. In July this rises to 62° F., the elevation of the station being 12,150 feet. During the spring and summer months the prevalence of fierce cutting winds, which are shaped by the conformation of the valleys into blasts as through a funnel, following the strike of the valleys either up or down, makes travelling painful and existence in camp most unpleasant. In the absence of wind the summer atmosphere is often bright and exhilarating, but there is a constant tendency to sudden squalls of wind and rain, which pass as quickly as they gather. The most settled record of the Pamir Boundary Commission of 1895 lasted from the 19th of August to the 11th of September, the maximum temperature being recorded at 77° on the 21st August at Kizil Robat (12,570 feet); and yet on the 16th August snow had fallen to the depth of 6 inches and the Beyik Pass was blocked. There were indications that monsoon influences extended as far north at least as the Great Pamir, and a definite analogy was established between the record of barometric pressure on the Pamirs and that of the outer ranges of the Himalaya.

Climate of the Pamirs.

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(T. H. H*.)

Pampa, a territory in the centre of the Argentine Republic, bounded on the N. by Cordoba, San Luis, and Mendoza, on the S. by the territory of Rio Negro, on the E. by Buenos Aires, and on the W. by Mendoza and the territory of Neuquen. Official area at the census of 1895, 56,320 square miles; population, 25,914. It is divided into fifteen departments. The capital, General Acha, has a population of about 1500. In 1895 there were 530,162 head of cattle, 232,489 head of horses, and 5,295,177 head of sheep in the territory.

Pamplona, capital of the province and ancient kingdom of Navarre, Spain, on the Arga. Population, 26,656 in 1887, and 29,753 in 1897. Modern detached forts have been erected. The imposing forts on the peak of San Cristobal and on Miravalles Hill command the approach of Pamplona in view of a French invasion, exactly as the fort of San Marcos, the entrenched camp of Choritogueta, and the fort of Guadalupe near Fuentarabia sweep the approaches to Irun and San Sebastian in Guipuzcoa. Part of the old outworks of Pamplona has been demolished, and suburbs are springing up near the walls and bastions. In the new part of the town are many industries, including cloth, linen stuffs, flour, soap, leather, cards, paper, earthenware, iron, and nails. The fairs are the centre of a trade in agricultural products and live stock, especially in July, when the Navarrese flock to their provincial capital for the patron saint's day, San Firmin. The town is well provided with schools for both sexes, and has an institute, normal schools, and a seminary, hospitals, and fine municipal buildings, kept in order, like their roads and streets, by the autonomous provincial council and municipality. The interior of the walled town has preserved its old-world aspect.

Pana, a city of Christian county, Illinois, U.S.A., near the centre of the state, on the Baltimore and Ohio South-Western, the Cleveland, Cincinnati, Chicago, and St Louis, and the Illinois Central railways, at an altitude of 697 feet. Its site is the level prairie, and its plan is fairly regular. It is in a coal region, and it has some trade and manufactures. Population (1880), 3009; (1890), 5077; (1900), 5530, of whom 727 were foreign-born.

Panama, the chief town of the department of the same name in the republic of Colombia, South America, situated at the upper extremity of the Gulf of Panama. La Boca dock at the Pacific terminus of the canal, three miles from the city, was completed in 1898. Its wharf, 1000 feet in length, can be approached by large steamers, which formerly had to anchor off Flamenco Island and load and unload from small vessels. The city is well laid out, and possesses beautiful squares, parks, and promenades. Among modern buildings are the hospital erected at the expense of the Canal Company, and the Grand Hotel. In October 1899 plans were prepared for a new aqueduct to supply the city with water. The chief exports are hides, deerskins, mother-of-pearl shells, and ivory; the imports include all kinds of dress goods, hardware, furniture, drugs, perfumery, &c. There is a line of steamers from Panama to San Francisco, and also lines south to Valparaiso. Over 200 vessels enter the port annually, with a total tonnage of over 250,000. (For the canal, see CANALS.) Population about 25,000.

Panch Mahals (= Five Districts), a district of British India, in the Gujarat division of Bombay. It includes the ancient Hindu capital of Champaner, now a ruin, and the hill sanatorium of Pawagarh. The administrative headquarters are at Godhra.

Area, 1613 square miles; population (1881), 255,479; (1891), 313,417; (1901), 261,870; showing an increase of 23 per cent. between 1881 and 1891, but a decrease of 16·4 per cent. between 1891 and 1901; average density, 162 persons per square mile. The land revenue is Rs.3,28,000, the incidence of assessment being just over R.1 per acre; cultivated area (1897–98), 357,099 acres, of which 2471 were irrigated from wells, &c., including 175 from Government canals; number of police, 699; children at school (1897–98), 5560, being 2·17 per cent. of the total population; registered death-rate (1897), 20 per thousand. The principal crops are inferior grain, rice, pulse, and oil-seeds; there are manufactures of lac bracelets and lacquered toys. Both portions of the district are now crossed by the branch of the Bombay and Baroda Railway from Anand, through Godhra and Dohad, to Rutlam; and a chord line from Godhra to Baroda city is projected. The district suffered very severely from the famine of 1899–1900.

Panderma, the ancient *Panormus*, a town of Asia Minor, situated on the south shore of the Sea of Marmora, near the site of Cyzicus. It has a trade in cereals, cotton, opium, and boracite. Its population comprises 4000 Moslems and 2000 Christians.

Pandharpur, a town of British India, in the Sholapur district of Bombay, on the right bank of the river Bhima, 38 miles west of Sholapur town. Population (1881), 16,910; (1891), 19,953. Pandharpur is the most popular place of pilgrimage in the Deccan. Three assemblages are held annually. The municipal high school had 101 pupils in 1896–97, and there is also an industrial school. There are two printing-presses, each issuing a vernacular newspaper. In 1900 a light railway was constructed from Barsi Road, 32 miles, partly as a famine relief work, which it is proposed to extend 20 miles farther to Sangola.

Panipat, a town of British India, in the Karnal district of the Punjab, near the old right bank of the Jumna, 53 miles north of Delhi by rail. Population (1881), 25,022; (1891), 27,547; municipal income (1897–98), Rs.24,475. It is a centre of trade, and has manufactures of cotton cloth, metal-ware, and glass. There are a municipal school, and two factories for ginning and pressing cotton. The neighbourhood, which was the scene of three historic battles, is now a favourite manœuvring-ground for British camps of instruction.

Panna, or PUNNA, a native state of Central India, in the Bundelkhand agency. Area, 2568 square miles; population (1881), 227,306; (1891), 239,333, showing an increase of 5 per cent.; average density, 93 persons per square mile.

Estimated revenue, Rs.50,00,000; tribute, Rs.9950. The chief, whose title is maharaja, is a rajput of the Bundela clan, descended from Chhatar Sal, the champion of the independence of Bundelkhand in the 18th century. The late maharaja died in 1898, leaving an only son, Madho Singh. In 1902 this son was found guilty by a special commission on the charge of poisoning his uncle. The diamond mines, for which the state was formerly famous, are no longer profitable. The state suffered severely during the famine of 1896–97. There are no railways, but one or two good roads.

The town of PANNA is 62 miles south of Banda. Population (1881), 14,676; (1891), 14,705. The town is well laid out, with some handsome stone buildings, and has a high school.

Pannonhalma (MONS PANNONIAE, MONS SANCTI MARTINI), or GYÖR SZENT MARTON (German, *Martinsberg*), a famous abbey in Hungary, 11 miles south-east of Raab. Charlemagne built the first chapel, and the well-known Benedictine abbey dates from the time of King St Stephen, and still possesses the original deed (1001). The Benedictines have played no small part in Hungarian history. The Tatars could not take the well-fortified convent, nor could the Turks hold it for more than four years. The present building is a block of palaces, containing also a beautiful cathedral. In the convent there are a seminary for priests, a normal school, a gymnasium, and a library of 120,000 volumes, and precious archives. From its tower eleven counties can be seen. On the same hill stands one of the monuments erected in 1896 in commemoration of the thousand years' existence of the Hungarian state. The chief abbot has the rank of a bishop, and in spiritual matters is subordinated immediately to the Roman curia. The chief abbey, with its daughter abbeys and a few parishes, forms a separate ecclesiastical district, and the chief abbot is member of the Upper House of the Hungarian Parliament. Many of the chief abbots were celebrated men. Claudius Vaszary, the present cardinal archbishop of Esztergom and primate of Hungary, was a dignitary here.

Pantin, a town in the arrondissement of St Denis, department of Seine, France, ½ mile east of the fortifications of Paris by rail, on the canal d'Ourcq. The construction of steam engines, boilers, railway waggons, electric bells, glass, and perfumery, and the operations of dye-works, forges, foundries, distilleries, and saw-mills represent some of the varied branches of its industrial activity. Population (1891), 21,761; (1901), 29,646.

Panton, a township of Spain in the province of Lugo, in a mountainous district, watered by the rivers Sil and Cabe. Live stock is extensively reared, and large quantities of wheat, wine, oats, and potatoes are produced. The industries are distilling and linen manufacture. Population (1887), 11,552; (1897), 12,492.

Papenburg, a town of Prussia, province of Hanover, 27 miles by rail south by west of Emden, and near the right bank of the Ems, with which it is connected by a canal 5 miles long. It is a Dutch-looking place, built in 1675. It is, next after Emden, the most prosperous port of the province; was cleared by 631 vessels of 64,294 tons in 1900; and the trade is growing steadily. The canal is to be deepened to 17–18 feet, whilst new locks (300 feet long, 57 feet wide, and 18 feet deep) will connect the town with the Dortmund–Ems canal. The industries include shipbuilding, oil and glass mills, metal (nickel) and moss-litter factories. There is a school of navigation. Population (1885), 6916; (1900), 7611.

Paper may best be described as a more or less thin tissue composed of any fibrous material, whose individual fibres, first separated by mechanical action, are then deposited and felted together on wire cloth while suspended in water. The main constituent in the structure of all plants is the vegetable fibre or cellulose, which forms the casing or walls of the different cells, being the woody portion of the plant freed from all foreign substances, which forms, so to speak, the skeleton of vegetable fibre to the amount of 75 to 78 per cent. Its forms and combinations are extremely varied, but it always consists of the same chemical elements, carbon, hydrogen, and oxygen, and in the same proportions. The glutinous, resinous, silicious, and other intercellular matters surrounding the cells together constitute the perfect plant, and it is the object of the paper-maker to eliminate these impurities, and to produce the fibre as pure and as strong as possible. Flax, hemp, and cotton rags, having already undergone a process of manufacture, consist of almost pure fibres with the addition of fatty and colouring matters which can be got rid of by simple boiling under a low pressure of steam with a weak alkaline solution; but the substitutes for rags, such as esparto, wood, straw, &c., being used as they come from the soil, contain all the intercellular matter in its original form, which has to be dissolved by strong chemical treatment under a high temperature. The vegetable fibre or cellulose, being of a tougher and stronger nature, is untouched by the action of caustic soda (which is the chemical generally employed for the purpose), unless the treatment be carried too far, whilst animal fibres or other organic matters are rendered soluble or destroyed by it. The cellulose, after its resolution by chemical treatment, is still impregnated with insoluble colouring matters, which have to be eliminated or destroyed by treatment with a solution of chlorine or bleaching powder. The object of the paper-maker in treating any one particular fibre is to carry the action of the dissolving and bleaching agents just so far as to obtain the fibre as free from impurities and as white in colour as is necessary for the kind of paper he wishes to make from it. The usefulness of a plant for a good white paper depends upon the strength and elasticity of its fibres, upon the proportion of cellular tissue contained in them, and upon the ease with which this can be freed from the encrusting and intercellular matters.

Treatment of rags.

Rags arrive at the mill from the rag merchants, either roughly sorted into grades or mixed in quality and material, and the first process is to free them from sand, dust, and other impurities. To effect this they are usually passed in bulk through an ordinary revolving duster. They are then sorted into grades to suit the paper manufactured, and cut to a workable size about 4 inches square. For the best work, hand cutting, done by women, is still preferred, but it is expensive, and good machines have now been designed to perform the work. After further thrashing and dusting the rags are ready for boiling, the object of which is not only to get rid of the dirt still remaining in the rags, and to remove some of the colouring matter, but also to decompose a particular glutinous substance which would impair the flexibility of the fibres and render them too

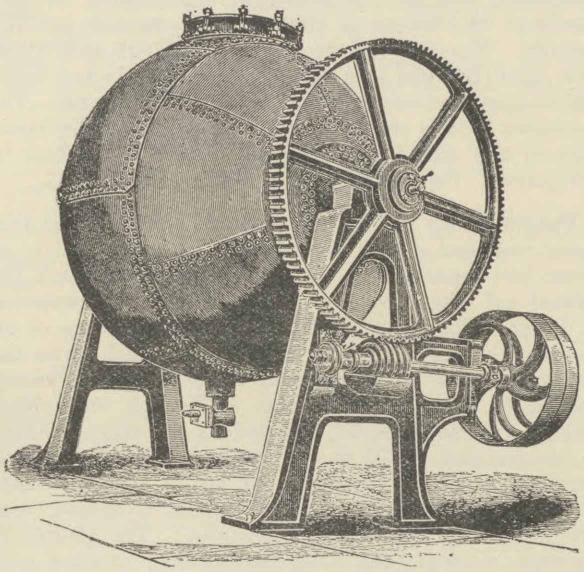


Fig. 1.—Revolving Spherical Rag Boiler.

harsh and stiff for readily making into paper. Various forms of vessels are used for boiling, but usually they are made to revolve by means of suitable gearing, and are either cylindrical or spherical (Fig. 1). In these the rags are boiled with an alkaline solution under a low steam pressure for six to twelve hours, according to the quality. The next step is that of washing and "breaking in," which takes place in an engine called the "breaker." (For description and illustration, see *Ency. Brit.* vol. xviii. p. 220.)

Esparto.

In treating esparto, the use of which for paper-making purposes is almost entirely confined to Great Britain, the object is to free it from all encrusting and intercellular matter. To effect this it is digested with a strong solution of caustic soda under a high temperature, in boilers which are almost invariably stationary. The most usual form is that known as Sinclair's patent (Fig. 2). This boiler is constructed of wrought-iron or steel plates, and holds from 2½ to 3 tons of grass. It is charged through the opening at the top A, and the boiled material taken out from a door B at the side; the grass rests on a false bottom of perforated plates C, through which the liquor drains, and by means of two "vomiting" pipes D, D, at the sides of the boiler connecting the space at the bottom with a similar space at the top, a continuous circulation of steam and liquor is maintained through the grass. The steam pressure is kept up to 35 to 40 ℔ per square inch for about three or four hours; then the strong liquor or lye, which contains all the resinous and intercellular matters of the esparto grass dissolved by the action of the caustic soda, is run off and stored in suitable tanks for subsequent recovery of the soda, while the grass is taken to the "potcher" or washing engine. In construction and working this is similar to the breaking engine used for rags: in it the grass is reduced to pulp, and washed for about twenty minutes to free it from the last traces of soda liquor remaining after the partial washing in the boiler. As soon as the wash water is running clear and free from colouring matter, it is shut off, and the necessary quantity of a solution of bleaching powder, or chlorine (averaging about 6 to 8 per cent. on the raw material), is run into the potcher, and the contents are heated by steam to a temperature of about 90° Fahr. After about four to six hours the bleaching is complete, the drum-washer is let down, fresh water run into the potcher, and the grass washed to free it from all traces of chlorine, an operation generally assisted by the use of a little antichlor. The esparto, as shipped in bales from the Spanish or African fields, is mixed with a certain quantity of roots, weeds, and other impurities unavoidable in the process of plucking; and as most of these do not boil or bleach as rapidly as the esparto, they would, if not taken out in the pulp, show up in the finished paper as specks and spots, and destroy its value. To get rid of them the esparto pulp when washed and bleached is run from the potcher into storage chests, from which it is pumped over a long narrow serpentine settling-table or "sand-table," made of wood and fitted with divisions or "weirs," behind which the heavy impurities or weeds fall to the bottom and are caught. The pulp is next passed over what is known as a "presse-pâte" (Fig. 3) or "half-stuff" machine, very similar to the wet end of a paper machine, consisting of strainers fitted with coarse-cut strainer plates, a short wire, and a pair of couch and press rolls. The pulp is drawn through the strainers by suction, which keep back the finer impurities which have passed the sand-table, and then flows on to the wire-cloth in the form of a thick web of pulp. After passing through the couch and press rolls, the pulp leaves the machine with about 70 per cent. of moisture, and is ready for the beating engine, the first operation of paper-making proper. This is the general and usual process, though various modifications are introduced in different mills and for different purposes.

Most kinds of straw can be utilized for making into paper, the varieties generally used being rye, oat, wheat, and barley; of these, the two former are the most important, as they give the largest yield in fibre. Germany and France are the two principal users of straw, which closely resembles esparto in its chemical constitution, and is reduced to pulp by a somewhat similar process.

Wood.

Scandinavia, Germany, the United States, and Canada are the countries which mainly use wood as a material for paper-making, owing to their possession of large forest areas. They also export large quantities of wood-pulp to other countries. The timbers chiefly used for the manufacture of wood-pulp are the spruces, pines, and poplars of various kinds. In Europe the Scotch fir (*Pinus sylvestris*), the spruce (*Picea excelsa*), the poplar (*Populus alba*), and the aspen (*Populus tremulo*) are the timbers principally employed; and in America the black spruce (*Picea nigra*), the hemlock (*Tsuga Canadensis*), the poplar (*Populus grandidentata*), and the aspen (*Populus tremuloides*). There are two kinds of wood-pulp prepared for paper manufacture, one prepared mechanically and the other chemically. The former is obtained by disintegrating the wood entirely by means of machinery without the use of chemicals, and is, as may readily be understood, a very inferior pulp, only used in the cheapest sorts, for news papers, &c. In the manufacture of chemical wood-pulp very great advances and improvements have been made since 1880, and the consumption of timber of various kinds for this purpose has enormously increased, so that wood-pulp has grown to be one of the most important fibres for paper-making purposes. There are two methods in use, known respectively as the soda or alkaline process and the sulphite or acid process, according as soda or sulphur (or rather sulphurous acid) forms the base of

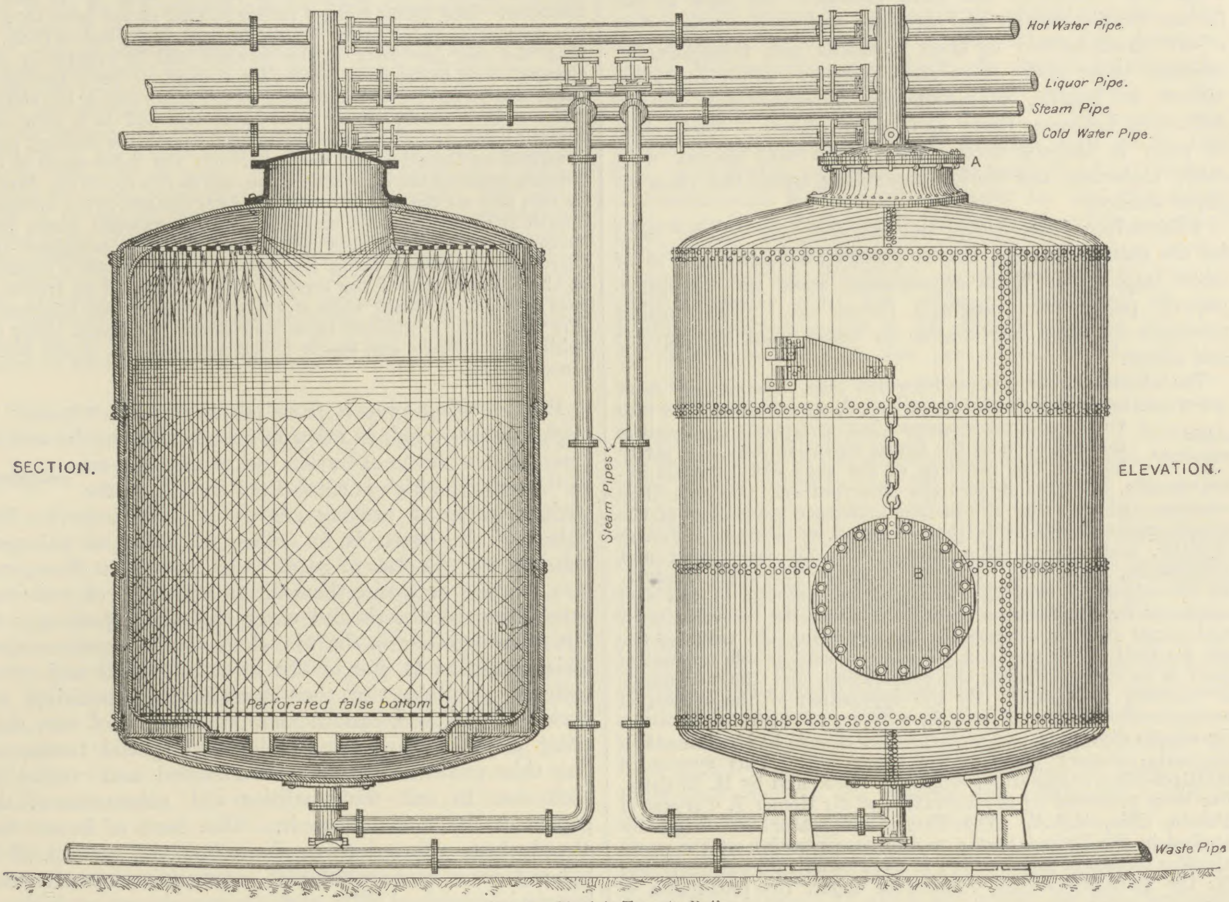


Fig. 2.—Sinclair Esparto Boiler.

the reagent employed. Trees of medium age are usually selected, varying from seventy to eighty years' growth, and running from 8 to 12 inches in diameter. They are felled in winter, and arrive at the mill in the form of logs about four feet long. After being freed from bark, and the knots taken out by suitable machinery, the logs are cut into small cubical chips about $\frac{1}{2}$ to $\frac{3}{4}$ inch in size by a revolving cutter. The chips are then bruised by passing them between two heavy iron rolls, to allow the boiling solution thoroughly to penetrate them, and are conveyed to the boilers over a screen of coarse wire-cloth, which separates out the fine sawdust as well as any dirt or sand.

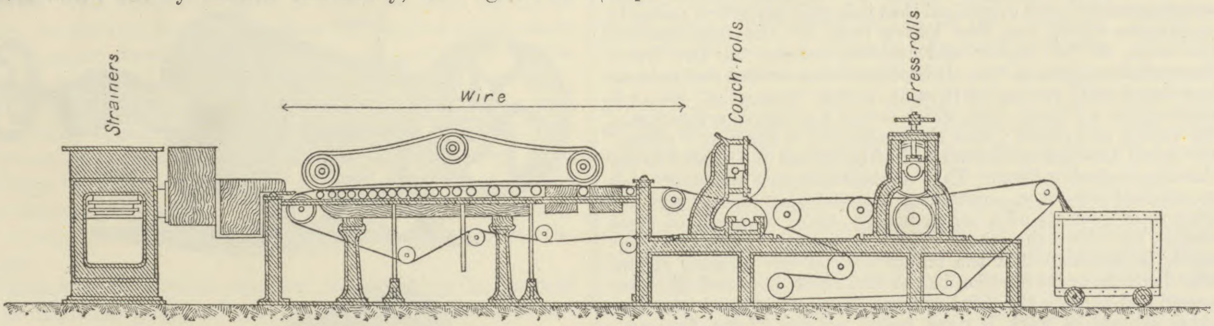


Fig. 3.—"Presse-Pâte," or Half-stuff Machine.

In the soda process the wood is boiled in large revolving or upright stationary boilers for about seven or eight hours, in a similar manner to esparto and straw, though it requires much severer treatment. The steam pressure varies from 90 ℔ to as much as 150 ℔ per square inch, and the amount of soda required is about 16 per cent. of Na_2O, estimated on the barked and cleaned wood. The essential feature of the sulphite process is the employment of a solution of sulphurous acid combined with a certain amount of base, either magnesia or lime. As the acid reaction of the bi-sulphite solution would attack any exposed ironwork with which it comes in contact, it is necessary that the boilers in all cases should be lined with lead. The type of boiler employed varies according to the process adopted. The principal patents connected with the sulphite process are those of Tilghman, Ekman, Francke, Ritter-Kellner, Mitscherlich, and Partington. The subsequent operations, in both the acid and alkaline processes, of washing, bleaching, and straining the pulp, are all very similar to those described for esparto, and require no further particular description. Wood-pulp produced by the sulphite process differs in a marked degree from that made by the soda process: the fibre in the former case is harsher and stronger, and papers made from it are characterized by their hardness and transparency, whereas those made from soda pulp are softer and more mellow in handle, corresponding in some way to the difference between linen and cotton fibres. Each class of pulp is largely used, both alone and mixed with other materials, the choice depending upon the class of paper desired.

Fibres like jute, hemp, manila, &c., are chiefly used for the manufacture of coarse papers where strength is of more importance than appearance, such as wrapping-papers, paper for telegraph forms, &c. The boiling processes for them are similar to those used for esparto and straw.

Soda recovery. The alkaline liquors or lyes in which rags, esparto, and other paper-making materials had been boiled, were formerly run into the nearest water-course; but now, partly because it is insisted upon by the Rivers Pollution Acts, and partly because the recovery of the soda can be made remunerative, all these liquors are preserved and the soda they contain utilized. One of the best and most economical of the simple recovery plants is that invented by Porion, a French distiller, and named after him. (See, for description and illustration, *Ency. Brit.* vol. xviii. p. 226.) It is open, however, to the objection that the whole of the sulphur in the coal employed for the furnaces finds its way into the recovered soda, and forms sulphur compounds, thus reducing the value of the ash for boiling purposes; in addition, a considerable amount of soda is volatilized during the evaporation, and the percentage of recovery is reduced. By the application of the system of multiple-effect evaporation to the recovery of waste liquors these drawbacks disappear, and an important change has been made in the soda-recovery plant of the paper-mill. This system of multiple-effect evaporation, originally introduced by M. Rillieux, has been perfected by the invention of Mr Homer T. Yaryan, of Toledo, Ohio, U.S.A. The Yaryan evaporator was originally applied in the United States to the concentration of the waste alkaline liquors of paper-mills; it then came into extensive use for the manufacture and refining of sugar, the production of glucose, and a variety of other purposes. The principle of multiple-effect evaporation is to utilize the latent heat of a vapour given off from a liquid under a certain pressure to vaporize a further quantity of the liquid under a pressure maintained by mechanical means below that of the first. The essential feature which distinguishes the Yaryan evaporator consists in the boiling of the liquor to be treated while it is passing through a series of tubes, which constitute a coil and are heated externally by steam or vapour. The quantity of liquor entering the coil is so controlled that it is only permitted partially to fill the tubes, and thus leaves room for the instantaneous liberation of the vapour and its free escape. As the liquor descends from tube to tube, it becomes concentrated and reduced in volume until ultimately it passes into a "separator," where it impinges on a plate or disc, which causes a complete separation of the vapour and liquid; each then passes on to the next "effect," the liquid through the second coil of tubes and the vapour to the chamber enclosing them. This combination of a series of tubes or coil, and separator, constitutes a vessel or "effect," and the evaporator consists of a series, usually three or more, of these vessels, one above the other. The vital feature, it will be understood, is therefore that the latent heat of the original steam, after performing its function in the first effect, is passed on to the second and then to the third or more effects, in each of which an equal amount of work is done before passing to the final condenser, where a vacuum is maintained. Thus, if the total temperature be divided three times, the result is a triple effect; if four times, a quadruple effect. Taking an evaporation of 10 ℔ of water per pound of coal, a single-effect apparatus will evaporate 10 ℔ of water, a double-effect 20 ℔, a triple-effect 30 ℔, and so on. The liquor to be concentrated is pumped from the storage tanks to the top or first effect of the Yaryan apparatus through a series of multiple-effect heaters, corresponding to the number of effects in the machine, by means of which the liquor is heated to as near the boiling-point as possible of the liquor in the tubes of the first effect. Live steam is introduced into the chamber surrounding the tubes of the first effect, and from the separator of the last effect the concentrated liquor is pumped to the incinerator. Any form of incinerating hearth can be used in conjunction with the multiple-effect evaporator, but one very suitable to the continuous work of, and the high degree of concentration produced by, the Yaryan machine is that known as the Warren rotary furnace. This consists of a revolving iron cylinder lined with brick, about 12 feet long by 10 feet in diameter. The lining being 6 inches thicker at the inlet than at the discharge, the interior of the furnace is conical in form, so that the ash gradually works forward and is eventually discharged fully burnt into trucks for storage, or on a travelling band, and so carried automatically to the dissolving or lixiviating tanks. The strong liquor runs in at one end in a slow continuous stream; by the rotation of the hearth the burning mass is carried up the sides and drops through the flame again to the bottom, much in the same manner as rags do in a revolving duster. In this way all the labour required to stir the ash of the ordinary hearth is dispensed with, and the burning material comes continuously in close contact with the flame, a complete and thorough combustion being the result. The fire-box is situated at the delivery end of the furnace, and is mounted on trucks so that it can be run back when cleaning or repairing the brickwork. The waste heat is utilized in raising steam in a steam boiler set behind the furnace, and finally in heating the weak liquor before concentration.

Beating. Paper-making proper, from prepared pulp, whether of rags, esparto, wood, or other raw material, may be said to commence with the operation technically known as "beating," which is carried out in one of the various forms of beating engine or "Holländer." The object of the beater is to reduce the fibres to a length suitable for the class of paper to be made from them, and also to beat or bruise them into a stiff pulp of sufficient consistency to absorb and carry the water necessary to felt them together on the wire-cloth of the paper-machine. This operation is one of the most important and most delicate processes in the manufacture, requiring experience, skill, and careful manipulation. Not only does every class of fibre demand its own special treatment, but this treatment has to be modified and varied in each case to suit the qualities and substances of the papers to be made from it. One form of beater has already been referred to in *Ency. Brit.* vol. xviii. p. 220; but engines of quite a different construction are now used largely in American mills, and also to some extent in Great Britain. These are known as "refiners," and the most important forms are the Jordan and Kingsland beaters (so called from the names of the inventors), or modifications of them.

The first (Fig. 4) consists of a conical plug or roll fixed on a shaft and revolving at a high rate of speed within an outer casing

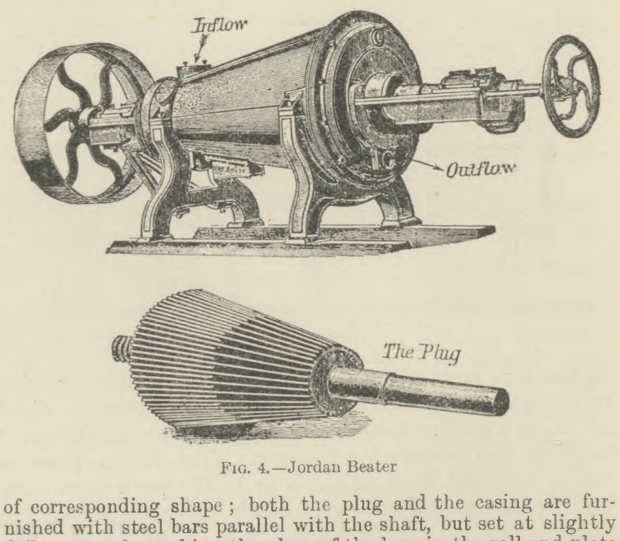


Fig. 4.—Jordan Beater

of corresponding shape; both the plug and the casing are furnished with steel bars parallel with the shaft, but set at slightly different angles, taking the place of the bars in the roll and plate of the ordinary beater. This conical plug or roll can be moved in either direction parallel to its axis, and by this means the cutting action of the two sets of bars can be increased or reduced. The pulp flows into the top of the beater at the smaller end of the cone through a box provided with an arrangement for regulating the flow, and passes out through an opening in the casing at the other end. The roll or plug revolves at from 350 to 400 revolutions per minute, and requires a power to drive it of from 25 to 40 h.p. according to the work done, and one engine is capable of passing as much as 1000 lb weight of dry pulp per hour. The Kingsland beater consists of a circular box or casing, on both inside faces of which are fixed a number of knives or bars of steel or bronze; inside the case is a revolving disc of metal fitted on both sides with corresponding and similar bars. The contact between the revolving and stationary bars can be regulated, as in the Jordan engine, to give the required amount of beating action on the pulp. The refiner is essentially a finishing process as an adjunct to the beating process proper. The advantages to be derived from its use are twofold, viz., a considerable saving in the time occupied in beating, and the production of a more uniformly and more evenly divided pulp, particularly where a mixture of different fibres is used. By the use of the refiner the time occupied in the beater can be reduced by nearly one-half, the half-beaten pulp passing through the refiner from the beater on its way to the paper-machine. It is not, however, generally employed for the best kinds of paper.

Sizing, &c. During the operation of beating various materials and chemicals are added to the pulp for the purposes of sizing, loading, colouring, &c. Papers for writing and most of those for printing purposes must be rendered non-absorbent of ink or other liquid applied to them, or they would partake of the nature of blotting-paper. To effect this some form of animal or vegetable size or glue must be applied to the paper, either as a coating on the finished web or sheet, or mixed with the pulp in the beating-engine. The latter, which is known as "engine-sizing," consists in filling up the interstices of the fibres with a chemical precipitate of finely divided rosin, which, when dried and heated on the cylinders of the paper-machine, possesses the property of being with difficulty wetted with water. Except in the very best qualities of paper, it is usual to add to the pulp a certain quantity of a cheap loading material, such as china-clay or kaolin, or pearl-hardening, a chemically precipitated form of sulphate of lime. The addition of such loading material to a moderate extent, say 10 to 15 per cent., is not entirely in the nature of an adulterant, as it serves to close up the pores of the paper, and for ordinary writing, printing, and lithographic papers renders the material softer, enabling it to take a much better and more even surface or glaze. But if added in excess it is detrimental to the strength and hardness of the sheet. Most materials, however well bleached, have a more or less yellowish tinge; to correct this, and produce the desired white shade in the paper, certain quantities of red and blue in the form of pigments or dyes must be added to the pulp. The blues usually employed are ultramarine, smalts, and the aniline blues, while the red dyes are generally preparations of either cochineal or the aniline dyes. In addition to these two colours, others are required in the manufacture of papers of different tints, and with one or two exceptions they must be mixed with the pulp in the beater.

Paper machine. There are two distinct processes of producing the finished paper from the pulp, known respectively as "hand-made" and "machine-made." Hand-made paper, except for certain of the best classes, has been almost superseded by machine-made, the expense of manufacture and consequent high price rendering it too costly for ordinary use; the entire process on the machine occupies at most a few minutes, which in the ordinary state of the weather could not be done by hand in less than a week. The paper-machine consists essentially of an endless mould of fine wire-cloth, on which the pulp flows and on which a continuous sheet of paper is formed; the sheet then passes through a series of rolls and over a number of steam-heated cylinders until it is dry. It need not be further described here, as details and illustrations may be found in the article in the ninth edition of this work (vol. xviii.), where also the other remaining processes of glazing, cutting, and sheeting are noticed. Paper-machines are now usually driven by two separate steam engines. The first, running at a constant speed, drives the strainers, pumps, shake motion, &c., while the second, working the paper-machine proper, varies in speed according to the rate at which it requires to be driven. The power consumed by the two engines will average from 40 to 100 h.p. The drying cylinders of the paper-machine form a convenient and economical condenser for the two steam engines, and it is customary to exhaust the driving engines into the drying cylinders and utilize the latent heat in the steam for drying the paper, supplementing the supply when necessary with live steam. The speed of the machine has frequently to be altered while in motion. An alteration of a few feet per minute can be effected by changing the driving speed of the steam engine governor; for a greater change, the machine must be stopped and other driving wheels substituted. Arrangements are made in the driving gear by which the various parts of the machine can be slightly altered in speed relatively to one another, to allow for the varying contraction or expansion of the paper web for different kinds and thicknesses of paper. The average speed of a paper-machine on fine writing-papers of medium weight is from 60 to 90 feet per minute; but for printing-papers, newspapers, &c., the machine is driven from 120 up to as much as 300 and 400 feet per minute. The width of machines varies greatly in different mills, from about 60 inches to as much as 150 inches wide. Mills running on higher classes of papers as a rule use narrow machines, as these make a closer and more even sheet of paper than wider ones; but for the cheaper and commoner qualities the wide machines are in vogue, as the cost of labour, &c., per ton of paper turned out is considerably reduced. The weight of paper that a machine can produce will of course depend upon its width and speed, and the thickness of the web of paper; on fine writing-papers an average machine will make from 20 to 40 tons per week, while for common printing and news papers the weekly output will amount to as much as 50 or 70 tons.

Standards of quality. With the enormously increased production of paper and the great reduction in price within recent years, due to the growing demand for cheap literature and publications, it has been found that the "science" of paper-making has scarcely advanced with the same rapid strides as the art itself. Although a sheet of paper made to-day differs but little as a fabric from the papers of earlier epochs, the introduction of new and cheaper forms of vegetable fibres and the auxiliary methods of treating them up to the point of putting them together as a sheet of paper have caused a great change in the quality, strength, and lasting power of the manufactured article. The undue introduction of excessive quantities of mechanical or ground wood-pulp in the period 1870–80 into the cheaper qualities of printing-papers, particularly in Germany, first drew attention to this matter, since it was noticed that books printed on paper in which much of this material had been used soon began to discolour and turn brown where exposed to the air or light, and after a time the paper became brittle. This important question began to be scientifically investigated in Germany about the year 1885 by the Imperial Testing Institution in Berlin. A scheme of testing papers has been formulated and officially adopted by which the chemical and physical properties of different papers are compared and brought to numerical expression. The result of these investigations has been the fixing of certain standards of quality for papers intended for different purposes. These qualities are grouped and defined under such heads as:—

Strength, expressed in terms of the weight or strain which the paper will support;

Elasticity and texture, measured by elongation under strain and resistance to crumpling or rubbing;

Bulk, expressed in the precise terms of specific gravity or weight per unit of volume.

Of not less importance are the qualities which belong to paper as a chemical substance or mixture, which are: (1) Its actual composition; (2) the liability to change under whatever conditions of storage and use it may be subjected to. For all papers that are to be used for any permanent purpose these physical and chemical qualities must come more and more into practical consideration, and ultimately rank as regulating the consumption and production of papers. For fuller information on this subject the reader is referred to the *Mitteilungen der Königlichen Versuchs-Anstalt*, Berlin, 1885 and onwards; and to the report of the committee of the Society of Arts on the "Deterioration of Paper," London, 1898.

British Paper-trade.—The *Directory of Paper-makers* for 1899 shows that in England and Wales there were 206 makers, employing 441 machines; in Scotland, 59 makers and 114 machines; in Ireland, 8 makers and 12 machines. These figures include 31 makers of hand-made paper, using 154 vats, in England; and 2 makers, 4 vats, in Scotland. A rough estimate of the amount of capital embarked in the industry may be formed on the basis that average mills would represent from £20,000 to £30,000 per machine. The following figures, abstracted from the Board of Trade returns for the year 1899, give the amounts and values of the imports and exports of paper and paper-making materials for Great Britain:—

Article.	Imports.		Exports.	
	Weight.	Value.	Weight.	Value.
	Cwts.	£	Cwts.	£
Paper and boards	5,307,079	3,724,254	71,757	929,370
	Tons.		Tons.	
Rags	20,617	174,661	65,041	341,749
Esparto	207,604	806,354	...	...
Wood-pulp—				
Chemical	196,926	1,441,809	...	...
Mechanical	218,180	547,897	...	...

Authorities.—Arnot. *Technology of the Paper-trade.* Cantor Lecture, Society of Arts. London, 1877.—Clapperton. *Practical Paper-making.* London, 1894.—Cross and Bevan. *Report on Indian Fibres and Fibrous Substances.* London, 1887; *Cellulose.* London, 1895; *Text-book of Paper-making.* London, 1888.—Davis. *The Manufacture of Paper.* Philadelphia, 1886. —Dropisch. *Die Papiermaschine.* Brunswick, 1878; *Papierfabrikation* (with atlas). Weimar, 1881.—Griffin and Little. *The Chemistry of Paper-making.* New York, 1894.—Herzberg. *Papier-prüfung.* Berlin, 1888 (English translation by P. N. Evans, London).—Hofmann. *Handbuch der Papierfabrikation.* Berlin, 1897.—Hoyer. *Fabrikation des Papiers.* Brunswick, 1886.—Kirchner. *Das Papier* (handbook appearing since 1897). Biberach.—Müller. *Die Fabrikation des Papiers*, 4th edition. Berlin, 1877.—"La Fabrication du Papier et du Carton," *Bibliothèque Scientifique, Industrielle et Agricole des Arts et Metiers*, viii. Paris, 1881.—Schubert. *Die Cellulosefabrikation*, 2nd edition. Berlin, 1897; *Die Praxis der Papierfabrikation.* Berlin, 1898; *Die Holzstoff oder Holzschliffabrikation.* Berlin, 1898.—*Spon's Encyclopædia of Arts and Manufactures*, "Fibrous Substances" and "Paper." London, 1882.—Wyatt. "Paper-making," *Proc. Inst. C. E.*, vol. lxxix., London, 1885; "Sizing Paper with Rosin," *Proc. Inst. C. E.*, vol. xci., London, 1887.—*Paper-makers' Monthly Journal.* London, since 1872.—*Paper-trade Journal.* New York, since 1872.—*Papier Zeitung.* Berlin, since 1876. (J. W. W.)

Paphos. See Cyprus.

Paraguay, an inland republican state of South America, lying between 20° 16′ 14″ and 26° 31′ S. and 54° 37′ and 62° W. It is bounded by the territories of the Argentine, Brazilian, and Bolivian republics, but the frontier line towards Bolivia has not yet been definitely fixed. The river Paraguay, running from north to south, divides the territory of the republic into two sections, the eastern section, or Paraguay Oriental, being the more important. The country as a whole is not well known. Outside the valley which stretches from Asuncion, the capital, to Villa Encarnacion, and away from certain frequented roads leading to the *yerbales*, there are few routes familiar to travellers. The western region, called the Gran Chaco, is to a large extent unexplored. The area comprised within the limits of the republic is estimated at about 97,700 square miles. According to the census of 1900, the population numbered 635,571, including an estimate of 80,000 for the Indians of the Chaco. The great majority of the inhabitants are of Indian descent, with very slight traces of foreign blood in their veins. Civilization has not made much progress, and the quaint habits and customs of the people have little similarity to those in the more advanced neighbouring republics. By nature the country people are gentle and patient, merry and smiling. As a general rule the Paraguayans are indolent, especially the men. Climatic conditions obviate the necessity of any superfluity of clothing. A cotton chemise, and a white *manta* wrapped in Moorish fashion over head and body, constitute the dress of the women; a cotton shirt and trousers that of the men. Boots and shoes are worn only by the upper classes. The common language of the country is Guarani, although in a few districts Tupi is spoken. The country people as a rule understand a little Spanish, if living near any trading centre. In 1893 a group of Australians, imbued with Socialistic tendencies, obtained a concession of 30 square leagues of land—about 135,000 acres—from the Paraguayan Government, and a number of immigrants from Australia settled on this tract. These colonists laboured under the condition that all property should be held in common. "New Australia" did not, however, prove a success. Disputes arose, and in the following year the project was abandoned, the land reverting to the Government. Thirty of the colonists with their families, in all ninety-three persons, agreed to stay and found a new settlement to be called "San Cosme." This experiment has succeeded somewhat better than the first, the settlers gaining a living by growing fruit and vegetables and occasionally working for wages when occasion offers. Another colony was founded with 150 Sicilian families, but this is by no means in a satisfactory condition. Immigration is small and does not increase. In 1892 there were only 539 immigrants; in 1897, 197; in 1898, 337; in 1899, 340; and in 1900, 170. The towns are few, small, and backward. Asuncion, the capital, with about 24,000 inhabitants, has neither water nor drainage works, and the streets are lighted with kerosene lamps placed at long intervals apart. Other towns are Concepcion, with 6000 inhabitants; Villa Rica, with 8000; San Pedro and Villa del Pilar, with 4000 each; and Villa Encarnacion, with 3000. The municipalities are all poor, and unable to bear further taxation for public works.

Administration.—The country is divided into 84 departments, grouped into 24 political districts, and the political constitution of 1870 is still in force. For the administration of justice there is a High Court, with lower tribunals and local magistrates accredited with judicial powers. The criminal courts are inefficient and dilatory, and crime as a rule is most inadequately punished. The death penalty nominally exists, but is rarely carried out. The civil courts are corrupt, and most tedious in procedure. The civil and criminal codes of Argentina, with a few modifications, have been adopted by Paraguay. The police system can hardly be said to extend beyond the cities, the expense of providing proper protection for life and property in the country districts being beyond the resources of the Government.

Religion and Instruction.—The Paraguayans adhere to the tenets of the Roman Catholic religion, implanted among them by the Jesuit missionaries in the 16th century, but they understand very little about religious principles. Education is in a most backward and neglected condition. Compulsory attendance at the schools for all children is nominally the law, but is never enforced. According to the official returns, there are 358 public and private elementary schools, with a staff of 680 teachers and 23,000 enrolled pupils. The actual attendance of children, however, does not exceed 12,000. The selection of the teaching staff is made without any regard to the capabilities of the applicants; salaries are on a very low scale, and frequently many months in arrear. At Asuncion a national college has been established with a staff of 15 professors, and 205 students were enrolled in 1898. The educational value of the college is not great. There are also an agricultural school, supported by the State; a school of arts and sciences, founded by the Sicilian friars; and a seminary.

Defence.—The army consists of 1 battalion of infantry, containing 1000 men; 2 squadrons of cavalry, with 1500 men; and 1 battery of artillery, with 750 men; total, 3250 men. There is also a national guard which may be called out in any emergency. Every Paraguayan between the ages of 20 and 50 is bound to serve. The republic has 1 gunboat with 4 guns, and 2 steam launches.

Finance.—The financial situation of the Paraguayan Government has been a source of anxiety for many years. In 1885, after interest had been unpaid for 11 years on bonds amounting to £1,505,400, an agreement was made for the issue of new scrip to the value of £850,000 in quittance of all claims for capital and arrears of interest, certain public lands being also ceded to the bondholders as compensation for their losses. In 1892 the Government again defaulted, and in 1895 an arrangement was made for a reduction of the rate of interest, for the funding of the arrears, and for the creation of a sinking fund. The Government were unable to meet their obligations under the new contract, and in 1898 the outstanding amount had risen to £994,600 sterling. Provision has now been made for the service of this foreign debt, and the authorities have been able regularly to meet the service of the coupons. Besides the London debt, there are many other claims on Paraguay. The national obligations are briefly set forth in the following statement as they stood at the end of 1898, gold debts being converted at the rate of $5 to the £, and the currency debts at the rate of $40 to the £.

Gold Debts—		
London debt		£994,640
Brazilian debt		1,792,037
Arrears of interest		183,256
Argentine debt		2,026,727
Arrears of interest		657,957
Argentine National Bank		8,517
General bonds		500,000
Paraguayan Central Railway Company		429,471
Total gold		£6,592,605
Currency Debts—		
Notes in circulation	$9,875,000	£246,875
Internal bonds	702,093	17,552
Floating debt	567,258	14,181
Total currency	$11,144,351	£278,608
Total debt		£6,871,213

The revenue of the republic is derived mainly from import duties, and the most important branches of expenditure are the salaries of public officials, the army, public instruction, and debt. The receipts and expenditure in 1891 and in each of the years 1896–99 were as follows:—

Years.	Receipts.	Expenditure.	Receipts.	Expenditure.
	$ Currency.	$ Currency.		
1891	1,647,717	2,485,203	£41,190	£62,130
1896	5,832,867	6,526,518	145,820	163,160
1897	4,200,009	6,852,334	105,000	171,308
1898	8,977,299	8,441,275	224,430	211,032
1899	9,866,000	8,122,139	246,650	203,054

The conversions in this statement are only approximate, the currency dollar being taken at 6d. for each of the years. The import and export duties in 1899 amounted to $7,996,440, and various taxes and contributions to $1,869,560. The estimated revenue for 1900 was $8,065,781, and expenditure $8,122,179, or, approximately, £201,640 and £203,050.

Industry.—The principal industries of the republic are the cultivation and preparation of *yerba maté* (Paraguayan tea), cattle-farming, fruit-growing, tobacco-planting, and timber-cutting. *Yerba maté*, classified as *Ilex paraguayensis*, is a shrub. The leaves are stripped, withered, rolled, and sorted, then packed in sacks and exported to Argentina for sale. This Paraguayan tea is used in place of the ordinary tea or coffee in many parts of South America. Medical experts state that the beverage infused from the leaves has a stimulating effect, and is also slightly diuretic. The total amount exported from Paraguay in 1896 was 5141 tons; in 1897 the total was 6548 tons; and in 1898, 7000 tons. The value of the yerba exported in 1899 was £97,360. The majority of the *yerbales* (tea plantations) were formerly the property of the national Government, but of late years private enterprise has stepped in and bought or leased the plantations. An important feature about *yerba maté* is the small expense necessary for its production, and the cheap rate, notwithstanding the high tariff on its importation, at which it can be placed on the Argentine market as compared with ordinary tea or Brazilian coffee.

The cattle industry comes next in importance. The number of animals is said to exceed 2,500,000, but exact figures are unobtainable. Hitherto the surplus stock has only found an outlet in the demands for local consumption, or for the value of the hides for export. The animals are small, but Durham and Hereford bulls are being introduced from Argentina to improve and enlarge the breed. The increase in the herds of recent years has caused the owners of *saladero* establishments in Argentina and Uruguay to try the working of factories in Paraguay for the preparation of *tasajo* (jerked beef) and the manufacture of extract of meat—the first for the Brazilian and Cuban markets, the latter for European consumption. The number of horses is estimated at 300,000; donkeys, 20,000; yaks, 10,000; pigs, 50,000; and sheep and goats, 240,000. Both grasses and climate are against sheep-farming on a large scale.

The fruit trade is confined to the exportation of oranges and pine-apples to the Buenos Aires, Rosario, and Montevidean markets. The orange groves are uncultivated, but yield abundantly. The demand for oranges is so large in Argentina that a ready sale could be found for a much larger quantity than is now exported. Both climate and soil in Paraguay could be turned to useful purpose for the cultivation of many tropical fruits and vegetables for sale in Argentina, and already some attempts are being made to develop a trade in this direction. Tobacco, although of inferior quality, is grown to a considerable extent, the total production for 1900 being about 280 tons, about one-eighth of which was exported. This industry might be largely increased in value if more attention were devoted to cultivation and curing.

The forests are a source of wealth as yet scarcely touched, and abound in such valuable timbers as quebracho, cedar, curupey, lapacho, and urundey. The difficulty and cost of transport at present block the development of this industry. In Buenos Aires, where the demand for lumber is constantly increasing, it is found cheaper to import from North America or Europe, a distance of 6000 miles, rather than from Paraguay, less than 1000 miles distant. In order to remove this anomalous condition of affairs, it is necessary that the great waterway formed by the Rio de la Plata, the Parana, and the Paraguay should be properly utilized.

The development of the agricultural and pastoral industries is encouraged, and land is assigned to colonists by the Government. In 1897 there were seven agricultural settlements, with altogether about 10,000 acres under cultivation. The climate is enervating, and otherwise there is no great inducement for European emigrants to go to Paraguay, since the best portion of the national lands is already in the hands of private individuals. During the year 1899 the Anglo-Paraguayan Land Company, the owners of the land ceded to the bondholders, sold 11 leagues (51,600 acres) at prices varying from £250 to £1000 per league.

Commerce.—The commercial situation of Paraguay has improved somewhat in consequence of the investment of some small amounts of foreign capital in industrial enterprise. The principal articles imported are textiles, hardware, wines, rice, flour, canned goods, and general provisions; the exports are *yerba maté*, hides, wood, oranges, hair, tobacco. Most of the trade is with Buenos Aires or Montevideo, direct dealing with Europe being the exception. The values since 1895 have been:—

	1895.	1896.	1897.	1898.	1899.	1900.
Imports	£492,010	£557,260	£440,690	£521,700	£429,570	£367,724
Exports	424,290	409,660	430,320	492,660	404,210	412,858

The textiles are mostly of British origin; the wines are from France. A promising trade was done with the adjoining Brazilian state of Matto Grosso for some time, under the terms of a treaty allowing free trade with that province of Brazil. In 1898, however, this arrangement with the Brazilian Government was rescinded, and business between Paraguay and Matto Grosso came to an end.

Whilst the commerce of Paraguay is extremely limited, it is, on the whole, fairly sound, and promises to increase in volume.

Communications.—There are two lines of passenger steamers plying between the port of Asuncion and Rio de la Plata, each of which runs one steamer weekly. There is also a fortnightly service of the Brazilian Lloyd's boats (cargo only) between Montevideo and Corumba, calling at Buenos Aires and Asuncion. In 1898, 418 ocean-going vessels and 750 coasting vessels entered at the port of Asuncion, and 408 ocean-going and 706 coasting vessels cleared. There are some fairly good waggon roads, and the Government appropriates annually a considerable sum for their extension. The transport of heavy goods is effected by bullock carts of antiquated type. In the capital there are half a dozen public vehicles and three private carriages. The only railway undertaking is that of the Paraguay Central Railway Company. The total length of line open to traffic is 156 miles. An extension has been projected for some years, but the failure of the Government to pay the guaranteed interest on the capital of the company has hitherto prevented the accomplishment of the work. A steam tramway connects Asuncion with San Lorenzo, 20 miles distant, and horse tramways run through the streets of the capital. In 1900 the railway carried 624,741 passengers and 75,503 tons of goods; the receipts being \$1,568,037 (or about £39,200), and the working expenses about 79 per cent. The tramway carried 870,546 passengers in 1899.

Post and Telegraph.—Paraguay entered the Universal Postal Union in 1884. In 1899 there were 139 post offices in the country, and in the same year 1,254,864 pieces of mail matter were handled. Four telegraph lines, of a total length of about 485 miles, connect Asuncion with other towns, and a submarine cable line puts the republic in communication with the rest of the world by way of Corrientes. In 1899 the inland telegrams numbered 18,925, and the international, 39,458. Telephone services are in operation at Asuncion and at Concepcion.

Money and Credit.—There are three banking companies, one of which in 1898 paid a dividend at the rate of 18 per cent. on a capital of \$1,000,000 currency. The capital invested in works for the development of the resources of the country is mostly foreign. The three British companies (railway, tramway, and land) have invested altogether about £1,430,000; a Belgian syndicate, working *yerbales*, cattle ranches, &c., £60,000; and a French company, for miscellaneous investments, £72,000. The money invested in private trading concerns probably amounts to about £1,000,000.

The money in circulation at the end of 1900 consisted almost entirely of \$12,000,000 paper (£300,000). The gold dollar (4 shillings) in 1900 was at a premium averaging over 800 per cent.

Weights and Measures.—The metric system is officially adopted, but the weights in common use are the *tonelada* (2025 lb), the *quintal* (101·4 lb), the *arroba* (25·35 lb), the *libra* (1·014 lb), and the *onza* (·0616 lb). The unit for liquid measure is the *cuarta* (·1665 gallon); that for dry measure, the *almud* (·66 bushel). The land measure is the *legua* (2·689 miles).

(W. W. R.; I. P. A. R.)

Recent Political History.—The modern political history of Paraguay dates from the death of Don Francisco Lopez in 1870. Succeeding his father, Don Carlos Lopez, as President in 1862, he made no pretence of governing the country according to the constitution of 1844, but arrogated to himself absolutely autocratic powers. In 1864 a dispute arose between Lopez and the Brazilian Government. The Paraguayan dictator, in order to enforce his demands, marched an army through Argentine territory for the purpose of invading the southern provinces of Brazil, and occupied the town of Uruguayana in Rio Grande do Sul. This act induced the Governments of Brazil, Uruguay, and Argentina to combine for the purpose of suppressing Lopez, whose aggressive behaviour and ambitious policy constituted a constant menace to the three countries. The invasion of Paraguay then took place, and a struggle involving an enormous sacrifice of life and treasure lasted for five years, only coming to a close when the Paraguayan forces were totally defeated and Lopez was killed at the battle of Aquidaban on 1st March 1870. During this warfare every male Paraguayan capable of bearing arms was forced into the fighting ranks, whole regiments being formed of boys of from 12 to 15 years of age. Nor were the women spared: they were used as beasts of burden to carry ammunition and stores, and when no longer capable of work were left to die by the roadside or ruthlessly murdered to avoid any ill consequences occurring from their capture by the enemy. When the war broke out, the population of Paraguay was 1,337,439 souls; when hostilities ceased the total number of inhabitants was 221,079 persons—28,746 men, 106,254 women above 15 years of age, and 86,079 children. Lopez was merciless in his treatment of his own people, and any attempt to evade military service was punished by death, as also was any evidence of hesitation to face the enemy. When gradually the Paraguayans were forced to retreat, the dictator ordered every town and village passed through to be razed to the ground, and every living animal for which no use could be found to be slaughtered. When the end came the country and people were in a state of absolute prostration.

After the death of Lopez, the Government was administered by a triumvirate consisting of Cirilo Rivarola, Carlos Loizaga, and José Diaz de Bedoza. In November 1870 a new constitution was formulated. The executive power was vested in the hands of a President elected by Congress for a term of four years, and assisted by five responsible ministers—namely, Interior, Finance, War and Marine, Worship and Instruction, and Foreign Affairs. Provision was also made for a Vice-President to act in case of the absence, death, resignation, or inability of the President. The legislative authority was to be exercised by a Congress consisting of two chambers, the Senate and the Chamber of Deputies, elected by the people, in the proportion of one senator for every 12,000 inhabitants and one deputy for every 6000, although in certain thinly populated districts a lesser number was required. The constitution provided that senators and deputies should receive an annual stipend of 1000 gold dollars. The choice for President of the republic fell upon Señor Cirilo Rivarola, and he was declared duly elected. The constitution of 1870 is still in force, but the majority of the Paraguayans have never availed themselves of the privilege of voting accorded to them. This inauguration of new political conditions did not mean, however, that all was plain sailing for the men in charge of Paraguayan destinies. The policy of Brazil had for many years leaned towards the annexation of Paraguay, in order that the Paraguay river might become the boundary to the south-west of the Brazilian empire. President Rivarola found himself thwarted in all directions by Brazilian intrigues, and in little more than a year after his election he resigned office, and was succeeded by the Vice-President, Señor Salvador Jovellanos. President Rivarola had aroused some strong hostile feelings during his tenure of power, and was shortly afterwards assassinated. President Jovellanos completed the term of office for which Rivarola had been originally selected, and in 1874 President Gill was chosen to succeed him. Brazilian intrigues were now once more set afoot, and the opposition to this policy, combined with the introduction of certain reform measures and the suppression of many flagrant abuses, resulted in a conspiracy against the President and his assassination in 1875. Vice-President Uriarte then assumed the Presidency, and served the remainder of the term. In 1878 Señor Baredo was elected, but died suddenly shortly afterwards, Vice-President Saguier succeeding to power. A conspiracy aided by the military element overthrew Saguier in 1881, and Congress then nominated General Caballero to hold office. He filled the position until 1886, when Congress elected Señor Escobar to the Presidency for the ensuing four years. The next chief magistrate was Señor Gonzalez, who made himself unpopular with the prominent politicians of Asuncion, and was eventually deposed in the beginning of 1894. The story of the conspiracy against him is an apt illustration of some South

American political methods. The malcontents approached the principal military officers, who gave promises of assistance to any movement against the President. Two deputies were then nominated to interview President Gonzalez and inform him that he would be required immediately to abdicate his office and leave the country. They went to Government House and found Señor Gonzalez in his office. Presenting their revolvers at his head, the deputies delivered the message with which they were charged. The President made no resistance, and was marched as a prisoner to the military barracks. The following day Señor Gonzalez was placed on board a steamer bound for Buenos Aires, and instructed not to return to Paraguay if he had any respect for his personal safety. Vice-President Moriñigo fulfilled the duties of President for the few months remaining of the term for which Señor Gonzalez had been elected, and in November 1894 was succeeded by Señor J. B. Egusquiza, who had been duly nominated by Congress. No noteworthy occurrences marked his term of office, with the exception of a dispute with Bolivia on the question of the boundary, and the rupture of official relations with Uruguay. The Uruguayan minister, in a despatch to his Government, had expressed the opinion that the Bolivian claim was just and reasonable. This despatch was, unfortunately, made public while the minister was absent from Asuncion. On his return to that city the hostile demonstrations against him were so strong that he was unable to land from his steamer. He went back to Montevideo; the formal rupture of relations then took place. Señor Aceval was nominated to the Presidency in 1898.

The dense ignorance of the mass of the people renders difficult the application of any political measures for the improvement of the general condition of the inhabitants. The constant penury of the Government is a further bar to legislation for the improvement of the educational system, the establishment of a more effective police force, or the carrying out of any important public works. Projects have been mooted from time to time for the entry of Paraguay into the Argentine Confederation or the Brazilian Union, but the idea has not been acceptable to the majority of the politicians who control the national destinies. The military element is always a stumbling-block in the way of any genuine political reform, such a policy virtually signifying the extinction of the power of the army to influence political events. The majority of the population care very little about the composition of the Government as long as taxation is not made too onerous and the men are not impressed for military service. (C. E. A.)

Paraguay River. See PLATA, RIO DE LA.

Parahyba do Norte, an Atlantic state of Brazil, situated between 6° 15′ and 7° 50′ S. and 34° 45′ and 38° 5′ W. Area, 28,854 square miles. Population in 1872, 382,587; in 1890, 497,000. It is bounded on the E. by the Atlantic, on the N. by the state of Rio Grande do Norte, on the W. by that of Ceará, and on the S. by that of Pernambuco. Capital, Parahyba, 10,000 inhabitants, with seven churches, a treasury, and other public buildings; the port, distant 30 kilometres, is called Cabedelo. Other towns are Arêa, Bananeiras, Cajazeiras, Campina Grande, Guarabira, Mamanguape, Pombal Souza, and Itabaiana.

Paramaribo, the administrative and commercial capital of Dutch Guiana, on the Surinam, at a point where the river is navigable for ships of 16 feet draught. The town covers an area of 1976 acres, and is divided into six inner and two outer quarters, and had in 1852 a population of only 6000, the fifth part of that of the colony (30,000). In 1900 its population amounted to 31,427, nearly one-half of the population of Dutch Guiana. A large number of the inhabitants of the colony have therefore withdrawn from the rural districts to the town, whose population is a conglomerate of different nations and religions. For statistics of trade and navigation, &c., see GUIANA, DUTCH.

Paraná. See PLATA, RIO DE LA.

Paraná, a city of the Argentine Republic, capital of the province of Entre Rios, on the river Paraná, nearly opposite to Santa Fé, about 240 miles north-west, in direct line, of Buenos Aires, situated in 31° 43′ S. and 60° 31′ W. It is the terminus of the provincial railway system, connecting with Concepcion in Uruguay. Various tramways run through the city. There is an important trade in lime; cereals are exported. At Bajada Grande, near Paraná, a magnificent wharf with all appliances for quick handling of ships' cargoes has been constructed. Paraná was the capital of the republic from 1852 to 1861. Population (1895), 24,261.

Paraná, a state of Brazil, between 22° 45′ and 26° 29′ S. and 47° 55′ and 55° 3′ W., bounded on the N. by São Paulo, on the W. by Matto Grosso and the Argentine Republic, on the S. by Santa Catharina, and on the E. by São Paulo and the Atlantic. Area, 85,453 square miles. Population in 1872, 126,722; in 1890, 626,722. The capital, Curitiba, has a population of about 20,000. Other towns are Paranaguá (8000), Ponta Grossa (7000), Castro (4000), Antonina (4000), Rio Negro (3000), Palmeira (2500), Campo Largo, Morretes, São José dos Pinhaes and Lapa, each with about 2000. There is a railway from Paranaguá to Curitiba. The principal article of export is *maté*, or Paraguay tea. Nearly the whole population is in the eastern half. Over 56,000 of the inhabitants are foreigners, and 60,000 foreign-born.

Paranagua, a town of Brazil, in the state of Paraná, of which it is the principal port. Population, about 8000. A railway connects the town with Curitiba. The principal article of export is *maté*, or Paraguay tea. The value of the foreign goods imported in 1893 was $264,868 (gold). In 1896 about 475 vessels of 243,000 tons visited this port, and in 1897, 431 vessels of 222,514 tons. A line of steamers runs directly between Paranagua and Hamburg.

Parasitic Diseases. See PATHOLOGY.

Parchim, a town of Germany, grand-duchy of Mecklenburg-Schwerin, 23 miles south-east of Schwerin. It was the birthplace of Field-Marshal Moltke (1800–1891), to whom a monument was erected in 1876. It is an ancient place, with town walls, a Gothic town hall, a couple of interesting churches (one 13th century, the other 14th century), a synagogue, and a mineral spring. Population (1885), 9726; (1900), 10,170.

Pardo Bazán, Emilia (1851– ——), Spanish author, was born at La Coruña, Spain, on 16th September 1851. Married in her eighteenth year to Sr D. José Quiroga, a Galician country gentleman, she interested herself in politics, and is believed to have taken an active part in the subterranean campaign against Amadeo of Savoy and, later, against the republic. In 1876 she came into notice as the successful competitor for a literary prize offered by the municipality of Oviedo, the subject of her essay being the Benedictine monk, Benito Jerónimo Feijóo, a figure of importance in the Spanish literature of the 18th century, and one of the glories of the province of Galicia. This was followed by a series of articles inserted in *La Ciencia Cristiana*, a magazine of the purest orthodoxy, edited by Juan

M. Orti y Lara. At this period the Sra Pardo Bazán, who has persistently published under her maiden name, was considered as a light among the Carlist party, and therefore as an aggressive Ultramontane. There is some reason for thinking that she has modified her earlier views concerning religious and civil policy, and in literature her progress is easily traced. Her first novel, *Pascual López* (1879), is a simple exercise in fantasy of no remarkable promise, though it contains good descriptive passages of the romantic type. It was followed by the much more striking story, *Un Viaje de Novios* (1881), in which a discreet attempt was made to introduce into Spain the methods of French realism, then at the height of its fashion. The book caused a sensation among the literary cliques, and this sensation was increased by the appearance of another naturalistic tale, *La Tribuna* (1885), wherein the influence of M. Zola and his school is unmistakable. Meanwhile, the writer's reply to her critics was issued under the title of *La Cuestión palpitante* (1883), a clever piece of rhetoric, but of no special value as regards criticism or dialectics. The naturalistic scenes of *El Cisne de Vilamorta* (1885) are more numerous, more pronounced, than in any of its predecessors, though the authoress shrinks from the logical application of her theories by supplying a romantic and inappropriate ending. Probably the best of Sra Pardo Bazán's work is embodied in *Los Pazos de Ulloa* (1886), the painfully exact history of a decadent aristocratic family, as notable for its portraits of types like Nucha and Julián as for its creation of characters like those of the political bravos, Barbacana and Trampeta. Yet perhaps its most abiding merit lies in its delightful pictures of country life, its poetic realization of Galician scenery set down in an elaborate, highly-coloured style, which, if not always academically correct, is invariably effective. A sequel, with the significant title of *La Madre Naturaleza* (1887), marks a further advance in the path of naturalism, and henceforward the Sra Pardo Bazán was universally recognized as one of the chiefs of the new naturalistic movement in Spain. The title was confirmed by the publication of *Insolación* and *Morriña*, both issued in 1889. In this year her reputation as a novelist reached its highest point. Her later stories, *La Cristiana* (1890), *La Prueba* (1890), *Cuentos de Amor* (1894), and *Arco Iris* (1895), though not wanting in simple charm, have failed to interest or to please. It might almost seem as though her mission was ended; but her energy has led her to seek success in literary criticism, in verse, in books of travel, in lectures, and in polemics. To this ambitious versatility we owe her biography of St Francis of Assisi, her sketches of the teachers of the Renaissance, her examination of the Russian novel, her speculations on Columbus, her discussion of John Stuart Mill's theories concerning the political position of women. These essays are executed with spirit and vigour, and they are interesting as the expression of a very individual temperament, as examples of popular exposition. *Los Pazos de Ulloa* and *La Madre Naturaleza* will outlive them, for both are characteristic products of an important movement.

Pardubitz, the chief town of a government district in Bohemia, Austria, 12½ miles south by west of Königgrätz. Population, including suburbs (1890), 12,367; (1900), 17,029 (estimated at 97 per cent. Czech, 3 per cent. German; 95·5 per cent. Catholic, 3 per cent. Jewish, and 1 per cent. Protestant). The Gothic chapel of the old chateau was restored in 1880, and a new town hall completed in 1894.

Parenzo, a seaport town in Istria, Austria, the seat of the Provincial Diet and an episcopal see. Population (1890), 8485; (1900), 9962, mostly Italian and Catholic. It is a station of the Austrian Lloyd Steamship Company. The principal resource of the inhabitants is fishing, shipbuilding, and seafaring pursuits. The trade is chiefly in wine, timber, and fish. It has extensive mulberry plantations.

Paris, a city of Illinois, U.S.A., capital of Edgar county. It is at the intersection of the Vandalia line and the Cleveland, Cincinnati, Chicago, and St Louis Railway, in the eastern part of the state, at an altitude of 700 feet. It has a level site and is regular in plan. It is in a rich farming region, and has a large trade. Population (1880), 4373; (1890), 4996; (1900), 6105, of whom 179 were foreign-born and 277 negroes.

PARIS.

PARIS, the capital of France, is situated on both banks of the Seine, 124 miles from its mouth, and 211 miles south-south-east of London, in 48° 50′ 49″ N. and 2° 20′ 15″ E. Its central position has always facilitated its commercial relations. The general character of its climate, somewhat continental in winter and oceanic in summer, has been more and more closely observed since the three observatories at different heights on the Eiffel Tower were added in 1889 to the old-established ones of Parc St Maur and Montsouris. The observatory at the Tour St Jacques, in the very centre of the city, and since 1896 a municipal establishment, is of special interest on account of the study made there of the transparency and purity of the air. There are barely 100 days in the year when the air is very clear. Generally the city is covered by a mantle of floating mists, possibly 1500 feet in thickness, which are chiefly brought by south-west winds. During the prevalence of north-easterly winds the sky is most obscured, since on that side lies the greatest number of factories with smoking chimneys. A chemical analysis of the air—taken in the first instance from Montsouris, on the outskirts, in the second from the centre of the city—shows that the former yields only 8 bacteria per cubic foot, whilst the latter yields as many as 200. To the hard winters mentioned in the ninth edition of the *Ency. Brit.* must be added those of 1890–91 (when for twenty days the Seine drifted large quantities of ice, and the frost lasted, almost without a break, for eighty days, from the end of November 1890 to the 15th of February 1891) and 1895 (when the Seine, during the whole month of February, a very late date for such great cold, either bore drifted ice or was frozen across).

Since 1840 Paris has been completely surrounded by a wall, which since 1860 has served also as the limit for the collection of municipal customs dues (*octroi*). Proposals are constantly being brought forward to demolish this wall—which, with its talus, is encircled by a broad and deep ditch—either entirely or at least from the Point du Jour, where the Seine intersects the wall below the city, to Pantin, so as to extend the limits of the city as far as the Seine, which runs almost parallel with the wall for that distance. The forts of St Jamme and of Aigremont, which the ninth edition indicates to the west of St Germain-en-Laye, had in 1902 not yet been built. On the other hand, those of Champigny and Sucy-en-Brie have been erected (between the forts of Villiers-sur-Marne and Villeneuve St Georges), commanding the mouth of the Marne and the battlefields of the 30th of November and the 2nd of December 1870. The Rue du Quatre

MAP OF PARIS.

Septembre, which unites the Place de l'Opéra to that of la Bourse, is now prolonged, under the name of Rue Réaumur, from the Bourse to the Square du Temple near the Place de la République, and runs parallel with the Grands

Boulevards through the busiest and most bustling part of the city. The business quarters of the east have been intersected by the Avenue de la République, between the place of that name and the cemetery of Père la Chaise. The Avenue Parmentier runs from the St Louis Hospital to the Place Voltaire, and the Avenue Ledru Rollin from the latter place to the Pont d'Austerlitz. On the Place de la Nation, where the statues of Philippe Auguste and St Louis already stand on high columns at the entrance to the Cours de Vincennes, the Triumph of the Republic, by Dalou, has been erected. Two new iron bridges for vehicles and pedestrians cross the Seine. The bridge Alexandre III., commemorating the Franco-Russian Alliance, connects the Esplanade des Invalides on the left bank with the Champs Elysées on the right; and the Pont Mirabeau, between the bridges of Grenelle and Point du Jour, unites the increasingly populous districts of Auteuil (right bank) and Grenelle (left bank). In addition a skew bridge, between the footbridge of Passy and the Grenelle bridge, carries the new line of railway from the Gare St Lazare to the Champ de Mars. The banks of the Seine, especially in the part below the city, have been further regulated by additional landing-stages, largely provided to meet the requirements of the Exhibition of 1900, the buildings of which extended along the river for a considerable distance. An important port has been designed at Ivry, just above the city on the left bank, at which the railway from Orleans terminates.

The district of Passy has more and more come to be a fashionable suburb, and a new quarter has sprung up near la Muette, on the former site of the municipal conservatories (*serres de la ville*), which have been transferred to the Parc aux Princes, on the southern boundary of the Bois de Boulogne. Here, in a number of nurseries, all the trees for the plantations of the town are grown. At the entrance to the Bois de Vincennes from the Avenue Daumesnil is a collection of different varieties of ornamental trees. The Bois de Boulogne, which has been devoted for some time to various sports (skating, pigeon-shooting, &c.), is now the headquarters of the Racing Club, which, however, has for its object the promotion of all sports. On the site of the Palais de l'Industrie, built in the Champs Elysées for the Exhibition of 1855, two Palais des Beaux Arts have arisen, built for the Exhibition of 1900, but designed to survive it. It is between these two edifices that the Avenue Nicolas II. passes, which opens upon the bridge Alexandre III., connecting the palace of the Elysée with the Hôtel des Invalides. The old church of St Geneviève, no longer used as a church, serves as a Pantheon for the burial of citizens to whom such honour is assigned. President Sadi Carnot, his grandfather Lazare Carnot, Victor Hugo, and others, lie in its vaults. The inner walls of the building are decorated with frescoes by eminent artists illustrating the history of St Geneviève, Jeanne d'Arc, and St Louis.

The only notable church built since 1875 is that of the Sacré Cœur, on the heights of Montmartre. This church is a national votive offering, decreed by the Constituent Assembly in 1871 and paid for by private subscriptions and collections. It was begun in 1876, but the ground not being solid enough for the first foundations, new and deeper ones, with pits 108 feet in depth, were made. The edifice is in Roman style, with a Byzantine dome 197 feet high, surmounted by a tower 263 feet high. Dominating Paris in every direction, it is one of the most colossal and also one of the most unsightly public monuments of modern times. It has a formidable bell called the Savoyarde, which is 10 feet high and 31 feet in circumference. This bell was a gift of four parishes in Savoy; it cost 65,500 francs, and was rung for the first time on 20th November 1895.

The Sorbonne has been completed. Its large, luxurious amphitheatres, and the spacious quarters of the University of Paris and of the faculties of science and literature form a striking contrast to the old and narrow quarters in which these institutions were formerly situated. The École de Médecine is being completed, the École de Droit considerably enlarged, and the Lycée Louis le Grand rebuilt. All these new buildings have greatly altered the appearance of the old Quartier Latin. Monuments have been raised to Francis Garnier, the hero of Tongking, on the Carrefour de l'Observatoire; Guy de Maupassant, the novelist, in the Parc Monceau; Alphand, the celebrated engineer, who for forty years has carried out the improvement of modern Paris, at the entrance to the Bois de Boulogne; and Charcot, the great doctor, opposite the hosital which he made famous, in the Place de la Salpêtrière. A monument to the chemist Lavoisier has been raised in the Place de la Madeleine, and a statue of Jeanne d'Arc, by Paul Dubois, in the Place St Augustin. The Opéra Comique, destroyed by fire (23rd February 1887), has been rebuilt on the old site in the Boulevard des Italiens. The house in which it found temporary accommodation in the Place du Châtelet has been rented by Sarah Bernhardt, the great tragédienne. The Théâtre Antoine has acquired a certain reputation for the audacity and originality of the pieces played there. A new hippodrome has been erected at Montmartre.

Population and vital statistics.

The population of Paris numbered 2,269,023 in 1881, 2,424,705 in 1891, and 2,660,559 in 1901, showing an increase of 6·8 per cent. between 1881 and 1891, and of 9·7 per cent. between 1891 and 1901.

The population shows an increasing tendency to spread out over the north-west region, in the districts of Passy and Auteuil; but the most populous quarters are still those of the centre and the north, particularly the Bonne-Nouvelle district. The Marbœuf quarter, just off the Champs Elysées, was entirely laid out between 1880 and 1885. Since 1870 the houses have always been built several storeys. In the rich quarters, Passy excepted, there are now scarcely any one-storey houses. The simple explanation is that formerly land was cheap, and the owner, having only a small capital, found it advantageous to construct his dwelling with materials of inferior quality, which could not support the weight of more than one storey, and to-day it is not possible to add other storeys to these light constructions. But since 1875 land, particularly in the north-west districts, has almost quadrupled in price, so that owners now find it to their interest to construct vast blocks of flats five or six storeys high, the rentals being thus proportionate to the capital invested in the land. In 1875 there were 66,850 houses and factories in Paris, representing rents to the value of 417,500,000 francs. In 1897 there were 75,000 houses, the rents of which aggregated 785,000,000; and a comparison of these totals is a sufficient demonstration of what we have just said, namely, that if the number of houses has increased in relatively small proportions (about 400 a year), on the other hand the rents of the houses have almost doubled. Here is another total: the approximate value of all the buildings in Paris, except some 400 belonging to the State, calculated at the price they would fetch, is now fourteen milliard francs, or £560,000,000, instead of seven and a half milliard francs in 1875. An interesting movement was begun in 1875 by MM. Müller and Cacheux, who were the first to have constructed upon 500,000 metres of land several hundred houses on the principle of building companies. The press giving its aid to this social and philanthropic enterprise, the result was the formation of the Working-men's Lodgings Company, of Passy-Auteuil, and of the Philanthropic Association, founded with a generous gift from M. Michel Heine, which began by constructing three houses of several storeys, each divided into small lodgings and rented at a price that would yield 3½ per cent. on the capital. The net income from these houses was devoted to the construction of similar dwellings. As the result of a congress held after the close of the Exhibition of 1889, a Cheap Lodgings Association was formed. Finally, the law of 30th November 1894 conferred certain advantages upon builders of small lodgings. In 1897 there were 810,468 premises used as dwellings, and 303,328 used for commercial or industrial purposes. Factories occupied 23,159 sites. The value of the total rental of these various properties was estimated at £31,400,000, and their marketable value at £440,000,000.

On comparing the following tables with those given in the ninth edition of the *Ency. Brit.*, it will be seen that the population is deserting the centre for the suburbs:—

Arrondissements.	Population present on the 29th March 1896.	Variation since 1881.	Population per acre.
Louvre	66,133	−9,257	140
Bourse	66,784	−9,610	275
Temple	87,335	−6,919	304
Hôtel de Ville	97,674	−6,086	249
Panthéon	115,947	+1,503	188
Luxembourg	100,692	+2,957	192
Palais-Bourbon	97,832	+14,505	98
Elysée	102,003	+12,999	108
Opéra	119,985	−2,911	228
St Laurent	153,785	−6,024	216
Popincourt	222,009	+12,763	249
Reuilly	117,715	+15,280	84
Gobelins	114,711	+23,396	74
Observatoire	122,126	+30,413	106
Vaugirard	133,177	+32,498	75
Passy	101,564	+40,862	57
Batignolles-Monceau	182,071	+38,884	166
Montmartre	224,488	+45,652	174
Buttes-Chaumont	134,128	+16,243	96
Ménilmontant	151,796	+24,879	118

As to the civil condition of the population, there were in 1891, amongst 2,424,705 inhabitants, 1,165,576 men, of whom 628,765 were single, 480,642 married, 51,885 widowers, 4284 divorced. In the same year women numbered 1,259,129, of whom 604,382 were single, 490,073 married, 158,533 widowed, 6141 divorced. The birth-rate is low—on an average 61,000 births per annum, or 25 per thousand inhabitants. The death-rate also is low, 55,000 to 58,000 deaths per annum, averaging 22 to 23 deaths per thousand inhabitants. This is accounted for by the fact that Paris is pre-eminently a town of adults, as the following table, referring to the year 1891, shows:—

Ages from		Ages from	
0 to 4 years	150,490	55 to 59 years	102,263
5 ,, 9 ,,	155,933	60 ,, 64 ,,	80,434
10 ,, 14 ,,	154,084	65 ,, 69 ,,	54,580
15 ,, 19 ,,	196,018	70 ,, 74 ,,	33,895
20 ,, 24 ,,	230,984	75 ,, 79 ,,	17,808
25 ,, 29 ,,	272,087	80 ,, 84 ,,	7,333
30 ,, 34 ,,	256,058	85 ,, 89 ,,	2,360
35 ,, 39 ,,	220,088	90 ,, 94 ,,	557
40 ,, 44 ,,	188,171	95 ,, 99 ,,	124
45 ,, 49 ,,	161,914	100 and over	9
50 ,, 54 ,,	132,102	Ages unknown	7,513

In these circumstances there is nothing remarkable in the annual number of marriages in Paris, 23,000, a high marriage-rate for the total number of inhabitants, but a low one compared with the number of marriageable persons.

A large number of the inhabitants (on an average 636 out of every 1000) are not Parisians by birth. In 1891 there were 2,196,627 of French parentage, 47,116 naturalized and 180,962 foreigners. Most of the latter belong to the following nationalities:—Belgians, 44,817; Germans, 26,863; Swiss, 24,786; Italians, 21,125; Luxembourgers, 13,157; English, 12,727; Russians, 9284; Americans, 4237; Austrians, 4387; Dutch, 4205; Spaniards, 4115. The Belgians, Germans, and Italians, mostly artisans, live chiefly in the industrial districts in the north and east of the city. The English and Americans, on the other hand, congregate in the wealthy districts of the Champs Elysées and Passy.

Occupations. The census of 1891 divided the population according to occupation as follows:—

(1) *Agriculture.*—Total number of persons engaged in agricultural pursuits, 8158, of whom 1767 were proprietors cultivating their own land, 384 farmers, 5861 horticulturists, 146 foresters.

(2) *Industries.*—Total number of persons employed, 1,071,254, of whom there were engaged in textile industries, 32,929; in mining and quarrying, 767; metallurgical industries, 2999; the manufacture of metal goods, 117,656; leather industry, 28,992; wood industry, 36,546; pottery, 8656; chemical industries, 13,814; building trade, 171,414; lighting, 8533; furnishing, 60,509; clothing and the toilette, 395,491; food supply, 46,665; industries connected with the sciences, arts, and literature, 76,625; watchmakers, jewellers, makers of *objets d'art*, &c., 67,015; State industries (manufacturers of carpets and tobacco), 2643.

(3) *Carrying Trade.*—Total number of persons employed, 138,690, of whom there were engaged in the building of ships, 218; in sea transport, 657; on canals and rivers, 2143; inland transport and towage on canals, 1039; making and repairing roads and bridges, 10,587; transport by railway, 40,600; street porters and messengers, 7442; carriers, 17,936; drivers of vehicles, 43,792; postmen and telegraph messengers, 14,276.

(4) *Commerce.*—Total number of persons employed, 560,066, among whom stockbrokers and bankers numbered 30,873; brokers, commission agents, or wholesale merchants, 30,955; keepers of hotels, coffee-houses, and public-houses, 120,296; retail provision dealers, 91,462; furniture dealers, 12,441; clothiers, 42,782; various, 231,257.

(5) *Army, Navy, and Police.*—Total number of persons employed, 42,926, of whom there were in the land force, 22,204; in the sea force, 1953 (the *infanterie de marine* is no longer actually represented in Paris); gendarmerie, 4360; police, 14,409.

(6) *Administration.*—Total number of persons employed, 37,798, of whom 17,978 were State officials, and 19,820 departmental and communal officials.

(7) *Liberal Professions.*—Total number of persons, 157,788, among whom members of the secular Catholic clergy numbered 2725; those belonging to Catholic religious communities, 6638, and to other religions, 829; while there were 3473 magistrates, 7268 barristers, 6926 legal officers, and 2995 solicitors; 9550 doctors, 719 veterinary surgeons, 8806 pharmaceutical chemists, 2648 dentists, 2108 midwives, and 5218 hospital assistants; 12,982 public lecturers and teachers, 10,807 private teachers, and 7276 teachers of accomplishments; 9847 *savants* or literary men, 20,352 civil engineers and architects, 3003 photographers, 5595 musicians, 20,654 sculptors, painters, and engravers, and 7369 lyric and dramatic artistes.

(8) Besides the above, there were 102,902 landed proprietors other than agricultural, 137,751 independent persons (*rentiers*), 12,910 pension-holders and retired persons living on their incomes, and 155,162 persons without definite occupation or unclassified.

Wages. The Chamber of Commerce has attempted to tabulate the alteration in the average daily wage in various trades between 1853 and 1892, as follows:—

	1853.	1892.		1853.	1892.
	Francs.	Francs.		Francs.	Francs.
Jewellers	4·25	7·50	Plumbers	4	6
Butchers	4·50	6	Bookbinders	3·50	5·50
Bakers	5	7	Ornamental Sculptors	4	7
Brewers	3·50	5	Locksmiths	4	6·50
Coachbuilders	4	6	Tailors	3	5
Hatters	4	6·50	Upholsterers	4	5
Coalheavers	3	5	Diggers	3	5
Carpenters	5	8·50	Turners (wood)	4	5
Wheelwrights	4	6	Turners (metal)	5	7
Coppersmiths	4·50	6	Glaziers	3·75	5·50
Shoemakers	3	3·50	*Women Workers.*		
Cutlers	4	6	Laundresses	2·50	4
Slaters	5	7·75	Embroiderers	2	3
Cabinetmakers	3·50	7·75	Corset-makers	1·50	2
Tinplaters	3·50	5	Dressmakers	1·75	2
Blacksmiths	5	7	Trouser-makers	2·50	4
Watchmakers	4·50	6	Lace-makers	2·50	3
Masons	4·25	7·50	Florists	2·50	3
Joiners	3·50	7·50	Seamstresses	1·50	2
House painters	4	8	Boot-stitchers	2·50	3
Hairdressers	2	3			

Municipal budget. The municipal debt of Paris has greatly increased since 1860, owing to the extensive works undertaken in widening streets, improving sanitation, facilitating traffic, building schools, extending the system of aqueducts, and drainage. The budget of 1895 allowed the sum of £4,371,440 for interest on and amortization of the debt. The following are the chief items of expenditure for the year 1900:—

Municipal debt	£4,519,037
Prefecture of police and republican guard	1,446,051
Poor relief	1,269,620
Education	1,213,082
Streets and roads	1,018,717
Public walks, plantation, and lighting	541,277
Central administration	411,680
Collection of municipal customs dues (*octroi*)	463,974
Waterworks and drainage	471,027
Management of public works (salaries and material)	237,654
Architecture and fine arts	135,480

To sum up, the total budget of expenditure amounted to £12,848,870 on account of ordinary expenditure, £89,340 of extraordinary expenditure due to the debt, while £248,000 was applied to the liquidation of expenses incurred in previous years.

The principal items of revenue in 1900 were:—

Municipal customs dues (*octroi*)	£6,651,774
Direct contributions	1,400,528
Income from water and canals	826,339
Markets, market-places, and slaughter-houses	533,310

Gas rates	£625,604
Government subsidy and receipts of the prefecture of police	488,532
Revenues from public vehicles	368,773
Contributory taxes towards paving and cleaning streets	205,118
Revenue for public instruction (legacies, &c.)	183,504
Stands in public places	211,234
Burial and cemetery dues	136,786
Government subsidy towards the paving of the town	176,000
Night-soil and sewage	182,630
Householders' street-cleaning tax (*taxe de balayage*)	138,040

The chief items in the *octroi* in 1897 were :—

Beverages	£2,691,133
Eatables	1,370,944
Oil	684,473
Fuel	567,229

As a result of efforts to reform these taxes, since 1st January 1901 no *octroi* have been levied on wine, beer, and cider (all classed as hygienic drinks), but the duty on alcohol has been increased, and now about 4 francs 30 centimes is paid on each litre of alcohol that enters Paris.

On 1st January 1898 the length of public streets bordered with trees was 162 miles ; unplanted, 445 miles (86,333 trees and 8024 seats). The area unbuilt over covered 4090 acres. On the 1st of January 1898 the stone paving covered 1495 acres, metalled roadways 343 acres, asphalt 94 acres, wood pavement 286 acres, earthen roadways 7 acres. The number of wheeled vehicles of all kinds, carts and carriages, automobiles and bicycles, goes on steadily increasing. Pedestrians would be endangered at the principal cross-roads if policemen were not stationed to interrupt now the one and now the other stream of traffic. Refuges in the centre of the widest public thoroughfares have become more numerous, and facilitate the crossing of pedestrians. The Place de l'Opéra is traversed by 60,000 vehicles, 70,000 horses, and 400,000 foot passengers during certain hours of the day. Through the Rue de Rivoli, on the other hand, 43,000 vehicles and 53,000 horses pass partly by night with consignments for the central markets. Steamers ply on the Seine from Charenton to Auteuil, others in connexion with them running as far up as Ablon and down to Suresnes. Thus more than a hundred boats, accommodating from 225 to 400 persons, convey an increasing number of passengers, 13,080,000 in 1880 ; 21,000,000 in 1890 ; 24,931,879 in 1897. Tramways are more and more replacing the old lines of omnibus (though new 'bus routes still continue to be opened) and mechanical traction of various kinds tends to supersede the use of horses on the tram-lines. In 1894 the General Omnibus Company carried on its different routes (tramway and other) 227,868,392 passengers, other companies carrying 60,384,560. In 1897 the General Omnibus Company carried 256,000,000, and other companies 62,000,000. The General Omnibus Company owned in 1897 16,000 horses, and circulated 1130 vehicles daily, which covered daily a distance equal to two and a half times the circumference of the earth. Railway traffic round Paris has for many years been provided by the Chemin de Fer de Ceinture, which has thirty stations along the length of the rampart or near it. In 1897 there were 27,507,797 travellers between stations other than those from Paris to Auteuil, while for those latter there were 23,711,512 passengers. Very frequent circular trains leave the station of St Lazare, running west, south, east, north, and finally again west to their terminus at Courcelles, from which they return to St Lazare by the reverse route. Another service following the same course leaves the Gare du Nord. Several years ago the line between Paris, Sceaux, and Limours was extended from the Place Denfert-Rochereau, south of the city, to the Place de Medicis, near the Luxembourg. This line will be prolonged inwards from the Place de Medicis to the Place St Michel, there to join the new inner line of the Paris–Orléans Railway, running into the heart of the city. This is continued along the Seine from the Quai d'Austerlitz as far as the Quai d'Orsay, opposite the Tuileries. A new western line, taking a new route from Paris (Meudon) to Versailles (making, with the old lines known as the "right bank" and "left bank" lines, three distinct railways) has its terminus at the Esplanade des Invalides. It is to be placed in connexion with the circular railway from St Lazare. The Champ de Mars is connected with the Gare St Lazare by a line which accompanies at some distance the Ceinture Railway between St Lazare and Passy, traversing the latter quarter through a tunnel which opens opposite the skew bridge above mentioned, crossing by which it reaches Grenelle. Finally it has been decided to provide Paris with a metropolitan railway. The above-mentioned lines (that of the Champ de Mars excepted) are termed *lignes de pénétration*, and serve to facilitate communication between the city and outlying districts. The Metropolitan, on the contrary, is to be purely urban and to serve only the inner traffic of the city. Although its rolling stock will be able to pass over the rails of the main line, which are on the same gauge, the latter will not be able to make use of the Metropolitan lines on account of the decorative structures of the latter being provided with a moulding which does not permit them to do so. The Metropolitan will connect Parisian stations on different lines, but a train coming from Marseilles or Bordeaux will be unable to pass over its rails *en route* for Calais or Havre unless it be composed of Metropolitan carriages. The Metropolitan runs from the Porte de Vincennes to the Arc de Triomphe de l'Étoile, whence it forks towards the Porte Maillot and the Porte Dauphine, both at the entrance to the Bois de Boulogne, and also towards the Trocadero. The working of the Porte de Vincennes–Port Maillot line has so far been very successful. A circular line follows the old outer boulevards (until 1860 the wall of Paris). A third line is to connect Porte Maillot with Ménilmontant on the north of the city, and a fourth to cross the city from north to south from the Porte de Clignancourt to that of Orléans. Short lines are to unite the Boulevard de Strasbourg with the Pont d'Austerlitz and the Cours de Vincennes with the Porte d'Italie. The combined length of all these lines will be 40 miles, 70 per cent. of which will run underground, 16 per cent. over viaducts, and 14 per cent. through cuttings. The cost of construction and the purchase of material is estimated at £6,600,000. The traction is electric.

Traffic: vehicles.

Traffic: railways.

The following table shows the number of passengers arriving at and departing from the various main stations in 1897 :—

Station.	État.	Nord.	Est and Vincennes.	Ouest.	Orléans and Sceaux.	Paris-Lyons-Mediterranean.
Arrivals	99,058	9,966,000	13,894,627	24,088,495	4,475,531	3,754,821
Departures	96,853	10,080,000	14,063,085	24,406,612	4,533,451	3,446,436

In all, then — apart from the Circle Railway — 56,278,532 passengers arrived in Paris, and 56,626,437 left. (Passengers travelling with season tickets or free passes have not been included.) The companies have been obliged to extend their stations. The Gare d'Orléans has, as already noted, been removed to the Quai d'Orsay in the centre of Paris. The Gare St Lazare has been rebuilt and considerably enlarged ; the Gare de Lyon is also undergoing reconstruction. The Gare de l'Est and the Gare Montparnasse are being greatly extended. The terminus of the railway du Nord is being enlarged to accommodate an increased number of lines. The road railways running into Paris must also be mentioned, also one from Paris to St Germain which has its terminus in the Place de l'Étoile, and one from Arpajon, the trains running on which stop by day in the Rue de Medicis, near the Luxembourg, but at night run up to the central markets.

The goods traffic has not increased at the same rate as the passenger traffic. The following table shows in tons the quantity of goods that entered and left Paris in 1897 :—

Station.	État.	Nord.	Est and Vincennes.	Ouest.	Orléans.	Paris-Lyons-Mediterranean.
Entered	57,568	2,052,218	828,602	1,438,244	766,527	1,006,288
Left	28,767	506,759	311,559	694,086	345,465	511,357

Thus, in all, the main lines brought in 6,149,447 tons and carried out 2,397,993 tons. (The figures for the Est et Vincennes and Orléans et Sceaux lines give the tonnage carried by goods train only.)

Water-supply.

A new aqueduct, 62 miles long, carries the waters of the Avre, drawn off near Verneuil, in the department of Eure, to the reservoir at Montretout beyond St Cloud on the left bank of the Seine, 334 feet above sea-level. New supplies acquired by the city in the Loing and Lunain basins are about to be added to those of the Vanne, which come from an adjoining district. The average daily supply from various sources during 1897 was as follows :—

Source.	Dhuis.	Vanne.	Avre.	Ourcq.	Seine.	Marne.	Artesian Wells, &c.
Cubic feet.	741,720	3,724,494	3,781,288	4,753,188	3,499,611	2,717,591	223,681

Thus each inhabitant may consume, on an average, 63 gallons (22 of which are spring water) in twenty-four hours. Actually the daily consumption per head in 1894 was only 45 gallons ; in London it was only 40 gallons. To guard against the dearth which might arise in times of augmented consumption and diminished supply, improved filters have been fitted up for the purpose of purifying the river water. An Anderson filter, which purifies 706,397 cubic feet of water in twenty-four hours, was established in 1896 at St Maur on the Marne. The water is distributed throughout the city by two systems: the low pressure, carrying the river water for use in the streets, courts, and industrial premises; the high pressure, taking the spring water to the various floors of buildings, and supplying pumps, Wallace fountains, and (on 1st January 1898) 6170 fire-plugs. On the same date the total length of pipes was 1493 miles. The water arrives in all cases from two different directions, so that in case of accident the interruptions of the supply may be reduced to a minimum.

Drainage. Great changes have been made in the drainage of Paris owing to the underground operations necessitated by the construction of the Orléans and Metropolitan railways. The chief improvement has consisted in keeping the Seine (except in certain cases of exceptional pressure, such as sudden and violent storms) free from sewage water, which is now utilized on sewage farms. The main sewers converge at Clichy, on the right bank of the Seine, where a powerful elevator forces the sewage partly across the bridge, partly through a tunnel acting as a syphon below the river-level, to the left bank. Thence part of the sewage is distributed over the estate of Gennevilliers, from which it returns purified, after having fertilized the plots, to the Seine. At Colombes a second elevator drives the surplus unused sewage to the hills above Argenteuil (right bank). A third elevator at Pierrelaye distributes another portion on the hills of Méry. The remainder is employed to water the Parc d'Achères (left bank), the irrigation fields of Carrières-sous-Poissy (right bank), and finally those of Mureaux, opposite Meulan. New works are undertaken as the sewage increases and as its value is better realized by the agricultural classes. The rent of an acre of land at Gennevilliers has now risen to nearly £10. Certain parts of Paris lie too low for their drains to run into the main sewers. Special elevators are required to raise the sewage of the districts of Bercy, Javel, and the Cité. The quantity of sewage carried through the drains will be enormously increased when the scheme of drainage by means of sewers, which would clear all the water-closets of all the houses in this manner, is completed. In 1896 only 8800 premises employed this system. Since then the administration has decided to apply it to all the houses of certain streets indicated from year to year, and on 1st January 1898 it was in use in 12,475 dwellings. But owners resist this claim, which presses heavily upon them, because the town is as yet unable to furnish them with the water necessary for the scheme. On 1st January 1898 there were still 58,430 cess-pools, 15,028 movable buckets, and 29,207 tinettes.

Lighting. The consumption of gas in Paris increases but slowly since the extension of the electric lighting system. The annual consumption is from 10,000,000,000 to 11,000,000,000 cubic feet of gas. Six different companies have obtained concessions from the city authorities for the electric lighting of prescribed sections for a period of eighteen years. These concessions do not confer a monopoly, but are simply authorizations. The city has retained the management of the municipal electrical works under the central markets (Halles Centrales). The difficulties introduced into the administration by these arrangements have left Paris far behind many lesser towns in its application of the system of electric lighting.

Public health. The *services d'hygiène* of the city have developed rapidly. The Conseil d'Hygiène et de Salubrité of the department of the Seine, composed of 24 members nominated by the prefect of police and 17 members called to it in virtue of their office, has published since 1895 an account of its bi-monthly meetings. It inquired into and reported upon six hundred cases in 1896. To it are referred such questions as the sources from which to obtain drinking-water for the town, the sanitary measures to be taken during important works, the work connected with the main sewers for the cleaning of the Seine and the utilization of the sewage water, the health of workpeople employed in factories, the sanitary condition of the occupants of schools and prisons, questions relating to the disinfection of infected districts, the heating of public vehicles and dwellings, the conveyance of infected persons, night shelters, &c. Since 1892 the *service des épidémies* has been active, inquiring into the origin of these scourges and seeking to arrest their progress. It is this body that receives the compulsory declarations of doctors on the subject of contagious affections under their treatment. Special vehicles are now set apart for the conveyance of persons suffering from contagious diseases, whereas formerly public vehicles which had carried such persons were afterwards used, without undergoing disinfection, to convey healthy persons. Special municipal hot chambers disinfect all personal belongings believed to be infected, while houses are attended to by special disinfectors. A laboratory has been fitted up for the diagnosing of certain complaints (diphtheria and typhoid fever, for example) which cannot be identified without scientific tests. A central sanitary association has been formed and has commenced the registration of every house, entering against the name of each all information as to its sanitary condition. This association will be the chief auxiliary of the commission, long established, on insanitary dwellings, which issues orders for landlords to execute, voluntarily or under compulsion, any repairs or alterations which it deems necessary.

Education. The old *salles d'asile* are now called *écoles maternelles.* In 1897 there were 153 such schools belonging to the municipality, with 53,888 scholars; 23 *laïques privées* (that is, voluntary schools taught by lay mistresses) with 1284 scholars; and 41 *congréganistes* (that is, voluntary schools taught by *religieuses*) with 8162 scholars. The children are divided into three classes according to age, from 2 years to 3½, from 3½ years to 5, from 5 years to 7. Seventeen *écoles enfantines*, exclusively managed, as are the *écoles maternelles*, by women teachers, serve as a link between the latter schools and the *écoles primaires*, of which there are 392 public with 156,070 scholars, 562 *laïques privées* with 29,347 scholars, and 230 *congréganistes* with 56,276 scholars. Every year the city continues to open fresh groups of schools either to replace or complete old ones, and to the six upper *écoles primaires* for boys (Chaptal, Turgot, Lavoisier, Colbert, J. B. Say, Arago) have been added two for girls (Sophie Germain founded in 1882, Edgard Quinet in 1892). The capital invested in the building of the 153 public *écoles maternelles* and the 392 public *écoles primaires* must be close on £9,000,000. The *cantines scolaires* annually disburse £28,000 in providing the children with hot dinners. The *caisses des écoles* give assistance to indigent children; the *classes de garde* retain some children beyond ordinary school hours, and the *classes de vacances* beyond the duration of the ordinary scholastic course. For several years a certain number of children have been sent to spend a few days at school colonies or in travelling, but notwithstanding the progress in the secularization of municipal schools, there are in every parish free *écoles primaires* conducted by religious societies. Of these 57 are conducted by Christian Brothers, 76 by nuns. The *écoles professionnelles*—Diderot, Germain Pilon, Bernard Palissy—train apprentices in the application of the fine arts to industries; the École Boulle trains cabinet-makers, and the École Estienne trains in all processes connected with the production of a book. The Municipal School of Physics and Chemistry imparts both theoretical and (specially) practical knowledge of these sciences. Six *écoles ménagères* train girls in the duties and employments of their sex. The number of State *lycées* giving secondary education has been increased. Louis le Grand has been divided into two distinct establishments—Louis le Grand and Montaigne, the former including the higher classes, the second the lower classes, corresponding to the *grand* and *petit* Condorcet. St Louis specially prepares for the great scientific schools. Henri IV., Charlemagne, Janson de Sailly, Buffon, Voltaire, Carnot (formerly the *école Monge*), Lakanal (at Sceaux), and Michelet (at Vanves) share with Stanilas (under church management) and the municipal Collège Rollin, the education of students in classics and modern subjects, the latter especially in reference to commerce and its practical application. In all these establishments the number of day pupils is increasing, that of boarders decreasing. There are now five *lycées* in which girls can receive secondary education: Fénélon, Racine, Molière, Lamartine, and Victor Hugo. The five faculties of medicine, law, science, literature, and Protestant theology, and the higher school of pharmacy form the body of faculties, the association of which has taken the name of the University of Paris. This university has acquired corporate rights which allow of its receiving gifts. At the Sorbonne (seat of the university) there is also established the École des Chartes. The faculty of Roman Catholic theology no longer depends upon the State. This course is given at the independent Roman Catholic University, which includes also faculties of science, literature, and law. But no university except that of the State can confer a degree. The city of Paris, besides founding special chairs at the Sorbonne, has opened special courses at the Hôtel de Ville. The Agricultural Institute, now installed in a separate building from that of the Conservatoire des Arts et Métiers, has developed greatly. The Pasteur Institute not only treats patients threatened with hydrophobia and prepares serums which successfully combat certain diseases, but gives a course of biological chemistry in connexion with the faculty of science. The École du Louvre imparts such practical instruction as can be drawn from collections and museums. The École Coloniale prepares colonial officials, teaches natives from French colonies, and trains pupils for colonial life.

Churches. Paris has 70 Roman Catholic churches, without reckoning the chapels attached to the Invalides and the Sorbonne or those of the religious orders, which have services mostly open to the public. The Reformed or Calvinist Church has 17 places of worship, and the Lutherans or Confession of Augsburg, the adherents of which are mainly Alsatians, have 10. The Jews have 4 synagogues. The priests, pastors, and rabbis of these four bodies receive stipends from the State. The Protestant Free Church, a secession from the Reformed Church, has 4 congregations; and French Protestantism also comprises 1 Swedenborgian, 2 Methodist, and 3 Baptist communities. The English-speaking colonies have 3 Anglican churches, 1 Scottish, 1 Wesleyan, 1 Independent, 2 American Episcopal, 1 American

Presbyterian, and 1 Roman Catholic. The other foreign colonies have a United Greek, a Russian, an Armenian, a Spanish, a German Lutheran, and a Swedish Protestant church. The mission founded in 1872 by the late Dr R. W. McAll, chiefly supported by American and British subscriptions, has 17 stations, and the Salvation Army 8. No religious census has been taken in France since 1872.

Galleries and museums. The old Salle des États at the Louvre has received a Rubens collection, which was opened at the same time as fourteen rooms containing pictures of the Dutch school. This necessitated a general rearrangement of the Louvre, and the artistic collections of the town of Paris have been installed in the small palace of the Champs Élysées. The Musée Historique de l'Armée has been set up at the Invalides; the museum of the town of Paris, called the Musée Carnavalet, has been completely remodelled, and the town library established at the Hôtel Le Pelletier St Fargeau, Rue de Sévigné. The Musée des Arts Décoratifs still awaits its installation in the pavillon de Marsan, in the Tuileries. The Musée Guimet, near the Trocadero, contains a collection of objects illustrative of the religions of the Far East. The Musée Cernuschi, bequeathed to the town, consists chiefly of Japanese and Chinese collections; the Grandidier collection at the Louvre includes Chinese and Oriental articles. The Musée Galliéra contains very fine tapestry belonging to the town of Paris.

Charity. The sum dispensed in public charity in 1896 amounted to £1,473,345, about two-thirds of which was appropriated by the medical department, the remaining third to outdoor relief. In that year 511,880 persons in Paris received public charity. The hospitals provided 26,294 beds, and 110,000 patients were treated in their own homes; 48,000 paupers and 73,000 indigent persons received assistance, the number of charity children being 48,000. The cost of public charity has considerably increased, having risen from £1,000,000 to £1,500,000 since 1880 without a proportionate increase in the population during that period. The sum of £360,000 is devoted to the maintenance of charity children or those deserted by their parents. Several new societies have devoted themselves to the protection of abandoned children, to the suppression of begging, to finding work for the unemployed, and to the reformation of prisoners. The Society for the Protection of Deserted and Criminal Children has assisted thousands of children. Other associations attend to the treatment of consumptives and sick children.

Hospitals. Several new hospitals have been built. Amongst them may be named the Bichat, for important surgical operations; Hérold, Broussais, chiefly for epidemic cases; and Boucicaut, founded by the liberality of the founder of the Bon Marché establishment. On the other hand, the military hospital of Gros Caillou has been demolished to make way for a new quarter.

Pawnbroking. The Mont de Piété, which formerly lent only upon the pledging of portable property, has for several years made loans to the bearer of certain financial securities quoted on the Bourse. There is now no limit fixed to the magnitude of transactions on the former security, but on the latter not more than £20 can be lent. The number of loans continues to decline. In 1897, 1,155,564 securities to the value of £1,315,215 were pledged, 1,026,271 to the value of £1,208,553 were cleared, 729,205 to the value of £916,678 were renewed, and 129,442 to the value of £88,563 were sold.

Banks. The amount of the deposits at the Caisse d'Épargne, or savings bank, of Paris continuing to increase (in 1895 it reached the sum of £6,400,000), the rate of interest on deposits has been reduced from 3 per cent. to $2\frac{3}{4}$ per cent., and the maximum deposit permitted to each depositor has been reduced from £80 to £60. Beyond this sum the surplus is employed in the purchase of *rentes* (stock) on behalf of the depositor. The deposits were thus reduced to £6,098,386 at the end of 1896, and to £5,906,377 at the end of 1897. The National Savings Bank, which transacts its operations at the various State post offices, in 1895 had 2,280,000 depositors and £28,000,000 in deposits. One quarter of its transactions took place within Paris. In the same proportion Paris was concerned in the business done by the National Office for Old Age Pensions, which in 1894 paid out £1,328,673 to 196,987 annuitants. The interest paid when the association was founded in 1852 was 5 per cent.; since 1894 it has fallen to $3\frac{1}{2}$ per cent. The privilege of issuing bank notes enjoyed by the Bank of France has been extended from 1897 to 1920. The maximum issue has been fixed at 5,000,000,000 francs, or £200,000,000. The bank can now discount the stock of the agricultural syndicates, and has a branch in the capital of each department and in numerous other commercial centres, in addition to sub-offices which yearly increase in number; all its officials must be French. The circulation of bank notes in 1897 amounted in value to £151,361,227. (See also the article BANKING.)

Justice. The Court of Appeal now consists of seven civil chambers, besides one for preliminary proceedings and one for appeal from the correctional police. The prisons of Mazas, Ste Pélagie, and La Grande Roquette have been closed, demolished, and replaced by the new prison of Fresnes-les-Rungis. This establishment covers 50 acres. The prisoners, kept in solitary confinement, are divided into three groups: those undergoing short sentences, those sentenced to hard labour while awaiting transference to their final place of detention or to sentences over a year, and sick prisoners occupying the central infirmary of the prison. The Petite Roquette (occupied by children) is also to be demolished, and to be replaced by the agricultural and horticultural colony of Montesson. Paris is to retain only the Conciergerie and depot of the Prefecture of Police, both within the walls of the Palais de Justice, and the prison of La Santé, which will receive prisoners awaiting trial and political prisoners.

Cremation. The only crematorium in France has been built at Père la Chaise, for the cremation of those who have expressed a desire for it and for the destruction of human remains from the dissecting rooms.

Fire. The fire brigade (*sapeurs-pompiers*) is a regiment of the army, consisting of 2 battalions and 12 companies, the War Office sharing the control of it with the Prefect of Police and the Minister of the Interior. It consists of 52 officers, 185 non-commissioned officers, 291 corporals, and 1225 privates. It is composed of volunteer conscripts who have been brought up to the building trades. They have a dark blue uniform, with a gilt helmet. Like soldiers in the regular army, they serve three years, but may re-enlist for seven years. They have nightly duties at the theatres, and may be engaged for private entertainments. There are 24 stations, each provided with 4 engines, 2 vans, a fire-escape, and a steam pump. There are 184 horses, the property of a contractor. There are 6928 fire-plugs, placed at intervals of 100 metres, and the pressure at most of these is sufficient to dispense with pumps; but formerly, when the water supply was less perfect, by-standers had to be impressed to pass the buckets from hand to hand. There were in 1901, besides 1544 chimney fires and 436 false alarms, 1422 calls, but only 23 of these were serious fires. The aggregate damage was 5,927,000 francs, but in the previous year the burning down of the Comédie Française had raised the total to 10,346,000 francs. The cost of the force in 1901 was 2,729,000 francs, besides 892,000 francs supplementary expense for plant, repairs, and rebuilding. The charge falls on the Paris municipality. In recognition of the unquestionable efficiency and courage of the force, President Loubet, at the Longchamps review of the 14th July 1902, affixed to its flag the cross of the Legion of Honour.

Markets. The 2,511,955 inhabitants of the city consumed in 1896, 352,021 tons 8 cwt. of bread; 123,362,426 gallons of wine and spirits; 171,043 tons 9 cwt. of meat; 26,737 tons 14 cwt. of fish; 27,724 tons 4 cwt. of poultry and game; 491,799,240 eggs; 20,199 tons of butter; 8572 tons 8 cwt. of oysters; 667 tons 8 cwt. of cheese; 1207 tons 15 cwt. of early fruits and vegetables (only the fish and early produce arriving at the central markets are reckoned; those arriving elsewhere escape computation). The Marché de la Villette continues to be the great centre for the supply of cattle, and its abattoir is still the principal one in the city. But on the left bank of the Seine the abattoirs of Grenelle, Villejuif, and les Fourneaux have been replaced by that of Morillons, which occupies an area of 25 acres near the station of the Brittany Railway. The corn trade is still carried on at the old corn-market (*halle aux blés*) transformed into the *bourse du commerce*, flour dealers meeting in the district between the Louvre and St Germain l'auxerrois. For several years manual labour has been the subject of supply and demand at the Labour Exchange (*bourse du travail*).

Shipping. The following are the general results of the navigation statistics of the Seine for 1898: entrances, 5,202,700 tons; traffic clearances, 1,689,000 tons; transit, 1,397,800 tons; local, 641,300; total, 8,930,800 tons. Detailed results for 1897 are given in the following table:—

Entrances.		Clearances.		Transit.		Total Movement.
Lower Seine.	Upper Seine.	Towards the Lower Seine.	Towards the Upper Seine.	Towards the Lower Seine.	Towards the Upper Seine.	
Tons. 1,066,026	Tons. 1,735,149	Tons. 612,120	Tons. 713,171	Tons. 957,118	Tons. 987,608	Tons. 6,071,192

Navigation of the Canals in 1897.

Ourcq Canal.		St Denis Canal.		St Martin's Canal.		Total for the three Canals.
Up.	Down.	Up.	Down.	Up.	Down.	
Tons. 97,685	Tons. 525,148	Tons. 1,400,497	Tons. 399,171	Tons. 763,537	Tons. 351,447	Tons. 3,537,485

The *postal department* of Paris was served in 1897 by 98 offices (exclusive of the great central office), 96 of which were telegraph offices; there were also 48 auxiliary offices managed by shopkeepers, &c. These sub-offices continue to increase in number, as also do the letter-boxes, of which there are no less than 2000. The circulation of letters for specified years is shown by the following tables:—

Post office, &c.

Year.	Prepaid Letters.	Unpaid Letters.
1886	49,193,000	478,000
1890	57,930,000	473,000
1895	67,011,000	467,918
1897	67,352,348	460,075

There were also despatched from Paris in 1897, 15,264,000 post-cards, price 10 centimes; 3,127,400 letter-cards, price 15 centimes; 53,110 cards, reply prepaid, price 20 centimes; 19,580 foreign letter-cards, price 25 centimes; 502,055 registered letters for Paris, 4,492,315 registered letters for France, 770,472 registered foreign letters, 862,424 registered packets for France, 410,160 registered foreign packets; 85,299 letters containing money orders for Paris, 1,059,700 letters containing money orders for France, and 260,027 for abroad; 31,556 boxes containing money orders for Paris, and 408,002 for France.

Year.	French Money Orders.		International Money Orders.		Amounts re-covered.	Un-recovered.
	Issued.	Paid.	Issued.	Paid.		
1887	£3,388,000	£5,424,000	£452,000	£680,000	£212,000	£148,000
1894	4,024,000	6,688,000	428,000	728,000	476,000	272,000
1897	4,174,040	6,794,510	461,090	817,510	306,523	154,683

The following table shows the number of newspapers sent by post in specified years to addresses (*a*) in the department of the Seine, (*b*) in other departments or abroad:—

	Political and Periodical Journals.		Non-political Periodicals.	
Year.	Department of the Seine.	Other Depts. or Foreign Countries.	Department of the Seine.	Other Depts. or Foreign Countries.
1887	18,000,000	104,000,000	17,000,000	40,000,000
1890	20,000,000	112,000,000	18,000,000	48,000,000
1895	22,216,000	119,000,000	22,300,000	52,913,815
1897	22,774,812	120,992,934	22,974,945	53,475,201

In the *parcel post* department 4,508,277 packages were received in Paris from places in France, 735,783 from abroad; 16,232,742 were despatched from Paris into the provinces, 1,834,314 abroad. The receipts of the Paris post office amounted in 1887 to £2,320,000, in 1894 to £2,600,000. The *personnel* of the service on the 31st December 1896 consisted of 211 higher officials, 1696 clerks, 271 women assistants, 2972 letter-carriers. It employed 300 horses, 120 drivers, 35 two-horse vans, 53 one-horse vans, 59 tilburys, 37 factors' omnibuses. Cyclists carry special collections to the railway stations. Automobiles have been employed in collecting the contents of letter-boxes.

In connexion with the *telegraph* service of Paris there are 104 offices. The telegraphic circulation is tabulated thus (numbers in thousands):—

Year.	Despatched to			Received from		
	Paris.	The Provinces.	Abroad.	Paris.	The Provinces.	Abroad.
1886	3168	3394	1244	3168	3337	959
1890	4058	7551	1487	4058	7722	1170
1895	4490	8563	1591	4490	8817	1250
1897	4692	8967	1374	4692	9035	1063

To this number must be added the telegrams passing through Paris, which in 1886 numbered 16,798,000; in 1897, 25,402,000. A large number of the messages sent in Paris for delivery within the city are forwarded through pneumatic tubes. In 1886 the number so despatched was 3,095,997; in 1897, 4,410,400. The staff consisted on the 31st December 1896 of 24 higher officials, 1220 clerks, and 839 women assistants.

The *telephone* service, like the postal and telegraph services monopolized by the State, consists of a central office communicating with eleven divisional offices, to which subscribers in various districts come for connexion. The public can make use of telephone boxes in the post, telegraph, and telephone offices, and in certain railway stations. The time allowed for conversation is usually fixed at five minutes. The rate of charge varies according as the communication is exchanged with Paris or beyond, and the distance from the inner office. Telephonic messages can be conveyed, if desired, from the receiving office to specified addresses. Conversations are most frequent between Paris and, among foreign towns, Brussels, London, and Geneva. In France, Rouen, Havre, Lille, Lyons, Marseilles, and Reims are the towns that most frequently communicate with the capital. On the 31st December 1896 the telephone staff comprised four higher officials, 230 clerks, 1401 women assistants, 148 under-officials. The network of telephones increases continuously, and about 2500 new subscribers are added every year.

Exhibitions, &c.

The International Exhibitions which may be said to follow one another periodically in Paris (1855, 1867, 1878, 1889, 1900) offer a means of reviewing the progress made during the intervals between them in the various branches of art and industry, especially as each Exhibition carries out a programme vaster than that of its predecessor. Thus, whilst the 1855 Exhibition concerned itself only with contemporary art and industry, that of 1867 told the story of their development. In 1878 the Rue des Nations reproduced in Paris a monument of every foreign country with its local colour. In 1889 the Rue du Caire enabled one to live for a time in that celebrated capital. But these, after all, were but temporary shows, designed for the entertainment of crowds. The progress of greatest importance demonstrated in 1889 was that made in the art of construction in iron, as illustrated by two notable examples—the Eiffel Tower, the most gigantic tower of the whole world, 990 feet high, and the Gallery of Machinery, with its boldly designed girders (remarkable for their immense span). Glass buildings are features of the time; and in place of the flat and uniform *façades* which border the boulevards opened during the Second Empire, contemporary architects build carved and sculptured *façades*, with ledges and projections. And notwithstanding the heavy cost of the disasters of 1870, several important public buildings have been erected since—the Opéra, the Tuileries, the new Sorbonne, the schools of medicine and law, the general post office, central telephone office, the galleries of the natural history museum, the Opéra Comique, amongst others. Several *lycées* and hospitals and numerous schools have been either built or enlarged; the railway stations are magnificent structures; among bank buildings those of the Crédit Lyonnais may be quoted as models of their kind, and several handsome new museums have been opened, mainly by private individuals who see in such foundations the best means of safeguarding the future of their collections. Dwelling-houses, too, are much more intelligently arranged than those of older date, and are fitted with all the latest improvements devised by science for the comfort of man. (G. Ms.)

Parisian Events since 1875.—After the adoption of the Constitution of 1875, the first important political event in Paris was the dissolution of the Chamber of Deputies, pronounced by the Senate on 19th June 1877, at the request of Marshal MacMahon, then President of the Republic. The elections that followed this act gave a large majority to the Republicans. The Universal Exhibition of 1878, destined to show Europe that France had recovered her material prosperity and moral power, attracted a large concourse, but the different sovereigns abstained. The number of admissions was about 13,000,000. A grand fête, full of gaiety and enthusiasm, was held on 30th June. This was the first public rejoicing since the war. Marshal MacMahon resigned the Presidency in 1879, and was succeeded by M. Jules Grévy. The terrible winter of 1879–80 was the severest of the century; the Seine, entirely frozen, resembled a sea of ice. The 14th of July, the anniversary of the taking of the Bastille, was adopted as the French national holiday, and celebrated for the first time in 1880. A grand military review was held in the Bois de Boulogne, at which President Grévy distributed flags to all the regiments of the army. On 17th March 1881 a national loan of a thousand million francs was issued for the purpose of executing important public works. This loan was covered fifteen times, Paris alone subscribing for ten thousand millions. At the time of the legislative elections, on 21st August and 4th September 1881, several tumults occurred in the Belleville district. Gambetta, who was a candidate in the two wards of that district, vainly tried to address the electors.

The great orator died in the following year, on the 31st of December, from the effects of an accident, and his funeral, celebrated in Paris at the expense of the State, was attended by an immense gathering. A slight Legitimist agitation followed Gambetta's death. An unfortunate event occurred on 29th September 1883, the day when the king of Spain, Alphonso XII., returned from his visit to Berlin, where he had reviewed the 15th regiment of Prussian Uhlans, of which he was the honorary colonel. The cries of "Down with the Uhlan!" with which he was greeted by the Paris crowd, gave rise to serious diplomatic incidents. On 26th May 1885 the following decree was rendered: "The Pantheon is restored to its primitive and legal destination. The remains of the great men who have merited national recognition will be disposed therein." But it was only on 4th August 1899 that the ashes of Lazare Carnot, Hoche, Marceau, Latour d'Auvergne, and Baudin were solemnly transported to the Pantheon. Victor Hugo's funeral was celebrated on 1st June 1885, and by an urgency vote they were made national obsequies. It was decided that the corpse should be exposed one day and one night under the Arc de Triomphe, veiled with an immense crape. A few days before, upon the occasion of the anniversary of the fall of the Commune, a tumultuous political manifestation had been made in front of the tomb of the Communists buried in Père Lachaise cemetery.

M. Jules Grévy was re-elected President of the French Republic in 1885. The following year the Monarchists renewed their political demonstrations; the most important one was the reception given by the Count of Paris at the Galliera mansion on the occasion of the marriage of his daughter with the King of Portugal. The Count of Paris had invited to this reception all the foreign ambassadors, and some disturbance having taken place, the Chamber of Deputies, on 11th June 1886, voted a law interdicting sojourn upon French territory to the Orleanist and Bonapartist pretenders to the throne of France, and also to their direct heirs. At that epoch Paris was in a state of agitation and discontent, and various catastrophes occurred. First of all came the disastrous bankruptcy of a large financial concern called the Union Générale; then the scandal concerning the traffic in decorations, in which M. Wilson, son-in-law of M. Jules Grévy, was compromised, and which eventually led to the resignation of the President; finally, the deplorable Panama affair profoundly enervated the Parisians, and made them feel the necessity of shouting for a military master, some adventurer who would promise them a revenge. All this led to Boulangism. It was by wild acclamations and frantic shouts that General Boulanger was greeted, first at the review of the army on the 14th of July, then two days later at the opening of the Military Club, afterwards at the Winter Circus, where the Patriots' League held a mass meeting under the presidency of Paul Déroulède, and finally, on 8th July, at an immense demonstration at the Lyons railway station, when "le brav' Général" left Paris to take command of the 13th army corps at Clermont Ferrand. Popular refrains were sung in the streets in the midst of immense excitement on 27th January 1889 at the time of the election of General Boulanger as deputy for the Seine department. A majority of 80,000 votes had invested him with an immense moral authority, and he appeared as though elected as the candidate of the entire country; but he lacked the necessary audacity to complete his triumph, and the Government having decided to prosecute him for conspiracy against the security of the State, before the Senate acting as a High Court of Justice, he fled with his accomplices, Rochefort and Dillon. All three were condemned by default, on 14th August, to imprisonment in a fortified enclosure.

Other events had also troubled this astonishing interlude of Boulangism. On 23rd February 1887 a terrible fire destroyed the Opéra Comique during a performance, and a great many of the audience perished in the flames. The first performance of *Lohengrin*, which took place at the Eden Theatre on 1st May 1887, was also the cause of street rioting. In 1888 there were several strikes. That of the day labourers, which lasted more than a month, occasioned violent scenes, owing to the sudden death of Émile Eudes, a Communist, while he was speaking in favour of the strike at a public meeting. On 2nd December there were manifestations in memory of Baudin, a representative of the people, killed upon the barricades in 1851 while fighting in the defence of the Republic. But a calm finally came, and then the Parisians thought only of celebrating the centenary of the Revolution of 1789 by a universal exhibition. This Exhibition contained a profusion of marvels such as had never before been seen, and indicated what enormous industrial progress had been accomplished. Sadi Carnot, who had succeeded M. Jules Grévy as President of the Republic on 3rd December 1887, officially opened the Exhibition on 6th May 1889. Numerous fêtes were held in the grounds while the exhibition lasted. The Eiffel Tower and the illuminated fountains enraptured the crowd of visitors, while the Rue du Caire, with its Egyptian donkey-drivers, obtained a prodigious success. Most of the nations were represented at this Exhibition. Germany alone confined her co-operation to the display of some paintings. The Shah of Persia, in honour of whom splendid fêtes were organized, and the King of Greece, the Prince of Wales, the Lord Mayor of London, several Russian grand dukes, Annamite, Tunisian, Moorish, Egyptian, and African princes, successively visited the Exhibition. There were 30,000,000 visitors. On the 18th of August a banquet was offered in the Palais de l'Industrie by the Paris Municipal Council to all the mayors in France, and 15,000 of these officials were present.

In 1890 the duke of Orleans, having attained his majority, came to Paris to draw for military service with the young conscripts of his class. He was arrested, and placed, first in the Conciergerie, and later in the prison at Clairvaux, but was released after a few months' incarceration. The following years were remarkable for more strikes and several demonstrations by the students, which led in 1893 to conflicts with the police, in one of which a student was killed. On the 17th of October an enthusiastic welcome was extended to Admiral Avellan and the Russian sailors upon their arrival in Paris. It was about this time that dynamite began to be used by the Anarchists. After Ravachol, who commenced the sinister exploits of the "propaganda by acts," it was Vaillant that threw a bomb into the "Temple of the Laws" on 9th December 1893, and wounded forty-six deputies. Then there was a succession of these attacks during the two following months, for Ravachol and Vaillant had found emulators. Henry scattered fright and death among the peaceable customers of a brasserie, while bombs were thrown into the doorways and staircases of houses inhabited by wealthy people. Upon the steps of the Madeleine Church, Parvels, who was already the author of two dynamite plots, was struck down by the destructive machine that he was about to throw into the body of the church. Laurent Tailhade himself, who had celebrated with his pen the beauty of Vaillant's gesture, was subsequently wounded by dynamite thrown into the Café Foy, where he was lunching. Finally came the attack on President Carnot, who, on 24th June 1894, fell at Lyons under the blow of the Italian anarchist Caserio's dagger. His funeral was celebrated at Paris on 1st July. M. Casimir-Perier, elected President of the Republic on the preceding day, followed the procession on foot. He resigned office on 15th January 1895, and on the 17th M. Félix Faure was chosen as his successor.

The visit of the Emperor and Empress of Russia, on the 5th, 6th, and 7th of October 1896, was celebrated by incomparable fêtes. The Rue de la Paix was decorated with ropes and sails, stretched across the street like the rigging of a vast vessel, in honour of the Russian sailors. Nothing could be seen anywhere except flags, cockades, and badges formed of the colours of the two friendly nations. In the evening there were open-air balls, with farandoles and orchestras at all the street corners. Popular enthusiasm was again manifested on 31st August, when President Faure returned from his visit to the Russian court. On 4th May 1897 the terrible conflagration at the Charity Bazaar in the Rue Jean Goujon threw into mourning one hundred and forty families of the nobility or the aristocracy of Paris, and spread sorrow among the class always considerate in its benevolence. Then all minds were again troubled and disturbances occurred in the streets for more than two years over the Dreyfus case, dividing the French people into two camps. Certain newspapers kept up the agitation, which was the cause of numerous prosecutions.

Félix Faure died suddenly on the 18th of February 1899. The very day of his funeral, Paul Déroulède and Marcel Habert tried to make a *coup d'état* by urging General Roget to lead his troops, which had formed part of the guard of honour at the obsequies, against the Élysée. Immediately arrested and put on trial, Déroulède and Habert were acquitted by a timorous jury.

M. Émile Loubet, President of the Senate, was chosen as successor to M. Félix Faure. Upon his return to Paris from the Versailles Congress, where he had been elected President of the French Republic, he was greeted by hisses and cries of "Panama!" cries in no wise justifiable. Some time afterwards, Jules Guérin, by a desperate resistance against a summons of the police to give himself up, made the public believe for two months in the existence of an impregnable fortress in the Rue Chabrol, in the very centre of Paris. On the 4th of June there was a great scandal at the Auteuil Races, which President Loubet had been, according to custom, invited to attend. He was insulted and struck by Baron de Christiani, who was encouraged by the young royalists of the "Œillets Blancs" Association. A week later, the extraordinary and excessive police measures taken to prevent a disturbance at the Grand Prix occasioned the downfall of the Dupuy ministry. M. Waldeck-Rousseau then formed a cabinet, himself becoming President of the Council. The new premier immediately took energetic measures against the enemies of the Republic. Compromising documents found in various domiciliary searches made among the Monarchists and Nationalists formed the basis of prosecutions before the High Court of Justice. The trial resulted in the condemnation of Jules Guérin to a term of imprisonment, and the banishment of Paul Déroulède, Marcel Habert, André Buffet, and the Marquis de Lur Saluces, thereby ridding France of all these promoters of disorder, and opening a new era of peace, which lasted throughout the Universal Exhibition of 1900. This Exhibition covered an enormous space, including the slope of the Trocadéro, the Champ de Mars, the Esplanade of the Invalides, and both sides of the Seine bordered by the Rue de Paris and the Rue des Nations. Seen from the new Alexandre III. bridge, the spectacle was as fairy-like as a stage setting. Close beside, at the left, were the palaces of the different nations, each one showing its characteristic architecture, and all being of an astonishing diversity. To the right were the pavilion of the city of Paris and the enormous greenhouses, and in the distance Old Paris, so picturesquely constructed by Robida. In short, exotic edifices and scintillating cupolas arose with unparalleled profusion, creating in the heart of Paris a veritable city of dreams and illusion. The most distant countries sent their art treasures or the marvels of their industry. The number of visitors was 51,000,000, and the personages of mark included the Shah of Persia, the King of Sweden, the King of the Belgians, and the King of Greece, all of whom were successively the guests of France. On the 22nd of September 22,000 mayors accepted the invitation to the banquet offered in their honour by President Loubet, and thus solemnly affirmed their Republican faith. This admirably organized banquet was spread in the Tuileries Gardens. The Exhibition of 1900, a brilliant epilogue of the closing century, was a grand manifestation of universal concord, of the union of peoples by art, science, industry, all branches of human genius. (DE B.)

Paris, a city of Texas, U.S.A., capital of Lamar county. It is in the north-eastern part of the state, on the Gulf, Colorado, and Santa Fé, the St Louis and San Francisco, the Texas and Pacific, and the Texas Midland railways, at an altitude of 563 feet. It is in a grain and cotton region, for which it is a collecting and distributing point, and has a large trade and some manufactures. Population (1880), 3980; (1890), 8254; (1900), 9358, of whom 182 were foreign-born and 3061 negroes.

Paris, Louis Philippe Albert d'Orléans, COMTE DE (1838–1894), son of the Duc d'Orléans, the eldest son of King Louis Philippe, was born on 24th August 1838. His mother was the Princess Helen of Mecklenburg-Schwerin, a Protestant. By the death of his father through a carriage accident in 1842, the count, who was then only four years of age, became heir-apparent to the French throne. On the deposition of Louis Philippe in 1848, the Duchess of Orléans struggled to secure the succession to her son, and bore him through an excited populace to the Chamber of Deputies. The Chamber itself was soon invaded, however, and the Republic proclaimed. The Orleanists were driven into exile, and the duchess proceeded with her two sons, the Comte de Paris and the Duc de Chartres, first to Eisenach in Saxony, and then to Claremont in Surrey. At the latter place the count's education was conducted by his mother. He was reared in the Roman Catholic faith, and received his first communion at the hands of Cardinal Wiseman in 1850. After his mother's death in 1858, the count made a long foreign tour. In 1861 he and his brother accompanied their uncle, the Prince de Joinville, to the United States. During the campaign on the Potomac the brothers were attached to the staff of General McClellan. In April 1862 the count took part in the siege of Yorktown, and was present at the battle of Williamsburg on 5th May. He was also with McClellan at the battle of Fair Oaks, and was personally engaged in the sanguinary encounter at Gaines Mill on the 27th of June. When difficulties arose between France and the United States with regard to the affairs of Mexico, the Orléans princes withdrew from the American army and returned to Europe, paying a visit to President Lincoln before embarking. During the winter of 1862–63 the count took a special interest in the organization of the Lancashire Cotton Famine Fund, and contributed an article to the *Revue des Deux Mondes* entitled "Christmas Week in Lancashire." On 30th May 1864 he married his cousin, the Princess

Marie Isabelle, daughter of the Duc de Montpensier, and his son and heir, the Duc d'Orléans, was born at York House, Twickenham, in 1869. The count was refused permission to serve in the Franco-Prussian war, but after the fall of Napoleon III. he returned to France. Abstaining from putting himself forward, he lived quietly on his estates, which had been restored to him by a vote of the Assembly. He gave considerable study to social questions, and the relations between capital and labour, and published a valuable little work on trades unions. In August 1873 there was an important political conference at Frohsdorf, the result of which was that a fusion was effected, by which the Comte de Paris agreed to waive his claims to the throne in favour of those of the Comte de Chambord. By the death of the latter in 1883 the count became undisputed head of the House of Bourbon; but the old Legitimists did not hail him with much enthusiasm, nor did the count show any disposition to push his claims. The popularity of the Orleans family, however, was shown on the occasion of the marriage of the Comte de Paris's eldest daughter with the Duke of Braganza, son of the King of Portugal, in May 1886. This so alarmed the French Government that it led to a new law of expulsion, by which direct claimants to the French throne and their heirs were banished from France. The Comte de Paris again retired to England, taking up his abode at Sheen House, near Richmond Park. Here he devoted his leisure to his favourite studies. In addition to his work *Les Associations Ouvrières en Angleterre*, which was published in 1869 and translated into English, the count edited the letters of his father, and published at intervals in eight volumes his *Histoire de la Guerre Civile en Amérique.* In his later years the count seriously compromised the prospects of the Royalist party by the relations into which he entered with General Boulanger. He died 8th September 1894.

Parker, Joseph (1830–——), English Congregational minister, was born at Hexham-on-Tyne, 9th April 1830, his father being a stone-cutter. In 1852 he attended classes at University College, London. Ordained (1853) to the career of a Congregational pastor, he was called to Banbury, where he worked from 1853 to 1858, and then to Manchester, where in 1868 he published *Ecce Deus* (a reply to *Ecce Homo*); but in 1869 he came to London, and became minister of the Poultney Chapel in Holborn, in substitution for which afterwards the great City Temple was built in 1874, by his exertions, at a cost of £70,000. He became famous as a vigorous, stirring, and original preacher on conservative theological lines. In 1880 he visited the United States, where he was compared with Henry Ward Beecher, who had just died; and Parker was expected at the moment to take his place, but he returned to England with the degree of D.D. from Chicago University. In 1889 he issued *The People's Prayer-book*, and in 1885 began the publication of *The People's Bible* (in 25 vols.), a series of discourses which came out at intervals up to 1895. Among his other works may be mentioned *City Temple Sermons* (1869–70), *The Inner Life of Christ* (1881), *Apostolic Life* (1884), *My Life and Teaching* (1889), *A Preacher's Life* (1899), and some autobiographical sketches of ministerial life, *Springdale Abbey* (1869) and *Tyne Chylde* (1883). Dr Parker shared for many years with Mr Spurgeon the reputation of being the most impressive Dissenting preacher in England. He became chairman of the London Congregational Board and of the Congregational Union. He married twice, first in 1851, and secondly in 1864, and the death of his second wife in 1898 deprived him of a devoted helper.

Parkersburg, a city of West Virginia, U.S.A., capital of Wood county, on the west bank of the Ohio river, at the mouth of the Little Kanawha river, in the western part of the state, at an altitude of 616 feet. Next to Wheeling it is the largest city in West Virginia. It has four railways, the Baltimore and Ohio, the Baltimore and Ohio South-Western, the Little Kanawha, and the Ohio River. It has a large trade, both by rail and river. It is in a coal, oil, and natural gas region, and contains the shops of the Ohio River Railway, oil refineries, iron-works, lumber-mills, &c. Population (1890), 8408; (1900), 11,703, of whom 515 were foreign-born and 783 negroes.

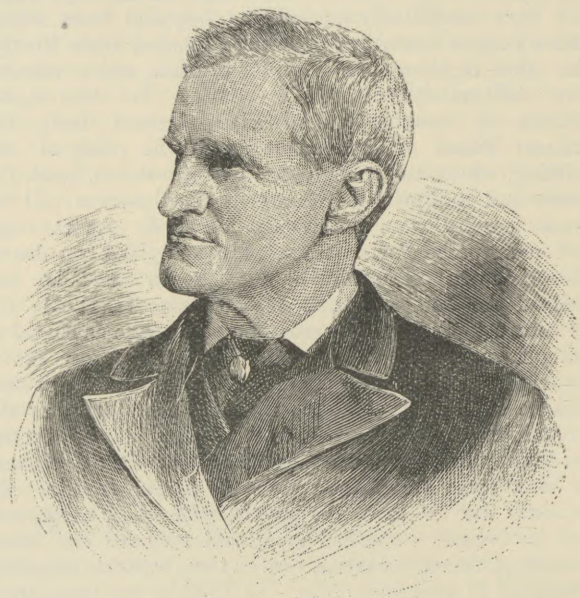
Parkes, Sir Harry Smith (1828–1885), English diplomatist, son of Harry Parkes, the founder of the firm of Parkes, Otway and Co., ironmasters, was born at Birchills Hall, near Walsall in Staffordshire, in 1828. When but four years old his mother died, and in the following year his father was killed in a carriage accident. Being thus left an orphan, he found a home with his uncle, a retired naval officer, at Birmingham. He received his early education at a boarding-school at Balsall Heath, and afterwards at King Edward's Grammar School. In 1837 his uncle died, and in 1841 he sailed for Macao in China, to take up his residence at the house of his cousin, Mrs Gutzlaff. At this time what was known as the "Opium War" had broken out, and Parkes eagerly prepared himself to take part in the events which were passing around him by diligently applying himself to the study of Chinese. In this pursuit he was fortunate to have the help and supervision of Dr Gutzlaff and John Robert Morrison, secretary and interpreter to Sir Henry Pottinger. Under these congenial influences he made rapid progress, and in 1842 he received his first appointment in the consular service. Fortunately for him, he was privileged to accompany Sir Henry Pottinger in his expedition up the Yangtse-kiang to Nanking, and after having taken part in the capture of Chinkiang and the surrender of Nanking, he witnessed the signing of the treaty on board the *Cornwallis* in August 1842. By this treaty the five ports of Canton, Amoy, Foochow, Ningpo, and Shanghai were opened to trade. After short residences at Canton and the newly opened Amoy, Parkes was appointed to the consulate at Foochow. Here he served under Mr (afterwards Sir) Rutherford Alcock, who was one of the few Englishmen who knew how to manage the Chinese. Though the war was over, the people were still hostile to foreigners, and it was only by the exercise of strong pressure that Alcock and his young interpreter were able to protect themselves and their countrymen from the assaults of the natives. In 1846 he was transferred with Alcock to Shanghai, which was even then beginning to show signs of developing into the place of importance which it has since become. In 1849 he returned to England on leave, and after visiting the Continent and doing some hard work for the Foreign Office, he returned to China in 1851. After a short stay at Amoy he was transferred to Canton as interpreter, and there he was first brought into contact with Commissioner Yeh, whose insolence and obstinacy led up to the second China war. Yeh had now met a man of even greater determination and power than himself, and when, as a climax to many outrages, Yeh seized the British lorcha *Arrow* and made prisoners of her crew, Parkes at once closed with his enemy. In response to a strongly-worded despatch from Parkes, Sir John Bowring placed matters in the hands of the admiral, who took Canton and, with Parkes's personal help, made a prisoner of Yeh. As the city was to be held, an allied commission was appointed to govern it, consisting of two Englishmen, of whom one was Parkes, and a French naval officer. Being the only one of the three who had any experience of the Chinese character, the burden of the work fell upon Parkes, who virtually governed this city of a million inhabitants for three years. Meanwhile the treacherous attack at Taku upon Sir Frederick Bruce, who was on his way to Peking to exchange the ratifications of the treaty concluded in 1858, led to a renewal of hostilities in the north, and Parkes was ordered up to serve as interpreter and adviser to Lord Elgin. In pursuance of these duties he went in advance of the army to the city of Tungchow, near Peking, to arrange a meeting between Lord Elgin and the Chinese commissioners who had been appointed to draw up the preliminaries of peace. While thus engaged he, Mr (afterwards Lord) Loch, Mr de Norman, Lord Elgin's secretary of legation, Mr Bowlby, the *Times* correspondent, and others, were treacherously taken prisoners. Parkes and Loch were carried off to the prison of the Board of Punishments at Peking, where they were separately herded with the lowest class of criminals. After ten days' confinement in this den of iniquity they were removed to a temple in the city, where they were comfortably housed and fed, and from which, after a further detention, they were granted their liberty. The other captives were not so fortunate, and a number were deliberately tortured to death. For this signal instance of treachery Lord Elgin burned down the Summer Palace of the emperor, and the ruins of this building, which have since been left unrestored, mark the horror and indignation with which this baseness and inhuman cruelty were universally regarded. At the conclusion of peace Parkes returned to England on leave, when he was made K.C.B. for his services; he had received the Companionship of the Order in 1860. On his return to China he served for a short time as consul at Shanghai, and was then appointed minister in Japan (1865). For eighteen years he held this post, and throughout that time he strenuously used his influence in support of the Liberal party of Japan, whose first object was to abolish the native feudal system of government and to substitute for it a more enlightened form of administration. So earnestly did he throw in his lot with these reformers, that he became a marked man, and incurred the bitter hostility of the reactionaries, who on three separate occasions attempted to assassinate him. In 1882 he was transferred to Peking, where, with his usual energy, he worked for the good of his country; and although in conducting negotiations he had many serious contentions with the mandarins, he retained throughout their respect and regard. While in Peking his health failed, and he died of malarial fever on the 21st of March 1885. In 1856 Sir H. (then Mr) Parkes married Miss Fanny Plumer, who died in 1879. (R. K. D.)

Parkes, Sir Henry (1815–1896), Australian statesman, was born at Stoneleigh, in Warwickshire, on 27th May 1815. The son of parents in very humble circumstances, he received only a rudimentary education, and at an early age was obliged to earn his living as a common labourer. Failing to make his way in England, he emigrated to Australia in 1839, and after a time settled in Sydney as an ivory-turner. Conscious of his great powers, he worked unremittingly to repair the deficiencies of his education, and developed a genuine taste for literature, and a gift for versification which won the approval of so severe a judge as Tennyson. His first volume of poems was published in 1842, under the title of *Stolen Moments.* He now began to take an active part in politics, and soon showed himself the wielder of an incisive style as a leader-writer, and a popular orator of unrivalled influence. He took a prominent part in the movement against the transportation of convicts, and in 1849 started the *Empire* newspaper to inculcate his policy of attacking abuses while remaining loyal to the Crown. The paper at once made its mark, but owing to financial difficulties ceased to appear in 1858. One of the reforms for which Parkes fought most strenuously was the full introduction of responsible government. He was triumphantly returned to the Legislative Council under the old constitution as member for Sydney, and on the establishment of a legislative assembly in 1856 was returned for East Sydney. In the debates on the new constitution he successfully attacked the proposal to create a hereditary Upper House, but vainly endeavoured to exclude the principle of nomination. His parliamentary career was twice interrupted by pecuniary embarrassments; indeed, he never acquired the art of making money, and in spite of a public subscription raised in 1887, died in absolute penury. He was elected for East Sydney in 1859 at the first general election under the new electoral Act, and sat till 1861, when he was sent to England as a commissioner for promoting emigration. He made a prolonged stay in England, and described his impressions in a series of letters to the *Sydney Morning Herald*, some of which were reprinted in 1869 under the title of *Australian Views of England.* He returned to Australia in 1863, and, re-entering the Assembly, became colonial secretary in the Martin ministry from 1866 to 1868. He succeeded in passing the Public Schools Act of 1866, which for the first time instituted an efficient system of primary education in the colony; but the Roman Catholic and Anglican communities, holding that the position of the denominational schools was menaced, displayed a bitter hostility to Parkes which survived the passing of the Bill. His great chance came in 1872, when the Martin ministry resigned on the question of the sum payable by Victoria in lieu of border duties. Parkes, who during his visit to England had fallen deeply under the influence of Cobden, had persistently advocated free-trade as a remedy for the financial distress of the colony. He now became prime minister and colonial secretary; and rising to the height of his opportunity, he not only removed the cause of dispute by throwing the colony open to trade, but made Sydney the chief port on the continent. It was due solely to his influence that New South Wales for many years alone of the Australian colonies adhered to a free-trade policy. He held office till 1875, and on the fall of the Robertson ministry again became premier and colonial secretary from March till August 1877. At the end of this year he was made K.C.M.G. Finding that the state of parties did not allow of the existence of a stable ministry, he formed a coalition with Sir John Robertson, and became premier and colonial secretary for the third time from December 1878 to January 1883. This administration was distinguished by a wide programme of social legislation, including temperance and employers' liability Acts, and reform of education and of the electoral law. In 1882 and in 1883–84 he paid prolonged visits to England. Already distinguished among Australian statesmen for breadth of outlook and passionate devotion to the Empire, he returned with those qualities enhanced. For a time he found himself almost in a position of isolation, but in 1887 the disastrous policy of protection adopted by his successors brought him again into office. His free-trade policy was once more successful. Other important measures of his administration were the reform of the civil service, the prohibition of Chinese immigration, and the Railways and Public Works Acts. He fell from office in January 1889, but in the following March became for the fifth time premier and colonial secretary. The remainder of his life was chiefly devoted to the question of Australian federation. He had from his early days been an advocate of this idea; but that inability to recognize the merits of his opponents, which, combined with excessive self-esteem, formed the chief defect of his character, prevented his co-operating in subsequent attempts at federation. The Federal Convention at Melbourne in 1890 was mainly his work; and he presided over the Convention at Sydney in 1891, and was chiefly responsible for the draft constitution there carried. Defeated in October 1891 on his refusal to accept an eight hours' day for coal-miners, he remained in opposition for the rest of his career, sacrificing even free-trade in the hope of smoothing the path of federation. He died at Sydney on 27th April 1896; but though he did not live to see the realization of his efforts, he may justly be called the Father of the Australian Commonwealth. He published, in addition to the works already named and numerous volumes of verse, a collection of speeches on the *Federal Government of Australia* (1890), and an autobiography, *Fifty Years in the making of Australian History* (1892). (H. SY.)

Parkman, Francis (1823–1893), American historian, was born in Boston, 16th September 1823. His great-grandfather, Ebenezer Parkman, a graduate of Harvard in 1741, was for nearly sixty years minister of the Congregational Church in Westborough, and was noted for his devotion to the study of history. One of this good clergyman's sons, Samuel Parkman, became an eminent merchant in Boston, and exhibited much skill in horticulture. Samuel's son, Francis Parkman, a graduate of Harvard in 1807, was one of the most eminent of the Boston clergymen, a pupil and friend of Channing, and noted among Unitarians for a broadly tolerant disposition. This Doctor Parkman, a man of rare sagacity and exquisite humour, was the father of Francis Parkman, the historian. His mother was a descendant of the celebrated John Cotton. She was the daughter of Nathaniel Hall of Medford, member of a family which was represented in the convention that framed the constitution of Massachusetts in 1780.

Francis Parkman was the eldest of her six children. As a boy, his health was delicate, so that it was thought best for him to spend much of his time at his grandfather Hall's home in Medford rather than in the city. That home was situated on the border of the Middlesex Fells, a rough and rocky woodland, 4000 acres in extent, as wild and savage in many places as the primeval forest. The place is within 8 miles of Boston, and it may be doubted if anywhere else can be found another such magnificent piece of wilderness so near to a great city. There young Parkman spent his leisure hours in collecting eggs, insects, and reptiles, trapping squirrels and woodchucks, and shooting birds with arrows. This breezy life saved him from the artificial stupidity which is too often superinduced in boys by their school training. At the age of fourteen Parkman began to show a strong taste for literary composition. In 1841, while a student at Harvard, he made a rough journey of exploration in the woods of northern New Hampshire, where he had a taste of adventure slightly spiced with hardship. About this time he made up his mind to write a history of the last French war in America, which ended in the conquest of Canada, and some time afterwards he enlarged the plan so as to include the whole course of the American conflict between France and Great Britain; or, to use his own words, "The history of the American forest; for this was the light in which I regarded it. My theme fascinated me, and I was haunted with wilderness images day and night." The way in which true genius works could not be more happily described. In the course of 1842 an attack of illness led to his making a journey in Italy, where he spent some time in a monastery belonging to one of the strictest of all the monastic orders, the Passionists, brethren addicted to wearing hair shirts and scourging themselves without mercy. In the young historian's eyes these good brethren were of much value as living and breathing historic material. In 1844 he graduated at Harvard with high rank.

He now made up his mind to study the real wilderness in its gloom and vastness, and to meet face to face the dusky warriors of the Stone Age. To-day such a thing can hardly be done within the United States, for nowhere does the primitive wilderness exist save here and there in shreds and patches. So recently as the middle of the 19th century, however, it covered the western half of the continent, and could be reached by a journey of 1600 or 1700 miles from Boston to the plains of Nebraska. Parkman had become an adept in woodcraft and a dead shot with the rifle, and could do such things with horses, tame or wild, as civilized people never see done except in a circus. In company with his friend and class-mate, Mr



Francis Parkman.

Quincy Shaw, he passed several months with the Ogillalah band of Sioux. Knowledge, intrepidity, and tact carried Parkman through these experiences unscathed, and good luck kept him clear of encounters with hostile Indians, in which these qualities might not have sufficed to avert destruction. It was a very important experience in relation to his life work. This outdoor life, however, did not suffice to recruit Parkman's health, and by 1848, when he began writing *The Conspiracy of Pontiac*, he had reached a truly pitiable condition. The trouble seems to have been some form of nervous exhaustion, accompanied with such hypersensitiveness of the eyes that it was impossible to keep them open except in a dark room. Against these difficulties he struggled with characteristic obstinacy. He invented a machine which so supported his hand that he could write legibly with closed eyes. Books and documents were read aloud to him, while notes were made by him with eyes shut, and were afterwards deciphered and read aloud to him till he had mastered them. After half an hour his strength would give out, and in these circumstances his rate of composition for a long time averaged scarcely six lines a day. The superb historical monograph composed under such difficulties was published in 1851. It had but a small sale, as the American public was then too ignorant to feel much interest in American history.

Undeterred by this inhospitable reception, Parkman took up at the beginning his great work on *France and England in the New World*, to which the book just mentioned was in reality the sequel. This work obliged him to trace out, collect, arrange, and digest a great mass of incongruous material scattered on both sides of the Atlantic, a large portion of which was in manuscript, and required much tedious exploration and the employment of trained copyists. This work involved several journeys to Europe, and was performed with a thoroughness approaching finality. In 1865 the first volume of the great work appeared, under the title of *Pioneers of France in the New World;* and then seven-and-twenty years more elapsed before the final volumes came out in 1892. Nowhere can we find a better illustration of the French critic's definition of a great life—a thought conceived in youth, and realized in later years. After the *Pioneers* the sequence is *The Jesuits in North America, La Salle and the Discovery of the Great West, The Old Régime in Canada, Frontenac and New France and Louis XIV., Montcalm and Wolfe, A Half Century of Conflict.* As one obstacle after another was surmounted, as one grand division of the work after another became an accomplished fact, the effect upon Parkman's condition seems to have been bracing, and he acquired fresh impetus as he approached the goal. There can be little doubt that his physical condition was much improved by his habit of cultivating plants in garden and conservatory. He was a horticulturist of profound attainments, and himself originated several new varieties of flowers. His work in this department made him an enthusiastic adherent of the views of Darwin. He was professor of horticulture in the Agricultural School of Harvard in 1871–72, and published a few books on the subject of gardening. He died at Jamaica Plain, near Boston, on 8th November 1893.

The significance of Parkman's work consists partly in the success with which he has depicted the North American Indians, those belated children of the Stone Age, who have been so persistently misunderstood alike by romancers, such as Cooper, and by detractors like Dr Palfrey. Parkman was the first great literary author who really understood the Indian's character and motives. Against this savage background of the forest Parkman shows the rise, progress, and dramatic termination of the colossal struggle between France and Great Britain for colonial empire. With true philosophic insight he shows that France failed in the struggle not because of any inferiority in the ability and character of the men to whom the work was entrusted, but chiefly by reason of her despotic and protective régime. There is no more eloquent commentary upon the wholesome results of British self-government than is to be found in Parkman's book. But while the author deals with history philosophically, he does not, like Buckle, hurl at the reader's head huge generalizations, or, like Carlyle, preach him into somnolence. With all its manifold instructiveness, his book is a narrative as entertaining as those of Macaulay or Froude. In judicial impartiality Parkman may be compared with Gardiner, and for depth and accuracy of learning, with Bishop Stubbs. Take him for all in all, he is incomparably the greatest historian that America has produced. (J. Fi.)

Parla Kimedi, a town of British India, in the Ganjam district of Madras. Population (1881), 10,812; (1891), 16,379; municipal income (1897–98), Rs. 13,600. It is the residence of a raja, who claims descent from the ancient kings of Orissa. His estate covers an area of 764 square miles, and pays a revenue of £8782 out of an estimated income of £53,274. He maintains a college, with 32 students in 1896–97; a high school, with 302 pupils; a printing-press, issuing an English newspaper; and two libraries. A steam tramway of 2 feet gauge, for 25 miles, has been sanctioned.

Parliament.—*Procedure.*—The change in the character of the House of Commons since 1832 has rendered necessary important changes in its rules of procedure. No fewer than seventeen committees made recommendations for the improvement of procedure between that date and 1902, but until the forms of the House were openly utilized to delay the progress of Government business the changes made were comparatively insignificant. They were necessitated by the increased volume of business with which the reformed Parliaments had to deal, and by the gradual transfer to Government of the whole work of controversial legislation. They consisted in (1) the discontinuance of superfluous forms, questions, and amendments; (2) restrictions of debates upon questions of form; (3) improved arrangements for the distribution of business; (4) the delegation of some of the minor functions of the House to committees and officers of the House; and (5) increased publicity in the proceedings of the House.

Irish obstruction.

With the entry of Mr Parnell and his Irish Nationalist followers into Parliament (1875–1880) a new era began in the history of the House of Commons. Parnell's professed object was to discredit that assembly, and, by demonstrating its insufficiency to deal with the affairs of the United Kingdom, to prove the necessity of Home Rule for Ireland. His tactics were to oppose all business of whatever kind, and at all hours. The Speaker could only administer the rules as they stood. They had been evolved out of the experience of centuries, during which the House had been on the whole homogeneous, and, however much members might differ in politics, they were wholly loyal to the historic assembly to which they had been elected, and were, moreover, answerable to the public opinion of their fellow-countrymen. But it was to public opinion in Ireland, not in England, that Mr Parnell looked for support, and so far were his efforts to discredit the House of Commons from exciting resentment there, that they gained for him a popularity unrivalled since the days of O'Connell. In one sense, indeed, his tactics were justified by their success, for after ten years' persistence in this novel method of opposition he succeeded in convincing one of the great political parties that the Irish claims could no longer be safely resisted, for the reason, among others, that "Ireland blocked the way" to British legislative reforms. It was not until February 1880 that the House so far overcame its reluctance to restrict liberty of discussion as to pass, in its earliest form, the rule dealing with "order in debate." It provided that whenever a member was named by the Speaker or Chairman as "disregarding the authority of the Chair, or abusing the rules of the House by persistently and wilfully obstructing the rules of the House," a motion might be made, to be decided without amendment or debate, for his suspension from the service of the House during the remainder of the sitting; and that if the same member should be suspended three times in one session, his suspension on the third occasion should continue for a week, and until a motion had been made upon which it should be decided, at one sitting, by the House, whether the suspension should then cease or not. The general election, which took place two months later, restored Mr Gladstone to power and to the leadership of the House. Mr Parnell returned to Parliament with a more numerous following, and resumed his former tactics. In January 1881 the Protection of Persons and Property (Ireland) Bill was introduced. For twenty-two hours Parnell fought the motion giving precedence to the Bill, and for four sittings its introduction. The fourth sitting lasted forty-one hours. Then Mr Speaker Brand intervened, and declined to call on any other member who might rise to address the House, because repeated dilatory motions had been supported by small minorities in opposition to the general sense of the House. He added: "A crisis has thus arisen which demands the prompt interposition of the Chair and of the House. The usual rules have proved powerless to ensure orderly and effective debate. An important measure, recommended by her Majesty nearly a month since, and declared to be urgent in the interests of the State by a decisive majority, is being arrested by the action of an inconsiderable minority, the members of which have resorted to those modes of obstruction which have been recognized by the House as a parliamentary offence. The dignity, the credit, and the authority of this House are seriously threatened, and it is necessary they should be vindicated. . . . Future measures for ensuring orderly debate I must leave to the judgment of the House. But the House must either assume more effectual control over its debates, or entrust greater powers to the Chair." The Speaker then put the question, which was carried by an overwhelming majority. Then followed the decisive struggle. Mr Gladstone gave notice for the next day (3rd February) of an urgency rule, which ordered, "That if the House shall resolve by a majority of three to one that the state of public business is urgent, the whole power of the House to make rules shall be and remain with the Speaker until he shall declare that the state of public business is no longer urgent." On the next day a scene of great disorder ended in the suspension of the Nationalist members, at first singly, and afterwards in groups. The urgency rule was then passed without further difficulty, and the House proceeded to resolve, "That the state of public business is urgent." The Speaker laid upon the table rules of sufficient stringency, and while they remained in force progress in public business was possible. During this session the Speaker had to intervene on points of order 935 times, and the Chairman of Committees 939 times; so that, allowing only five minutes on each occasion, the wrangling between the Chair and members occupied 150 hours.

The events of the session of 1881 and the direct appeal of the Speaker to the House proved the necessity of changes in the rules of procedure more drastic than had hitherto been proposed. Accordingly, in the first week of the session of 1882 Mr Gladstone laid his proposals on the table, and in moving the first resolution on 20th February, he reviewed, in an eloquent speech, the history of the Standing Orders. It was his opinion, on general grounds, that the House should settle its own procedure, but he showed that the numerous committees which, since 1832, had sat on the subject, had failed for the most part to carry their recommendations into effect from the lack of the requisite "propelling power," and he expressed his regret that the concentration of this power in the hands of the Government had rendered it necessary that they should undertake a task not properly theirs. He noted two main features in the history of the case: (1) the constantly increasing labours of the House, and (2) its constantly decreasing power to despatch its duties; and while he declared that "the fundamental change which has occurred is owing to the passing of the first great Reform Bill," he pointed out that the strain had not become intolerable till the development in recent years of obstructive tactics. He defined obstruction as "the disposition either of the minority of the House, or of individuals, to resist the prevailing will of the House otherwise than by argument," and reached the conclusion that the only remedy for a state of things by which the dignity and efficiency of the House were alike compromised, was the adoption in a carefully guarded form of the process known on the Continent as the "clôture." He explained that in his early years the House was virtually possessed of a closing power, because it was possessed of a means of sufficiently making known its inclinations; and to those inclinations uniform deference was paid by members, but that since this moral sanction had ceased to be operative, it was necessary to substitute for it a written law. The power to close debate had been of necessity assumed by almost all the European and American assemblies, the conduct of whose members was shaped by no traditional considerations; and the entry into Parliament of a body of men to whom the traditions of the House were as nothing, made it necessary for the House of Commons to follow this example. He proposed, therefore, that when it appeared to the Speaker, or to the Chairman of Committees, during any debate to be the evident sense of the House, or of the committee, that the question be now put, he might so inform the House, and that thereupon on a motion being made, "That the question be now put," the question under discussion should be forthwith put from the Chair, and decided in the affirmative if supported by more than 200 members, or, when less than 40 members had voted against it, by more than 100 members. This resolution was vehemently contested by the Opposition, who denounced it as an unprecedented interference with the liberty of debate, but was eventually carried in the autumn session of the same year, after a discussion extending over nineteen sittings.

The closure.

On 20th November the Standing Order of 28th February 1880, providing for the suspension of members who persistently and wilfully obstructed the business of the House or disregarded the authority of the Chair, was amended by the increase of the penalty to suspension on the first occasion for one week, on the second occasion for a fortnight, and on the third, or any subsequent occasion, for a month. The other rules, framed with a view to freeing the wheels of the parliamentary machine, and for the most part identical with the regulations adopted by Mr Speaker Brand under the urgency resolution of 1881, were carried in the course of the autumn session, and became Standing Orders on 27th November.

Mr Gladstone's closure rule verified neither the hopes of its supporters nor the fears of its opponents. It was not put into operation until 20th February 1885, when the Speaker's declaration of the evident sense of the House was ratified by a majority of 207—a margin of but seven votes over the necessary quorum. It was clear that no Speaker was likely to run the risk of a rebuff by again assuming the initiative unless in the face of extreme urgency, and, in fact, the rule was enforced twice only during the five years of its existence.

In 1887 the Conservative Government, before the introduction of a new Coercion Bill for Ireland, gave efficiency to the rule by an important amendment. They proposed that any member during a debate might claim to move, "That the question be now put," and that with the consent of the Chair this question should be put forthwith, and decided without amendment or debate. Thus the initiative was transferred from the Speaker to the House. Mr Gladstone objected strongly to this alteration, chiefly on the ground that it would throw an unfair burden of responsibility upon the Speaker, who would now have to decide on a question of opinion, whereas under the old rule he was only called upon to determine a question of evident fact. The alternative most generally advocated by the Opposition was the automatic closure by a bare majority at the end of each sitting, an arrangement by which the Chair would be relieved from an invidious responsibility; but it was pointed out that under such a system the length of debates would not vary with the importance of the questions debated. After fourteen sittings the closure rule was passed on 18th March and made a Standing Order.

In the next session, on 28th February 1888, the rule was yet further strengthened by the reduction of the majority necessary for its enforcement from 200 to 100. No further alteration was made up to 1902, so that the rule in its present form stands as follows:—

That, after a question has been proposed, a member rising in his place may claim to move, "That the question be now put," and, unless it shall appear to the Chair that such motion is an abuse of the rules of the House, or an infringement of the rights of the minority, the question, "That the question be now put," shall be put forthwith, and decided without amendment or debate.

When the motion "That the question be now put" has been carried, and the question consequent thereon has been decided, any further motion may be made (the assent of the Chair as aforesaid not having been withheld), which may be requisite to bring to a decision any question already proposed from the Chair; and also if a clause be then under consideration, a motion may be made (the assent of the Chair as aforesaid not having been withheld), "That the question 'That certain words of the clause defined in the motion stand part of the clause,' or 'That the clause stand part of, or be added to, the Bill,' be now put." Such motions shall be put forthwith, and decided without amendment or debate.

That questions for the closure of debate shall be decided in the affirmative, if, when a division be taken, it appears by the numbers declared from the Chair that not less than one hundred members voted in the majority in support of the motion.

The closure, originally brought into being to defeat the tactics of obstruction in special emergencies, has now become a part of parliamentary routine. The modern practice of retarding the progress of Government measures by amendments moved to every line, has unhappily been adopted by both the great political parties when in Opposition, and has led on two occasions to the forcing through Parliament by means of the process known as the "guillotine" of important Bills, most of the clauses in which had been undiscussed. On 17th June 1887, after prolonged debates on the Crimes Bill in committee, clause 6 only having been reached, the remaining 14 clauses were put without discussion, and the Bill was reported in accordance with previous notice. This precedent was followed by Mr Gladstone in 1893, when many of the clauses of the Home Rule Bill were carried through committee and on report by the same machinery. Thus to the Conservatives must be imputed the invention of this irrational method of legislation, to their opponents the use of it to carry a great constitutional innovation to which the majority of English and Scottish representatives were opposed.

The "guillotine."

The principle of closure has been extended to the debates on Supply. The old rule, that the redress of grievances should precede the granting of money, dating from a time when the minister of the Crown was so far from commanding the confidence of the majority in the House of Commons that he was the chief object of their attacks, nevertheless continued to govern the proceedings of the House in relation to Supply without much resultant inconvenience, until the period when the new methods adopted by the Irish Nationalist party created a new situation. Until 1872 it continued to be possible to discuss any subject by an amendment to the motion for going into Supply. In that year a resolution was passed limiting the amendments to matters relevant to the class of estimates about to be considered, and these relevant amendments were further restricted to the first day on which it was proposed to go into committee. This resolution was continued in 1873, but was allowed to drop in 1874. It was revived in a modified form in 1876, but was again allowed to drop in 1877. In 1879, on the recommendation of the Northcote committee, it was provided in a Sessional Order that whenever the committees of Supply or of Ways and Means stood as the first order on a Monday, the Speaker should leave the chair without question put, except on first going into committee on the Army, Navy, and Civil Service estimates respectively. In 1882 Thursday was added to Monday for the purposes of the Order, and, some further exceptions having been made to the operation of the rule, it became a Standing Order. The conditions, however, under which the estimates were voted remained unsatisfactory. The most useful function of the Opposition is the exposure of abuses in the various departments of administration, and this can best be performed upon the estimates. But ministers, occupied with their legislative proposals, were irresistibly tempted to postpone the consideration of the estimates until the last weeks of the session, when they were hurried through thin Houses, the members of which were impatient to be gone. In order to meet this abuse, and to distribute with some regard to the comparative importance of the subjects discussed the limited time which it was possible to allot to the estimates, Mr Balfour in 1896 proposed and carried a Sessional Order for the closure of Supply. By this, Supply, unimpeded by any dilatory motion, was to be the first order of the day on every Friday. A maximum of twenty-three days was to be given to its consideration, of which the last three alone might be taken after 5th August. On the last but one of the allotted days at 10 o'clock the Chairman was to put the outstanding votes, and on the last day the Speaker at the same hour was to put the remaining questions necessary to complete the reports of Supply. During the course of the session Mr Balfour consulted the leaders both of the Liberal and of the Nationalist Oppositions as to the estimates which they desired to discuss, and those were placed first on the paper on the succeeding Fridays. This Order was renewed in successive sessions until 1901, when an alteration was made in it by which logic was sacrificed to expediency. Year after year, when the closure of Supply came on, many hours were spent in the division lobby owing to the necessity under the order of a decision on every vote separately. In 1901 Mr Balfour so altered the resolution that the question was put, not with respect to each vote, but to each class of votes in the Civil Service estimates, and to the total amounts of the outstanding votes in the Army, Navy, and Revenue estimates. It is in this form that the Order was carried in the earlier session of 1902, with the view of making it a Standing Order.

Supply rule.

The appointment of standing committees, competent to represent the general opinion of the House, and aided by members appointed specially to serve in regard to particular Bills, was suggested by Sir Erskine May in his evidence before the Northcote committee of 1878. Effect was given to this suggestion by the resolutions of November and December 1882, when two standing committees were appointed for the consideration of all Bills relating to law and courts of justice and of trade, which might, by order of the House, be referred to them. In accordance with these resolutions the standing committees were set up in the session of 1883. The Criminal Procedure Bill was referred to the standing committee on law, and the Bankruptcy Bill to the standing committee on trade. In the latter instance the experiment proved a success, but the Criminal Procedure Bill was withdrawn. Between 1883 and 1888 the standing committees were not reconstituted. By 1886 it had become clear to most of the opponents of Home Rule that some alternative scheme of delegation to relieve the labours of Parliament was necessary to their position. Accordingly, the Hartington committee of 1886 made in their report a recommendation which, had it been adopted, would have

Standing committees.

revolutionized parliamentary procedure. They advised that the whole House should be divided at the commencement of the session into four standing committees, twenty members being a quorum in each, and that to these committees every public Bill, after the second reading, should be referred, except those originating in the committee of Ways and Means. This suggestion did not recommend itself to the House, but in 1888 the resolutions of 1882 were revived, and, after trade had been defined to include agriculture and fishing, they were made Standing Orders.

As constituted in 1902, these committees consisted of not less than sixty nor more than eighty members, nominated by the committee of selection, who have regard to the classes of Bills committed to such committees, to the composition of the House, and to the qualifications of the members selected; and who have power to discharge members from time to time, and to appoint others in their place. The quorum of each committee is twenty. The committee of selection have also power to add fifteen members to a standing committee in respect of any particular Bill. Bills reported from the standing committees are proceeded with as if they had been reported from committees of the whole House. The system of standing committees has worked well on the whole. At first it was understood that controversial Bills were not to be referred to them, but there has been a tendency to dispense with this limitation.

Time of business.

Important alterations have been made in the time-table of the House of Commons in recent years. The Standing Order of February 1879, under which no opposed business, except money Bills, Bills to which no notice of opposition had been given, and proceedings under any Act of Parliament, might be taken after 12.30 A.M., was amended in 1882, by exempting from the operation of the Order motions for leave to bring in Bills, and Bills which had passed through committee of the whole House. By the Standing Order of 24th February 1888 the House resolved to meet at 3 o'clock, instead of at 4, on every Monday, Tuesday, Thursday, and Friday. The sittings, under the Order, continued till midnight, when the business then under consideration was interrupted, and no further opposed business was taken. At 1 o'clock the Speaker adjourned the House without question put. On Wednesdays, when the House met at 12, the interruption of business was at 5.30 P.M., and the House stood adjourned at 6. Closure might be moved at the interruption of business, on the question then under consideration, and on the questions consequent thereon. Bills originating in committee of Ways and Means, and proceedings under any Act of Parliament, were exempted from the provisions of this Order.

The sittings of the House continued to be regulated by the Standing Order of 1888 until May 1902, when further important changes were made. The chief inconvenience experienced under the Order of 1888 was the frequent postponement of the orders of the day by the unexpected intervention of motions for adjournment or of private business. A main object of the amended rule was to give certainty to members as to the business to be taken at any particular sitting. Thursday was substituted for Friday as the day on which Supply is to be taken, with the additional proviso that no business other than the business of Supply may be taken before 12 o'clock on that night, and Friday took the place of Wednesday for the morning sittings. It was further ordered that the House shall meet every Monday, Tuesday, Wednesday, and Thursday, at 2 o'clock for an afternoon sitting, and at 9 o'clock for an evening sitting. The afternoon sittings last till 7.30, when the Speaker adjourns the House without question put. The 12 o'clock rule of 1888 holds good for the evening sittings. No alteration has been made in the hours of the morning sittings. To secure the afternoon sittings from interruption, it has been ordered that all private business not disposed of by 2.15 shall be postponed until such time as the Chairman of Ways and Means may determine, and that motions for adjournment for the discussion of a "definite matter of urgent public importance" shall stand over until the evening sitting of the same day, when they take precedence of private business. These motions for adjournment, in accordance with the Standing Order of November 1882, must be made after the questions asked at the commencement of public business have been disposed of. The member who proposes to make such a motion must obtain the acquiescence of the Speaker in his claim that the question he wishes to discuss is a definite matter of urgent public importance, and also the support of at least forty members, signified by their rising in their places on the Speaker's invitation. Another change in procedure introduced in 1902 relates to questions addressed to ministers. These questions are now taken at 2.15 P.M., and may be asked until 2.55, when, with the exception of questions unanswered owing to the absence of the minister addressed, or those of an urgent nature which have not appeared upon the paper, they give way to the business of the House. But the most important change is contained in the following provisions:—

> Any member who desires an oral answer to his question may distinguish it by an asterisk, but notice of any such question must appear at latest on the notice paper circulated on the day before that on which an answer is desired.
>
> If any member does not distinguish his question by an asterisk, or if he, or any other member deputed by him, is not present to ask it, or if it is not reached by five minutes before 3 of the clock, the minister to whom it is addressed shall cause an answer to be printed and circulated with the votes, unless the member has signified his desire to postpone the question.

This rule worked well, and much time was saved for public business.

The consequences of the rise of obstruction and of the 12 o'clock rule, together with the mandate of the electors, having combined to place in the Government all the motive power of the House of Commons, it had followed of necessity that in successive sessions ministers had taken by resolution most of the time at the disposal of that assembly. To this allocation of time a formal sanction was given by the Order of 11th April 1902. Government business now enjoys precedence at every sitting except the evening sitting on Tuesday and Wednesday, and the sitting on Friday. After Easter it has precedence at the evening sittings on Tuesday, and after Whitsuntide at all evening sittings, and at all Friday sittings except the sittings on the third and fourth Fridays after Whitsunday. At the evening sittings allocated to private members, notices of motion take precedence of the orders of the day. It is therefore only on Fridays before Whitsuntide and on two Fridays subsequently that the Bills introduced by private members can now be discussed.

Suspension of members.

On 5th March 1901 certain Irish Nationalist members refused to leave the House for a division on a motion for closure moved by Mr Balfour. They were thereupon suspended for wilfully obstructing the business of the House, and as they declined to withdraw, the Speaker was obliged to direct the Serjeant-at-Arms to cause them to be removed by force. Action had to be taken to preclude the recurrence of so scandalous a scene. On 7th March, at the instance of Mr Balfour, a paragraph was added to the Standing Order of 1882 relating to order in debate, to the effect that in cases where recourse to force had been found necessary to compel any member, or members acting jointly, to obey the direction of the Speaker, such member or members shall thereupon, and without further question put, be suspended from the House during the remainder of the session. It was proposed still further to increase the several periods of suspension for disregarding the authority of the Chair—on the first occasion so as to last for 20 days on which the House sits, on the second occasion for 40 days, and on the third or any subsequent occasion for 80 days. The amendments embodying this alteration were proposed in February 1902, but their further consideration was postponed till the autumn session.

History.—The Reform Act of 1884 was ultimately carried with the goodwill of both the great political parties. The Conservatives resisted Mr Gladstone's attempt to carry a great extension of the franchise before he had disclosed his scheme of redistribution, and the Bill was thrown out by the House of Lords in August 1884. But after a conference of Mr Gladstone with Lord Salisbury, to whom the whole scheme was confided, an agreement was reached, and the Bill was passed in the autumn session. In the following session (1885) the Redistribution Act was passed.

A uniform household and lodger franchise was established in counties and boroughs. If a dwelling was held as part payment for service, the occupier was not deprived of his vote because his home was the property of his master. The obligation was thrown on the overseers of ascertaining whether any other man besides the owner was entitled to be registered as an inhabitant occupier, and the owner was bound to supply the overseers with the information. The Registration Acts were otherwise widely amended. Polling-places were multiplied, so that little time need be lost in recording a vote. These and other beneficial changes went a long way towards giving a vote to every one who had a decent home. By the Redistribution of Seats Act, 1885, all boroughs with less than 15,000 inhabitants ceased to return a member. These small towns were merged into their counties, and the counties were subdivided into a great number of single-member constituencies, so that the inhabitants of the disfranchised boroughs voted for the member for the division of the county in which they were situated. Boroughs with less than 50,000 inhabitants returning two members were in future to return only one, and towns of over 100,000 were divided into separate constituencies, and received additional members in proportion to their population. The members for the City of London were reduced to two, but Greater London, including Croydon, returned sixty. Divided Liverpool returned nine, Glasgow seven, Edinburgh, Dublin, and Belfast each four, and so on. Six additional seats were given to England and twelve to Scotland, so that, allowing for a diminution by disfranchisement for corruption, the numbers of the House of Commons were raised to 670 members.

The most noteworthy effect from a constitutional standpoint of the successive Reform Acts has been the gain in power, of the executive on the one hand and of the electorate on the other, at the expense of the House of Commons. Before 1832 the functions of ministers were mainly administrative, and Parliament was able to deal much as it pleased with their rare legislative proposals without thereby depriving them of office. Moreover, since before that date ministers were, generally speaking, in fact as well as in theory appointed by the king, while the general confidence of the majority in the House of Commons followed the confidence, not of the electorate, but of the Crown, that House was able on occasions to exercise an effective control over foreign policy. Pitt, after 1784, was defeated several times on foreign and domestic issues, yet his resignation was neither expected nor desired. In 1788, when the regency of the prince of Wales appeared probable, and again in 1812, it was generally assumed that it would be in his power to dismiss his father's ministers and to maintain the Whigs in office without dissolving Parliament. This system, while it gave to ministers security of tenure, left much effective freedom of action to the House of Commons. But the Reform Act of 1832 introduced a new order of things. In 1835 the result of a general election was for the first time the direct cause of a change of ministry, and in 1841 a House of Commons was elected for the express purpose of bringing a particular statesman into power. The electorate voted for Sir Robert Peel, and it would have been as impossible for the House then elected to deny him their support as it would be for the college of electors in the United States to exercise their private judgment in the selection of a President. The Premier now derives his power neither from the Crown, nor from Parliament, but from the electorate, and to the electorate he is able to appeal if deserted by his majority. Unless it is prepared to drive him from the office in which it was elected to support him, that majority will not venture to defeat, or even seriously to modify, his legislative proposals, or to pass any censure on his foreign policy, for all such action is now held to be equivalent to a vote of no confidence. From the passing of the Reform Act of 1867 down to 1900 (with a single exception due to the lowering of the franchise and the redistribution of seats) the electorate voted alternately for the rival party leaders, and it was the function of the Houses elected for that purpose to pass the measures and to endorse the general policy with which those leaders were respectively identified. The Cabinet tends to become an executive committee acting on behalf of the electorate, charged to make certain changes in the law, pledged to govern the country in accordance with certain general principles ascertained beforehand, and removable only after a dissolution. This change of system has greatly added to the power of the Cabinet, because the control to which they were subject when dependent on the House of Commons was constant and immediate, whereas it is only at long intervals of time that they have to settle accounts with the electorate. On the other hand, the virtual identification of the electorate with the nation by the successive extensions of the franchise has added immensely to its power, the chief remaining limitations of which are supplied by the Septennial Act and the non-payment of members. The House of Lords restricts the action rather of the House of Commons than of the electorate, for the acquiescence of the Upper House in the decision of the electors, when they have been appealed to on a specific point at issue between the two Houses, has been affirmed in principle by Lord Salisbury, and may now be regarded as a constitutional convention.

Between 1885 and 1902 there was no further change in the constitution of either House of Parliament. But the frequent differences between the two Houses during the Parliament of 1880–85, culminating in the postponement by the Upper House of the Reform Bill, caused the status of that House to be much discussed during the general election of 1885, and proposals for its "mending or ending" to be freely canvassed on Radical platforms. On 5th March 1886 Mr Labouchere moved a resolution in the House of Commons condemning the hereditary principle. This was resisted by Mr Gladstone, then Prime Minister, on the ground that he had never supported an abstract resolution unless he was prepared to follow it up by action, and that the time for this had not arrived. On a division the motion was negatived by 202 votes against 166. The question of the constitution of the

House of Lords was much agitated in 1888. The Conservatives were again in power, but many of them thought that it would be prudent to forestall by a moderate reform the more drastic remedies now openly advocated by their opponents. On the other hand, Radicals were disposed to resist all changes involving the maintenance of the hereditary principle, lest they should thereby strengthen the House of Lords. On 9th March Mr Labouchere again moved his resolution in the House of Commons. Mr W. H. Smith, the leader of the House, in resisting the motion, admitted that some changes were desirable, and agreed with a previous speaker that it was by the Conservatives that such changes ought to be effected. On 19th March in the same year Lord Rosebery, in the House of Lords, moved for a select committee to inquire into the subject. He took the opportunity to explain his own plan of reform. While he did not wish to abolish the hereditary principle, he desired that no peer, outside the Royal family, should be a member of the House by right of birth alone. To the representatives of the Peers he proposed to add other men who had achieved distinction in a public career. He attached a high importance to the existence of a second chamber. His motion was negatived by 97 votes against 50. On 26th April Lord Dunraven withdrew a Bill for the reform of the House of Lords on the promise of the Government to deal with the matter, and on 18th June Lord Salisbury fulfilled this pledge. He introduced a Bill on that day to provide for the creation of a limited number of life peers and for the exclusion of unworthy members from the House. Under this measure a maximum of five life-peerages in any one year might be created, but the total number was never to exceed fifty. In respect of three out of these five life-peers the choice of the Crown was restricted to judges, generals, admirals, ambassadors, privy councillors, and ex-governors of colonies. The two additional life-peers were to be appointed in regard to some special qualification to be stated in the message to the House announcing the intention of the Crown to make the appointment. Power was also to be given to the House to expel members for the period of the current Parliament by an address to the Crown praying that their writs of summons might be cancelled. The Bill was read a second time on 10th July, but it met with a cold reception and was dropped. The only outcome of all that was written and said in this year was that in 1889, after the report of a select committee set up in 1888, the Lords made a few changes in their Standing Orders, among which the order establishing a quorum of thirty in divisions and those for the constitution of standing committees were the most important.

The Parliament which met at Westminster in August 1892 was more democratic in its tendencies than any of its predecessors. At the beginning of the session of 1893, in the course of which the Home Rule Bill was passed by the House of Commons, Government Bills were introduced for quinquennial parliaments, for the amendment of registration, and for the limitation of each elector to a single vote. The introduction of these Bills served merely as a declaration of Government policy, and they were not further pressed. On 24th March a resolution in favour of payment of members was carried by 276 votes against 229, and again in 1895 by 176 to 158. But the rejection of the Home Rule Bill by the House of Lords, with the apparent acquiescence of the country, combined with the retirement of Mr Gladstone to weaken the influence of this House of Commons, and small importance was attached to its abstract resolutions. In the ensuing session of 1894 an amendment to the Address condemning the hereditary principle was moved by Mr Labouchere, and carried by 147 to 145. The Government, however, holding that this was not the way in which a great question should be raised, withdrew the Address, and carried another without the insertion. In his last public utterance Mr Gladstone directed the attention of his party to the reform of the House of Lords, and Lord Rosebery endeavoured to concentrate on such a policy the energies of his supporters at the general election. But the result of the dissolution of 1895, showing, as it did, that on the chief political issue of the day the electorate had agreed with the House of Lords, and had disagreed with the House of Commons, greatly strengthened the Upper House, and after that date the subject was but little discussed. The House of Lords claims the right to resist changes made by the House of Commons until the will of the people has been definitely declared, and its defenders contend that its ultimate dependence on the electorate, now generally acknowledged, renders the freedom from ministerial control secured to it by its constitution a national safeguard.

The transfer of all real legislative power from the House of Commons, as such, to the Government has been completed since 1888 by the working of the 12 o'clock rule. The new position of ministers after the Reform Act, when they gradually became, as it were, the mandatories of the electorate, inaugurated the change. Sir Charles Wood, speaking in 1855, remarked that in 1828 "changes in our laws were proposed by independent members and carried, not as party questions, by the combined action of both sides of the House. Now," he added, "when an independent member brings forward a subject, it is not to propose himself a measure, but to call to it the attention of the Government. Our defects as legislators, which is *not* our business, damage us as administrators, which *is* our business." In 1825 a private member was able to carry through the House of Commons a measure so bitterly contested as Catholic Emancipation, and though this could not have been done after 1832, it was still, for another half century, possible for private members to surmount the opposition to Bills of less importance. But when a limit was fixed to the time during which opposed business might be taken, and when Government became accustomed to monopolize nearly all the time within that limit, controversial legislation initiated by private members became impossible. A resolute minority, however inconsiderable numerically, can stop the progress of any private member's Bill. The Deceased Wife's Sister Bill won the first place in the ballot in the session of 1902. It was read a second time by a majority of more than two to one on the first Wednesday of the session available for private members' Bills, but, though more favourably circumstanced than any other Bill not introduced by the Government, it made no further progress. Thus the separation of the legislative from the executive power accomplished, after long struggles, by the early parliaments has practically ceased to exist.

Procedure in Foreign Legislative Assemblies.—The average time occupied by a single sitting of the House of Commons is at least double that found necessary by any other European assembly. The usual length of a sitting in each of the French chambers is from four to five hours, from 2 P.M. to about 6.30 P.M. The German Reichstag meets at 1 P.M., and sits on an average for four hours. The Austrian Reichsrath sits from 11 A.M. till about 4 P.M. The Italian Senate sits from 3.30 P.M. till about 6.30 P.M., and the Chamber of Deputies from 2 till about 6 P.M. In the United States, on the other hand, the sittings are even longer than at Westminster. Thus, the House of Representatives meets at 11 A.M., the Senate at noon, and both Houses often sit till late at night. The ordinary method of taking divisions which obtains in the Parliaments of France, Germany, Italy, Austria, and the United States is *par assis et levé*. Members in favour of a motion rise in their places, while those opposed to it remain sitting. This method is more expeditious than that in use at Westminster, the process usually occupying only five minutes, but it must be remembered that in most foreign Chambers members sit in a rising half-circle round the presidential chair, and it is consequently easier for the president to take the opinion of the House in this way than it would be for the Speaker in the existing House of Commons. When the president is in doubt as to the result obtained by *assis et levé*, or at the request of a group of members varying in number in the different assemblies, or, finally, on certain specified occasions, such as the final passing of a Bill, recourse is had to other methods of taking a vote: *e.g.*, in France, to the public ballot; in Austria and Italy, to the roll-call or the ballot; in Germany, to ballot, or to a process resembling that of the British Parliament; and in the United States to the roll-call. In the Senate of the United States divisions are always taken by the roll-call. The number of members necessary to form a quorum is in most assemblies much larger than at Westminster. In the American House of Representatives and in the German Reichstag a quorum consists of an absolute majority of the whole House; in the Austrian Reichsrath, of one hundred members. It is possible that an increase in the quorum of the House of Commons, at present consisting of forty members, might tend to shorten the length of its sittings.

Foreign assemblies, as a rule, meet in the autumn and rise in the early summer. In March 1890 a resolution moved by Sir George Trevelyan, proposing that the House of Commons should in this respect follow their example, was negatived by a majority of only four votes (173 to 169). The French Chamber of Deputies sits on an average about 125 days in the year, and the Senate about 90 days; there are some 86 working days in the session of the German Reichstag; the Italian Chamber sits about 140 days in the year; and the Austrian Lower House about 150 days. The power to suspend the sitting in cases of grave disorder is everywhere possessed by presidents of foreign legislative assemblies. This power was given to the Speaker of the House of Commons on 17th February 1902 by a sessional order which it was proposed to make a Standing Order. In the French and other assemblies Bills do not lapse at a prorogation. Proposals have often been made to introduce this practice into British procedure. A committee, presided over by Mr Goschen, was appointed in 1890 to inquire into the subject. In their report they postulated three principles: (1) That it was desirable to increase the power of the House of Commons to deal with long controversial measures; (2) That it was desirable to shorten the length of sessions; (3) That it was *not* desirable, so long as any alternative remained, to increase the stringency of the closing power. From these principles they deduced the necessity of freeing Parliament in certain cases from the obligation of repeating in two successive sessions the same debate upon the same questions. This report was adopted by a majority of 11 to 9, Mr Gladstone and his Liberal colleagues constituting the minority. Mr Gladstone drew up a counter report, in which he summarized his objections to the proposal. These were in substance: (1) That the advantage of altering the scope of a Bill in a new session would be lost; (2) That the motions at the end of a session for suspending Bills would waste more time than would be economized by the suspensions; (3) That the powers of closure already possessed by the House rendered the change unnecessary; and (4) That the House of Lords might, by a similar Standing Order, assume an unlimited power of postponing Bills passed by the House of Commons. No steps were taken to give effect to the recommendations of the committee. (A. J. S. M.; F. C. H.)

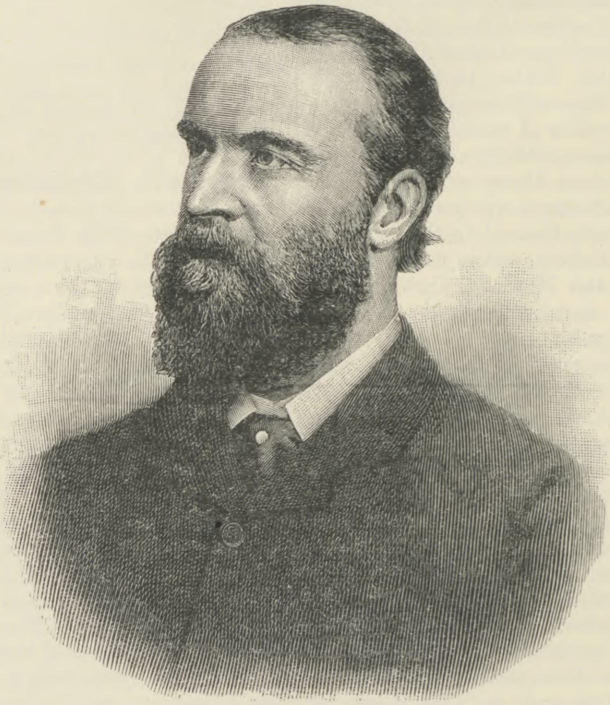
Parma, a town, episcopal see, and capital of the province of Parma, Emilia, Italy, between the Apennines and the Po, 55 miles north-west of Bologna by rail. The university, which was attended by 550 students, with 42 professors, in 1898, and has faculties of law, medicine, and natural science, possesses an observatory and natural science collections, amongst the latter being the Eritrean Zoological Museum. Parma has three theatres, in addition to the ruined Farnese Theatre. It also possesses an officers' school, which is adorned with frescoes by A. Caracci; a royal college, a royal school of music, an agricultural institute, and a technical school. Statues to Garibaldi (1893), Victor Emmanuel (1893), Correggio (1872), and Parmegianino (1879) adorn the town. From archæological discoveries it would appear that the ancient Gallic town was preceded by an Etruscan, and this again by a prehistoric settlement of the Bronze Age, the dwellings of which rested upon piles. Population (1881), 44,492; (1901), 49,370.

Parnell, Charles Stewart (1846–1891), Irish Nationalist leader, was born at Avondale, county Wicklow, on 27th June 1846. His father was John Henry Parnell, a country gentleman of strong Nationalist and Liberal sympathies, who married in 1834 Delia Tudor, daughter of Commodore Charles Stewart of the United States navy. The Parnell family was of English origin, and more than one of its members attained civic note at Congleton in Cheshire under the Stuarts and during the Commonwealth. Among them was Thomas Parnell, who migrated to Ireland after the Restoration. He had two sons, Thomas Parnell the poet and John Parnell, who became an Irish judge. From the latter Charles Stewart Parnell was lineally descended in the fifth generation. Sir John Parnell, Chancellor of the Exchequer in Grattan's Parliament, and one of O'Connell's lieutenants in the Parliament of the United Kingdom, was the grandson of Parnell the judge. The estate of Avondale was settled on him by a friend and bequeathed by him to his youngest son William (grandfather of Charles Stewart Parnell). His eldest son was imbecile. His second son was Sir Henry Parnell, a noted politician and financier in the early part of the 19th century. Sir Henry Parnell moved the resolution which displaced Wellington's Government in 1830. He held office under Grey and Melbourne, and after being raised to the peerage as Baron Congleton, he died by his own hand in 1842. William Parnell was no active politician, though he was a keen student of Irish politics, with a strong leaning towards the popular side, and in 1805 he published a pamphlet entitled "Thoughts on the Causes of Popular Discontents," which was favourably noticed by Sydney Smith in the *Edinburgh Review*. Thus by birth and ancestry, and especially by the influence of his mother, who inherited a hatred of England from her father, Charles Stewart Parnell was, as it were, dedicated to the Irish national cause. He was of English extraction, land-owner, and a Protestant. Educated at private schools in England and at Magdalene College, Cambridge, his temperament and demeanour were singularly un-Irish on the surface—reserved, cold, repellent, and unemotional; and yet no man was ever less English in his political sympathies, methods, and aims. He appears to have been rather turbulent as a school-boy, contentious, insubordinate, and not over-scrupulous. He had few friends, and was not popular with his companions. He was fond of cricket and devoted to mathematics, but had little taste for other studies or other games. He was subject to somnambulism, and liable to severe fits of depression—facts which, taken in connexion with the existence of mental affliction among his ancestors, with his love of solitude and mystery, and his invincible superstitions about omens, numbers, and the like, may perhaps suggest that his own mental equilibrium was not always stable. He was as little at home in an English school or an English university as he was afterwards in the House of Commons. "These English," he said to his brother at school, "despise us because we are Irish; but we must stand up to them. That's the way to treat an Englishman—stand up to him."

Parnell was not an active politician in his early years. He found salvation as a Nationalist and even as a potential rebel over the execution of the "Manchester Martyrs" in 1867, but it was not until some years afterwards that he resolved to enter Parliament. In the meanwhile he paid a lengthened visit to the United States. At the general election of 1874 he desired to stand for the county of Wicklow, of which he was high sheriff at the time. The Lord-Lieutenant declined to relieve him of his disqualifying office, and his brother John stood in his place, but was unsuccessful at the poll. Shortly afterwards a bye-election occurred in Dublin, owing to Colonel Taylor having accepted office in the Disraeli Government, and Parnell resolved to oppose him as a supporter of Isaac Butt, but was heavily beaten. He was, however, elected for Meath in the spring of 1875.

Butt had scrupulously respected the dignity of Parliament and the traditions and courtesy of debate. He looked very coldly on the method of "obstruction"—a method invented by certain members of the Conservative party in opposition to the first Gladstone Administration. Parnell, however, entered Parliament as a virtual rebel who knew that physical force was of no avail, but believed that political exasperation might attain the desired results. It would consolidate the national feeling of Ireland, and might convince the party of physical force that by giving him their covert support he could achieve in the senate what they could never achieve in the field. It was not for nothing that Mr Gladstone had declared that the Manchester murder and the Clerkenwell outrage had "drawn the attention of the people of Great Britain to the Irish question." Parnell resolved to make obstruction in Parliament do the work of outrage in the country, to set the church-bell ringing—to borrow Mr Gladstone's metaphor—and to keep it ringing in season and out of season in the ears of the House of Commons. He did not choose to condemn outrages to gratify the Pharisaism of English members of Parliament. He courted the alliance of the physical force party, and he had to pay the price for it. He invented and encouraged "boycotting," and did not discourage outrage. When a supporter in America offered him twenty-five dollars, "five for bread and twenty for lead," he accepted the gift, and he subsequently told the story on at least one Irish platform. In the course of the negotiations in 1882, which resulted in what was known as the Kilmainham Treaty, he wrote to Captain O'Shea: "If the arrears question be settled upon the lines indicated by us, I have every confidence that the exertions we should be able to make strenuously and unremittingly would be effective in stopping outrages and intimidation of all kinds." This is at least an admission that he had, or could place, his hand on the stop-valve, even if it be not open to the gloss placed on it by Captain O'Shea in a conversation repeated in the House of Commons by Mr Forster, "that the conspiracy which has been used to get up boycotting and outrage will now be used to put them down."

In 1877 Parnell entered on an organized course of obstruction. He and Mr Joseph Gillis Biggar, one of his henchmen, were gradually joined by a small band of the more advanced Home Rulers, and occasionally assisted up to a certain point by one or two English members. Butt was practically deposed and worried into his grave. Shaw, a "transient and embarrassed phantom," was elected in his place, but Parnell became the real leader of a Nationalist party. The original Home Rule party was split in twain, and after the general election of 1880 the more moderate section of it ceased to exist. Obstruction in Parnell's hands was no mere weapon of delay and exasperation; it was a calculated policy, the initial stage of a campaign designed to show the malcontents in Ireland and their kinsmen in other lands that Butt's strictly constitutional methods were quite helpless, but that the parliamentary armoury still contained weapons which he could so handle as to convince the Irish people and even the Fenian and other physical force societies that the way to Irish legislative independence lay through the House of Commons. The Fenians were hard to convince, but in the autumn of 1877 Parnell persuaded the Home Rule Confederation of Great Britain (an association founded by Butt, but largely supported by Fenians) to depose Butt from its presidency and to elect himself in his place. He defined his attitude quite clearly in a speech delivered in New York early in 1880:—"A true revolutionary movement in Ireland should, in my opinion, partake both of a constitutional and illegal character. It should be both an open and a secret organization, using the constitution for its own purposes, but also taking advantage of its secret combination." Parnell's opportunity came with the general election of 1880, which displaced the Conservative Government of Lord Beaconsfield and restored Mr Gladstone to power with a majority strong enough at the outset to overpower the Opposition, even should the latter be reinforced by the whole of Parnell's contingent. Distress was acute in Ireland, and famine was imminent. Ministers had taken measures to relieve the situation before the dissolution was announced, but Lord Beaconsfield had warned the country that there was a danger ahead in Ireland "in its ultimate results scarcely less disastrous



CHARLES STEWART PARNELL.
(From a photograph by William Lawrence, Dublin.)

than pestilence and famine. . . . A portion of its population is attempting to sever the constitutional tie which unites it to Great Britain in that bond which has favoured the power and prosperity of both. It is to be hoped that all men of light and leading will resist this destructive doctrine." The Liberal party and its leaders retorted that they were as strongly opposed to Home Rule as their opponents, but Lord Beaconsfield's manifesto undoubtedly had the effect of alienating the Irish vote in the English constituencies from the Tory party and throwing it on the side of the Liberal candidates. This was Parnell's deliberate policy. He would have no alliance with either English party. He would support each in turn with a sole regard to the balance of political power in Parliament and a fixed determination to hold it in his own hands if he could. From the time that he became its leader the Home Rule party sat together in the House of Commons and always on the Opposition side. Even when Mr Gladstone had formed a Home Rule Government in 1886 and introduced a Home Rule Bill, Parnell declined to follow the precedent set by O'Connell, who crossed the House with his followers and took his place on the ministerial side under the second Government of Lord Melbourne.

In the Government formed by Mr Gladstone in 1880 Lord Cowper became viceroy and Mr W. E. Forster chief secretary for Ireland. The outlook was gloomy enough, but the Gladstone Government do not seem to have anticipated, as Peel anticipated in 1841, that Ireland would be their difficulty. Yet the Land League had been formed by Mr Michael Davitt and others in the autumn of 1879 for the purpose of agrarian agitation, and Parnell after some hesitation had given it his sanction. He visited the United States at the close of 1879. It was then and there that the "new departure"—the alliance of the open and the secret organizations — was confirmed and consolidated. Parnell obtained the countenance and support of the Clan-na-Gael, a revolutionary organization of the American-Irish, and the Land League began to absorb all the more violent spirits in Ireland, though the Fenian brotherhood still held officially aloof from it. As soon as the general election was announced Parnell returned to Ireland in order to direct the campaign in person. Though he had supported the Liberals at the election, he soon found himself in conflict with a Government which could neither tolerate disturbance nor countenance a Nationalist agitation, and he entered on the struggle with forces organized, with money in his chest, and with a definite but still undeveloped plan of action. The prevailing distress increased and outrages began to multiply. A fresh Relief Bill was introduced by the Government, and in order to stave off a measure to prevent evictions introduced by the Irish party, Mr Forster consented to add a clause to the Relief Bill for giving compensation in certain circumstances to tenants evicted for non-payment of rent. This clause was afterwards embodied in a separate measure known as the Compensation for Disturbance Bill, which after a stormy career in the House of Commons was summarily rejected by the House of Lords.

The whole Irish question was once more opened up in its more dangerous and more exasperating form. It became clear that the land question — supposed to have been settled by Mr Gladstone's Act of 1870—would have to be reconsidered in all its bearings, and a commission was appointed for the purpose. In Ireland things went from bad to worse. Evictions increased and outrages were multiplied. Intimidation and boycotting were rampant. As the winter wore on, Mr Forster persuaded his colleagues that exceptional measures were needed. An abortive prosecution of Parnell and some of his leading colleagues had by this time intensified the situation. Parliament was summoned early, and a Coercion Bill for one year, practically suspending the Habeas Corpus Act and allowing the arrest of suspects at the discretion of the Government, was introduced, to be followed shortly by an Arms Bill. Parnell regarded the measure as a declaration of war, and met it in that spirit. Its discussion was doggedly obstructed at every stage, and on one occasion the debate was only brought to a close, after lasting for forty-one hours, by the Speaker's claiming to interpret the general sense of the House and resolving to put the question without further discussion. The rules of procedure were then amended afresh in a very drastic sense, and as soon as the Bill was passed Mr Gladstone introduced a new Land Bill, which occupied the greater part of the session. Parnell accepted it with many reserves. He could not ignore its concessions, and was not disposed to undervalue them, but he had to make it clear to the revolutionary party, whose support was indispensable, that he regarded it only as a payment on account, even from the agrarian point of view, and no payment at all from the national point of view. Accordingly the Land League at his instigation determined to "test" the Act by advising tenants in general to refrain from taking their cases into court until certain cases selected by the Land League had been decided. The Government treated this policy, which was certainly not designed to make the Act work freely and beneficially, as a deliberate attempt to intercept its benefits and to keep the Irish people in subjection to the Land League; and on this and other grounds—notably the attitude of the League and its leaders towards crime and outrage—Parnell was arrested under the Coercion Act and lodged in Kilmainham gaol (17th October 1881).

Parnell in prison at once became more powerful for evil than he had ever been, either for good or for evil, outside. He may have known that the policy of Mr Forster was little favoured by several of his colleagues, and he probably calculated that the detention of large numbers of suspects without cause assigned and without trial would sooner or later create opposition in England. Mr Forster had assured his colleagues and the House of Commons that the power of arbitrary arrest would enable the police to lay their hands on the chief agents of disturbance, and it was Parnell's policy to show that so long as the grievances of the Irish tenants remained unredressed no number of arrests could either check the tide of outrage or restore the country to tranquillity. Several of his leading colleagues followed him into captivity at Kilmainham, and the Land League was dissolved, its treasurer, Patrick Egan, escaping to Paris and carrying with him its books and accounts. Before it was formally suppressed the League had issued a manifesto, signed by Parnell and several of his fellow-prisoners, calling upon the tenants to pay no rents until the Government had restored the constitutional rights of the people. Discouraged by the priests, the No-Rent manifesto had little effect, but it embittered the struggle and exasperated the temper of the people on both sides of the Irish Channel.

Lord Cowper and Mr Forster were compelled to ask for a renewal of the Coercion Act with enlarged powers. But there were members of the Cabinet who had only accepted it with reluctance, and were now convinced not only that it had failed, but that it could never succeed. A *modus vivendi* was desired on both sides. Parnell was tired of imprisonment and solicitous for his ascendancy in Ireland; Mr Gladstone was impatient of failure. Negotiations were set on foot through the agency of Captain O'Shea—at that time and for long afterwards a firm political and personal friend of Parnell, but ultimately his accuser in the Divorce Court—and after a somewhat intricate course they resulted in what was known as the Kilmainham Treaty. As a consequence of this informal agreement, Parnell and two of his friends were to be released at once, the understanding being, as Mr Gladstone stated in a letter to Lord Cowper, "that Parnell and his friends are ready to abandon 'No Rent' formally, and to declare against outrage energetically, intimidation included, if and when the Government announce a satisfactory plan for dealing with arrears." Parnell's own version of the understanding has been quoted above. It also included a hope that the Government would allow the Coercion Act to lapse and govern the country by the same laws as in England. Parnell and his friends were released, and Lord Cowper and Mr Forster at once resigned.

The Phœnix Park murders (7th May 1882) followed (see IRELAND: *History*). Parnell was prostrated by this catastrophe. In a public manifesto to the Irish people he declared that "no act has ever been perpetrated in our country, during the exciting struggle for social and political rights of the past fifty years, that has so stained the name of hospitable Ireland as this cowardly and unprovoked assassination of a friendly stranger." Privately to his own friends and to Mr Gladstone he expressed his desire to withdraw from public life. There were those who believed that nevertheless he was privy to the Invincible conspiracy. There is some *primâ facie* foundation for this belief in the indifference he had always displayed towards crime and outrage when crime and outrage could be made to serve his purpose; in his equivocal relation to the more violent and unscrupulous forms of Irish sedition, and in the fact that Byrne, an official of the Land League, was in collusion with the Invincibles, that the knives with which the murder was done had been concealed at the offices of the Land League in London, and had been conveyed to Dublin by Byrne's wife. But the maxim *is fecit cui prodest* disallows these suspicions. Parnell gained nothing by the murders, and seemed for a time to have lost everything. A new Crimes Bill was introduced and made operative for a period of three years. A régime of renewed coercion was maintained by Lord Spencer and Mr (afterwards Sir George) Trevelyan, who had succeeded Lord Frederick Cavendish in the office of Chief Secretary; Ireland was tortured for three years by the necessary severity of its administration, and England was exasperated by a succession of dynamite outrages organized chiefly in America, which Parnell was powerless to prevent. The Phœnix Park murders did more than any other incident of his time and career to frustrate Parnell's policy and render Home Rule impossible. He had denounced the murders; forthwith the Irish revolutionaries began to suspect him as a mere Whig and time-server. He had connived at other crimes, and seemed to the majority of Englishmen to be a reckless and unscrupulous conspirator, the friend of murderers and assassins.

For more than two years after the Phœnix Park murders Parnell's influence in Parliament, and even in Ireland, was only intermittently and not very energetically exerted. His health was indifferent, his absences from the House of Commons were frequent and mysterious, and he had already formed those relations with Mrs O'Shea which were ultimately to bring him to the Divorce Court. The Phœnix Park murderers were arrested and brought to justice early in 1883. Mr Forster seized the opportunity to deliver a scathing indictment of Parnell in the House of Commons. In an almost contemptuous reply Parnell repudiated the charges in general terms, disavowed all sympathy with dynamite outrages, their authors, and abettors—the only occasion on which he ever did so—declined to plead in detail before an English tribunal, and declared that he sought only the approbation of the Irish people. This last was shortly afterwards manifested in the form of a subscription known as the "Parnell Tribute," which quickly reached the amount of £37,000, and was presented to Parnell, partly for the liquidation of debts he was known to have contracted, but mainly in recognition of his public services. The Irish National League, a successor to the suppressed Land League, was founded in the autumn of 1882 at a meeting over which Parnell presided, but he looked on it at first with little favour, and its action was largely paralysed by the operation of the Crimes Act and the vigorous administration of Lord Spencer.

The Crimes Act, passed in 1882, was to expire in 1885, but the Government of Mr Gladstone was in no position to renew it as it stood. In May notice was given for its partial renewal, subject to changes more of form than of substance. The second reading was fixed for 10th June. On 8th June Parnell, with thirty-nine of his followers, voted with the Opposition against the Budget, and defeated the Government by a majority of 264 votes to 252. Mr Gladstone forthwith resigned. Lord Salisbury undertook to form a Government, and Lord Carnarvon became viceroy. The session was rapidly brought to an end with a view to the dissolution rendered necessary by the Franchise Act passed in 1884—a measure which was certain to increase the number of Parnell's adherents in Parliament. It seems probable that Parnell had convinced himself before he resolved to join forces with the Opposition that a Conservative Government would not renew the Crimes Act. At any rate, no attempt to renew it was made by the new Government, which showed itself strangely complaisant towards Parnell and his followers by consenting to an inquiry, which Lord Spencer and his colleagues had steadfastly refused, into certain matters connected with recent agrarian murders and their punishment. Moreover, Lord Carnarvon, the new viceroy, was known to Parnell and to some others among the Irish leaders to be not unfavourable to some form of Home Rule if due regard were paid to imperial unity and security. He sought and obtained a personal interview with Parnell, explicitly declared that he was speaking for himself alone, heard Parnell's views, expounded his own, and forthwith reported what had taken place to the Prime Minister. In the result the new Cabinet refused to move in the direction apparently desired by Lord Carnarvon.

Parnell opened the electoral campaign with a speech in Dublin, in which he pronounced unequivocally in favour of self-government for Ireland, and expressed his confident hope "that it may not be necessary for us in the new Parliament to devote our attention to subsidiary measures, and that it may be possible for us to have a programme and a platform with only one plank, and that one plank National Independence." This was startling to English ears. The Press denounced Parnell; Lord Hartington (afterwards the Duke of Devonshire) protested against so fatal and mischievous a programme; Mr Chamberlain repudiated it with even greater emphasis. Meanwhile Mr Gladstone was slowly convincing himself that the passing of the Franchise Act had made it the duty of English statesmen and English party leaders to give a respectful hearing to the Irish National demand, and to consider how far it could be satisfied subject to the governing principle of "maintaining the supremacy of the Crown, the unity of the Empire, and all the authority of Parliament necessary for the conservation of the unity." This was the position he took up in the Hawarden Manifesto issued in September before the general election of 1885. Speaking later at Newport in October, Lord Salisbury treated the Irish leader with unwonted deference and respect, as though he were willing to parley with him, though he repudiated the analogy of Austria and Hungary as indicating a possible solution of the Irish problem in a federal sense. Parnell, however, took no notice of the Newport speech, and waited for Mr Gladstone to declare himself more fully in Midlothian. But in this he was disappointed. Mr Gladstone went no farther than he had gone at Hawarden, and he implored the electorate to give him a majority independent of the Irish vote. Subsequently Parnell invited him in a public speech to declare his policy and to sketch the constitution he would give to Ireland subject to the limitations he had insisted on. To this Mr Gladstone replied, "through the same confidential channel," that he could not consider the Irish demand before it had been constitutionally formulated, and that, not being in an official position, he could not usurp the functions of a Government. The reply to this was the issue of a manifesto to the Irish electors of Great Britain violently denouncing the Liberal party and directing all Irish Nationalists to give their votes to the Tories. In these circumstances the general election was fought, and resulted in the return of 335 Liberals, four of whom were classed as "independent," 249 Conservatives, and 86 followers of Parnell.

Mr Gladstone had now ascertained the strength of the Irish demand, but was left absolutely dependent on the votes of those who represented it. Through Mr Arthur Balfour he made informal overtures to Lord Salisbury proffering his own support in case the Prime Minister should be disposed to consider the Irish demand in a "just and liberal spirit"; but he received no encouragement. Towards the close of the year it became known through various channels that he himself was considering the matter and had advanced as far as accepting the principle of an Irish Parliament in Dublin for the transaction of Irish affairs. Before the end of January Lord Salisbury's Government was defeated on the Address, the Opposition including the full strength of the Irish party. Mr Gladstone once more became Prime Minister, with Mr John Morley (an old Home Ruler) as Chief Secretary, and Mr Chamberlain provisionally included in the Cabinet. Lord Hartington, Mr Bright, and some other Liberal chiefs, however, declined to join him.

Mr Gladstone's return to power at the head of an Administration conditionally committed to Home Rule marks the culminating point of Parnell's influence on English politics and English parties. The history of the Home Rule Government and of the Home Rule Bill introduced by it is narrated under IRELAND and ENGLAND: *History*. It must suffice to say here, that after the defeat of the Home Rule Ministry in 1886, Parnell associated himself more closely with the Liberal Opposition. At the same time he withdrew himself largely from active interposition in current parliamentary affairs, and relaxed his control over the action and policy of his followers in Ireland. He entered occasionally into London society—where in certain quarters he was now a welcome guest—but in general he lived apart, often concealing his whereabouts and giving no address but the House of Commons, answering no letters, and seldom fulfilling engagements. He seems to have thought that Home Rule being now in the keeping of an English party, it was time to show that he had in him the qualities of a statesman as well as those of a revolutionary and a rebel. His influence on the remedial legislation proposed by the Unionist Government for Ireland was considerable, and he seldom missed an opportunity of making it felt. It more than once happened to him to find measures, which had been contemptuously rejected when he had proposed them, ultimately adopted by the Government; and it may be that the comparative tranquillity which Ireland enjoyed at the close of the 19th century was due quite as much to legislation inspired and recommended by himself as to the disintegration of his following which ensued upon his appearance in the Divorce Court and long survived his death. No sooner was Lord Salisbury's new Government installed in office in 1886, than Parnell introduced a comprehensive Tenants' Relief Bill. The Government would have none of it, though in the following session they adopted and carried many of its leading provisions. Its rejection was followed by renewed agitation in Ireland, in which Parnell took no part. He was ill—"dangerously ill," he said himself at the time—and some of his more hot-headed followers devised the famous "Plan of Campaign," on which he was never consulted and which never had his approval. Ireland was once more thrown into a turmoil of agitation, turbulence, and crime, and the Unionist Government, which had hoped to be able to govern the country by means of the ordinary law, was compelled to resort to severe repressive measures and fresh coercive legislation. Mr Balfour became Chief Secretary, and early in the session of 1887 the new measure was introduced and carried. Parnell took no very prominent part in resisting it. In the course of the spring *The Times* had begun publishing a series of articles entitled "Parnellism and Crime," on lines following Mr Forster's indictment of Parnell in 1883, though with much greater detail of circumstance and accusation. Some of the charges were undoubtedly well founded, some were exaggerated, some were merely the colourable fictions of political prepossession, pronounced to be not proven by the special commission which ultimately inquired into them. One of the articles, which appeared on 18th April, was accompanied by the facsimile of a letter purporting to be signed but not written by Parnell, in which he apologized for his attitude on the Phœnix Park murders, and specially excused the murder of Mr Burke. On the same evening, in the House of Commons, Parnell declared the letter to be a forgery, and denied that he had ever written any letter to the same effect. He was not believed, and the second reading of the Crimes Act followed. Later in the session the attention of the House was again called to the subject, and it was invited by Sir Charles Lewis, an Ulster member and a bitter antagonist of the Nationalists, to declare the charges of *The Times* a breach of privilege. The Government met this proposal by an offer to pay the expenses of a libel action against *The Times* to be brought on behalf of the Irish members incriminated. This offer was refused. Mr Gladstone then proposed that a select committee should inquire into the charges, including the letter attributed to Parnell, and to this Parnell assented. But the Government rejected the proposal. For the rest, Parnell continued to maintain for the most part an attitude of moderation, reserve, and retreat, though he more than once came forward to protest against the harshness of the Irish administration and to plead for further remedial legislation. In July 1888 he announced that Mr Cecil Rhodes had sent him a sum of £10,000 in support of the Home Rule movement, subject to the condition that the Irish representation should be retained in the House of Commons in any future measure dealing with the question. About the same time the question of "Parnellism and Crime" again became acute. Mr F. H. O'Donnell, an ex-M.P. and former member of the Irish party, brought an action against *The Times* for libel. His case was a weak one, and a verdict was obtained by the defendants. But in the course of the proceedings the Attorney-General, counsel for *The Times*, affirmed the readiness of his clients to establish all the charges advanced, including the genuineness of the letter which Parnell had declared to be a forgery. Parnell once more invited the House of Commons to refer this particular issue—that of the letter—to a select committee. This was again refused; but after some hesitation the Government resolved to appoint by Act of Parliament a special commission, composed of three judges of the High Court, to inquire into all the charges advanced by *The Times*. This led to what was in substance, though not perhaps in judicial form, the most remarkable State trial of the 19th century. The commission began to sit in September 1888, and issued its report in February 1890. It heard evidence of immense volume and variety, and the speech of Sir Charles Russell in defence was afterwards published in a bulky volume. Parnell gave evidence at great length, with much composure and some cynicism. On the whole he produced a not unfavourable impression, though some of his statements might seem to justify Mr Gladstone's opinion that he was not a man of exact veracity. The report of the commission was a very voluminous document, and was very variously interpreted by different parties to the controversy. Their conclusions may be left to speak for themselves:—

"I. We find that the respondent members of Parliament collectively were not members of a conspiracy having for its object to establish the absolute independence of Ireland, but we find that some of them, together with Mr Davitt, established and joined in the Land League organization with the intention, by its means, to bring about the absolute independence of Ireland as a separate nation.

"II. We find that the respondents did enter into a conspiracy, by a system of coercion and intimidation, to promote an agrarian agitation against the payment of agricultural rents, for the purpose of impoverishing and expelling from the country the Irish landlords, who were styled 'the English garrison.'

"III. We find that the charge that 'when on certain occasions they thought it politic to denounce, and did denounce, certain crimes in public, they afterwards led their supporters to believe such denunciations were not sincere,' is not established. We entirely acquit Mr Parnell and the other respondents of the charge of insincerity in their denunciation of the Phœnix Park murders, and find that the 'facsimile' letter, on which this charge was chiefly based as against Mr Parnell, is a forgery.

"IV. We find that the respondents did disseminate the *Irish World* and other newspapers tending to incite to sedition and the commission of other crime.

"V. We find that the respondents did not directly incite persons to the commission of crime other than intimidation, but that they did incite to intimidation, and that the consequence of that incitement was that crime and outrage were committed by the persons incited. We find that it has not been proved that the respondents made payments for the purpose of inciting persons to commit crime.

"VI. We find, as to the allegation that the respondents did nothing to prevent crime, and expressed no *bonâ fide* disapproval, that some of the respondents, and in particular Mr Davitt, did express *bonâ fide* disapproval of crime and outrage, but that the respondents did not denounce the system of intimidation that led to crime and outrage, but persisted in it with knowledge of its effect.

"VII. We find that the respondents did defend persons charged with agrarian crime, and supported their families; but that it has not been proved that they subscribed to testimonials for, or were intimately associated with, notorious criminals, or that they made payments to procure the escape of criminals from justice.

"VIII. We find, as to the allegation that the respondents made payments to compensate persons who had been injured in the commission of crime, that they did make such payments.

"IX. As to the allegation that the respondents invited the assistance and co-operation of, and accepted subscriptions of money from, known advocates of crime and the use of dynamite, we find that the respondents did invite the assistance and co-operation of, and accepted subscriptions of money from, Patrick Ford, a known advocate of crime and the use of dynamite; but that it has not been proved that the respondents, or any of them, knew that the Clan-na-Gael controlled the League, or was collecting money for the Parliamentary Fund. It has been proved that the respondents invited and obtained the assistance and co-operation of the Physical Force Party in America, including the Clan-na-Gael, and in order to obtain that assistance abstained from repudiating or condemning the action of that party."

The specific charges brought against Parnell personally were thus dealt with by the commissioners:—

"(*a*) That at the time of the Kilmainham negotiations Mr Parnell knew that Sheridan and Boyton had been organizing outrage, and therefore wished to use them to put down outrage.

"We find that this charge has not been proved.

"(*b*) That Mr Parnell was intimate with the leading Invincibles; that he probably learned from them what they were about when he was released on *parole* in April 1882; and that he recognized the Phœnix Park murders as their handiwork.

"We find that there is no foundation for this charge. We have already stated that the Invincibles were not a branch of the Land League.

"(*c*) That Mr Parnell on 23rd January 1883, by an opportune remittance, enabled F. Byrne to escape from justice to France.

"We find that Mr Parnell did not make any remittance to enable F. Byrne to escape from justice."

The case of the *facsimile* letter alleged to have been written by Parnell broke down altogether. It was proved to be a forgery. It had been purchased with other documents from one Pigott, a needy and disreputable Irish journalist, who afterwards tried to blackmail Archbishop Walsh by offering, in a letter which was produced in court, to confess its forgery. Mercilessly cross-examined by Sir Charles Russell on this letter to the archbishop, Pigott broke down utterly. Before the commission sat again he fled to Madrid, and there blew his brains out. He had confessed the forgery to Mr Labouchere in the presence of Mr G. A. Sala, but did not stay to be cross-examined on his confession. The Attorney-General withdrew the letter on behalf of *The Times*, and the commission pronounced it to be a forgery. Shortly after the letter had been withdrawn, Parnell filed an action against *The Times* for libel, claiming damages to the amount of £100,000. The action was compromised without going into court by a payment of £5000.

Practically, the damaging effect of some of the findings of the commission was neutralized by Parnell's triumphant vindication in the matter of the *facsimile* letter and of the darker charges levelled at him. Parties remained of the same opinion as before: the Unionists still holding that Parnell was steeped to the lips in treason, if not in crime; while the Home Rulers made abundance of capital out of his personal vindication, and sought to excuse the incriminating findings of the commission by the historic antecedents of the Nationalist cause and party. The failure to produce the books and papers of the Land League was overlooked, and little importance was attached by partisans to the fact that in spite of this default (leaving unexplained the manner in which over £100,000 had been expended), the commissioners "found that the respondents did make payments to compensate persons who had been injured in the commission of crime." Parnell and his colleagues were accepted as allies worthy of the confidence of an English party; they were made much of in Gladstonian Liberal society; and towards the close of 1889, before the commission had reported, but some months after the forged letter had been withdrawn, Parnell visited Hawarden to confer with Mr Gladstone on the measure of Home Rule to be introduced by the latter should he again be restored to power. What occurred at this conference was afterwards disclosed by Parnell, but Mr Gladstone vehemently denied the accuracy of his statements on the subject.

But Parnell's fall was at hand. In December 1889 Captain O'Shea filed a petition for divorce on the ground of his wife's adultery with Parnell. Parnell's intimacy with Mrs O'Shea had begun in 1881, though at what date it became a guilty one is not in evidence. Captain O'Shea had in that year challenged him to a duel, but was pacified by the explanations of Mrs O'Shea. It is known that Captain O'Shea had been Parnell's confidential agent in the negotiation of the Kilmainham Treaty, and in 1885 Parnell had strained his personal authority to the utmost to secure

Captain O'Shea's return for Galway, and had quelled a formidable revolt among some of his most influential followers in doing so. It is not known why Captain O'Shea, who, if not blind to a matter of notoriety, must have been complaisant in 1885, became vindictive in 1889. No defence being offered, a decree of divorce was pronounced, and in June 1891 Parnell and Mrs O'Shea were married.

At first the Irish party determined to stand by Parnell. The decree was pronounced on 17th November 1890. On the 20th a great meeting of his political friends and supporters was held in Dublin, and a resolution that in all political matters Parnell possessed the confidence of the Irish nation was carried by acclamation. But the Irish party reckoned without its English allies. The "Nonconformist conscience," which had swallowed the report of the commission, was shocked by the decree of the Divorce Court. At a meeting of the National Liberal Federation held at Sheffield on 21st November, Mr John Morley was privately but firmly given to understand that the Nonconformists would insist on Parnell's resignation. Parliament was to meet on the 25th. Mr Gladstone tried to convey to Parnell privately his conviction that unless Parnell retired the cause of Home Rule was lost. But the message never reached Parnell. Mr Gladstone then requested Mr John Morley to see Parnell; but he could not be found. Finally, on the 24th, Mr Gladstone wrote to Mr Morley the famous and fatal letter, in which he declared his conviction "that, notwithstanding the splendid services rendered by Mr Parnell to his country, his continuance at the present moment in the leadership would be disastrous in the highest degree to the cause of Ireland," and that "the continuance I speak of would not only place many hearty and effective friends of the Irish cause in a position of great embarrassment, but would render my retention of the leadership of the Liberal party, based as it has been mainly upon the presentation of the Irish cause, almost a nullity." This letter was not published until after the Irish parliamentary party had met in the House of Commons and re-elected Parnell as its chairman without a dissentient voice. But its publication was a thunder-clap. A few days later Parnell was requested by a majority of the party to convene a fresh meeting. It took place in Committee Room No. 15, which became historic by the occasion, and after several days of angry recrimination and passionate discussion, during which Parnell, who occupied the chair, scornfully refused to put to the vote a resolution for his own deposition, 45 members retired to another room and there declared his leadership at an end. The remainder, twenty-six in number, stood by him. The party was thus divided into Parnellites and anti-Parnellites, and the schism was not healed until several years after Parnell's death.

This was practically the end of Parnell's political career in England. The scene of operations was transferred to Ireland, and there Parnell fought incessantly a bitter and a losing fight, which ended only with his death. He declared that Ireland could never achieve her emancipation by force, and that if she was to achieve it by constitutional methods, it could only be through the agency of a united Nationalist party rigidly eschewing alliance with any English party. This was the policy he proclaimed in a manifesto issued before the opening of the sittings in Committee Room No. 15, and with this policy, when deserted by the bulk of his former followers, he appealed to the Fenians in Ireland—"the hillside men," as Mr Davitt, who had abandoned him early in the crisis, contemptuously called them. The Fenians rallied to his side, giving him their votes and their support, but they were no match for the Church, which had declared against him. An attempt at reconciliation was made in the spring, at what was known as "the Boulogne negotiations," where Mr William O'Brien endeavoured to arrange an understanding; but it came to nothing in the end. Probably Parnell was never very anxious for its success. He seems to have regarded the situation as fatally compromised by the extent to which his former followers were committed to an English alliance, and he probably saw that the only way to recover his lost position was to build up a new independent party. He knew well enough that this would take time—five years was the shortest period he allowed himself—but before many months were passed he was dead. The life he led, the agonies he endured, the labours he undertook from the beginning of 1891, travelling weekly to Ireland and intoxicating himself with the atmosphere of passionate nationalism in which he moved, would have broken down a much stronger man. He who had been the most impassive of men became restless, nervous, almost distracted at times, unwilling to be alone, strange in his ways and demeanour. He visited Ireland for the last time late in September, and the last public meeting he attended was on the 27th of that month. The next day he sent for his friend Dr Kenny, who found him suffering from acute rheumatism and general debility. He left Ireland on the 30th, promising to return on the following Saturday week. He did return on that day, but it was in his coffin. He took to his bed shortly after his return to his home at Brighton, and on 6th October he died. His remains were conveyed to Dublin, and on Sunday, 11th October, they were laid to rest in the presence of a vast assemblage of the Irish people in Glasnevin Cemetery, not far from the grave of O'Connell.

The principal materials for a biography of Parnell and the history of the Parnellite movement are to be found in *Hansard's Parliamentary Debates*, 1875–91; in the *Annual Register* for the same period; in the *Report of the Special Commission* issued in 1890; in *The Life of Charles Stewart Parnell*, by R. Barry O'Brien; in *The Parnellite Movement*, by T. P. O'Connor, M.P.; and in a copious biography of Parnell contributed by an anonymous but well-informed writer to the *Dictionary of National Biography*, vol. xliii. (J. R. T.)

Paropamisus. See Herat.

Parramatta, a town of Australia, New South Wales, on the Parramatta river, in the county of Cumberland, 14 miles west of Sydney by rail. It is the oldest town in all Australia, and round it the first grain of the colony was grown. It is now noted for its orangeries and orchards. The mean rainfall (15 years) is 38·95 inches. Population (1891), 11,677; (1901), 12,560.

Parry, Sir Charles Hubert Hastings, Bart., English musical composer (1848-——), the second son of Thomas Gambier Parry, of Highnam Court, Gloucester, was born at Bournemouth, 27th February 1848. He was educated at Malvern, Twyford, near Winchester, Eton (from 1861), and Exeter College, Oxford. While still at Eton he wrote music, two anthems being published in 1865; a service in D was dedicated to Sir John Stainer. He took the degree of Mus.B. at Oxford at the age of eighteen, and that of B.A. in 1870; he then left Oxford for London, where in the following year he entered Lloyd's, abandoning business for art soon afterwards. He studied successively with H. H. Pierson (at Stuttgart), Sterndale Bennett, and Macfarren; but the man to whom the most important part of his artistic development was due was Mr Edward Dannreuther, at whose private concerts his chamber compositions were frequently performed. Among the larger works of this early period must be mentioned an overture, *Guillem de Cabestanh*

(Crystal Palace, 1879), a pianoforte concerto in F sharp minor, played by Dannreuther at the Crystal Palace and Richter Concerts in 1880, and his first choral work, the *Scenes from Prometheus Unbound*, produced at the Gloucester Festival, 1880. These, like a symphony in G, given at the Birmingham Festival of 1882, were distinctly caviare to the general; the ideas seemed strange even to educated hearers, who were further confused by the intricacy of their treatment. It was not until Shirley's ode, *The Glories of our Blood and State*, was brought out at Gloucester, 1883, and the *Partita* for violin and pianoforte was published about the same time, that Parry's importance came to be realized. With his sublime eight-part setting of Milton's *Blest Pair of Sirens* (Bach Choir, 1887) began a fine series of compositions to sacred or semi-sacred words. In *Judith* (Birmingham, 1888), the *Ode on St Cecilia's Day* (Leeds, 1889), *L'Allegro ed il Penseroso* (Norwich, 1890), *De Profundis* (Hereford, 1891), *The Lotus Eaters* (Cambridge, 1892), *Job* (Gloucester, 1892), *King Saul* (Birmingham, 1894), *Invocation to Music* (Leeds, 1895), *Magnificat* (Hereford, 1897), *A Song of Darkness and Light* (Gloucester, 1898), and *Te Deum* (Hereford, 1900), are revealed the highest qualities of music. Skill in piling up climax after climax, and command of every choral resource, are the technical qualities most prominent in these works; but in his orchestral compositions, such as the three later symphonies, in F, C, and E minor, in two suites, one for strings alone, and above all in his *Symphonic Variations* (1897), he shows himself a master of the orchestra, and his experiments in modification of the conventional classical forms, such as appear in the work last named, or in the *Nineteen Variations for Pianoforte Solo*, are always successful. His music to *The Birds* of Aristophanes (Cambridge, 1883) and *The Frogs* (Oxford, 1892) are striking examples of humour in music; and that to *Agamemnon* (Cambridge, 1900) is among the most impressive compositions of the kind. His chamber music, exquisite part songs, and solo songs maintain the high standard of his greater works. At the opening of the Royal College of Music in 1883 he was appointed professor of composition and of musical history, and in 1894, on the retirement of Sir George Grove, Parry succeeded him as principal. He was appointed Choragus of Oxford University in 1883, succeeding Stainer in the professorship of the University in 1900. He received the honorary degree of Mus.D. at Cambridge 1883, Oxford 1884, Dublin 1891; and was knighted in 1898. Outside the domain of creative music, Parry's work for the art has been of the greatest importance: as a contributor of many of the most important articles on musical forms, &c., in Grove's dictionary, his literary work first attracted attention; in his *Studies of Great Composers* musical biography was treated, almost for the first time, in a really enlightened and enlightening way; and his *Art of Music* is a splendid monument of musical literature, in which the theory of evolution is applied to musical history with wonderful skill and success.

Parsons, a city of Labette county, Kansas, U.S.A. It is situated at the intersection of the Kansas City, Fort Scott and Memphis, and the Missouri, Kansas, and Texas railways, in the south-eastern part of the state, at an altitude of 900 feet. Its site is level and its plan regular. It is in a rich farming country, and has a large trade. It contains railway offices and works, foundries and furniture factories. Population (1880), 4199; (1890), 6736; (1900), 7682, of whom 378 were foreign-born and 807 negroes.

Partabgarh, or PRATAPGARH, a district of British India, in the Fyzabad division of Oudh. The administrative headquarters are at Bela. Area, 1439 square miles; population (1881), 847,047; (1891), 910,895; (1901), 891,095, showing an increase of nearly 8 per cent. between 1881 and 1891, but a decrease of 2·2 per cent. between 1891 and 1901; average density, 619 persons per square mile, or almost one person to every acre in a tract that is entirely rural.

The land revenue and rates are Rs.10,71,800, the incidence of assessment being R.1 : 5 : 3 per acre; cultivated area (1896–97), 463,808 acres, of which 273,848 were irrigated from wells and tanks; number of police, 730; vernacular schools, 132, with 5225 pupils; registered death-rate (1897), 42 per thousand. The principal crops are rice, pulse, barley, sugar-cane, opium, and indigo. There are 47 indigo factories, with an out-turn valued at Rs.1,46,000. The district is traversed by the branch of the Oudh and Rohilkhand railway from Rae Bareli to Benares, which was opened in 1898. There are no Government canals. It manufactures sugar, and has a hemp-pressing factory.

Partabgarh, or PERTABGARH, a native state of India, in the Rajputana agency. Area, 959 square miles; population (1881), 79,298; (1891), 87,975; (1901), 52,029, showing an increase of 11 per cent. between 1881 and 1891, but a decrease of 40·9 between 1891 and 1901; average density, 54 persons per square mile; revenue (1896–97), Rs.4,01,387. A metalled road has been opened from PARTABGARH town to Mandesaur, on the Rajputana railway, 19 miles. The mint was closed in 1897. The town has a population of 13,000.

Partap [or PERTAB] **Singh, Sir** (1844-——), native Indian soldier and statesman, belonging to the Rathor rajputs of the Jodha class, was born in 1844, being the son of Maharaja Takht Singh, ruler of Marwar (or Jodhpur). In 1878 and again in 1879 he was chief minister of Jodhpur. In the following year he accompanied the British mission to Afghanistan, and on his return he resumed his duties as chief minister, carrying out many judicious reforms and administering Jodhpur with remarkable success. He visited England to take part in the celebration of the 1887 Jubilee of Queen Victoria's reign. His high soldierly instincts induced him to offer his services when war broke out on the north-western frontier of India, and he served on the staffs of Sir William Lockhart and General Elles in the Tirah and Momand expeditions beyond the Punjab border in the campaigns of 1897–98. He was slightly wounded, and he was mentioned in despatches, being promoted to the rank of full colonel for his services. He is reputed to be one of the keenest sportsmen and the best riders that even Rajputana has produced. When it was decided to send a force from India to China in 1900 to relieve the foreign embassies besieged in Peking, Sir Partap Singh at once offered the services of the Jodhpur Lancers, and himself proceeded with them to the seat of military operations. His father rendered good services to the British Government in the Mutiny, and Partap Singh always esteemed it a point of honour and a matter of filial duty to identify the famous state of Jodhpur with the British Government in times of trouble or foreign war. He cherished the memory of the protection given by the East India Company in 1818, when Jodhpur had suffered from internal dissension and the ravages of the Marathas, and was taken into subordinate alliance with the British on terms honourable to both parties. In social matters the Maharaja favoured the party of moderate reform, but it was as a rajput soldier and a loyal prince that he was most distinguished. No prince in India has ever won so many proofs of public estimation from the British Government and English society as Sir Partap Singh. From Queen Victoria he received the honour of knighthood and the decorations of the Bath and the Star of India; from King Edward VII. the distinction of "aide-de-camp"; from the

War Office the rank of colonel in the King's army; and from the University of Cambridge the degree of LL.D. From his own state of Jodhpur he obtained the title of Maharaja-Dhiraj. In 1901 he succeeded to the rulership of the state of Idar.

Parthenay, chief town of arrondissement, department of Deux-Sèvres, France, 25 miles north-north-east of Niort, on railway from Paris to Bordeaux. The town is picturesquely situated on a promontory overlooking the Thouet, and still retains considerable portions of its 13th-century ramparts, with large round towers, offering, next to Aigues-Mortes, the finest example of the fortifications of that period. Amongst ancient buildings of interest are the church of Ste Croix, of the 12th century, restored 1885, and with 15th-century belfry; the church of St Laurent, also restored in modern times, but portions of whose walls date from the 11th century; a ruined portal of Notre Dame de la Couldre, with beautiful sculpture and two equestrian statues; and 1 mile south-west of the town the ancient church of Parthenay-le-Vieux. The manufacture of knitted woollen goods and wool-spinning are the principal local industries. Population (1881), 3899; (1891), 5361; (1901), 6426.

Partick, a police burgh in the parish of Govan, Lanarkshire, Scotland, on the north bank of the Clyde, adjoining and continuous with Glasgow. Since 1850 it has grown from a village to be a large and wealthy residential quarter of Greater Glasgow. Five shipbuilding yards are situated in the burgh, which contains also the industries of paper-staining, flour-milling, hydraulic-machine making, weighing-machine making, brass-founding, and galvanizing. It has a town hall and a Victoria public park (1887). Partick forms the major part of the Partick division of Lanarkshire, which returns a member to Parliament. The municipality maintains a separate police force and a fire brigade, but uses Glasgow gas and water. One of the public schools has a secondary department. Area, 1006 acres. Population (1891), 36,538; (1901), 54,274.

Partnership.—In 1890 the Partnership Act of that year was passed to declare and amend the law of partnership; the Act came into operation on 1st January 1891. With one important exception (§ 23), it applies to the whole United Kingdom. It is not a complete code of partnership law; it contains no provisions regulating the administration of partnership assets in the event of death or bankruptcy, and is silent on the subject of goodwill. The existing rules of equity and common law continue in force, except so far as they are inconsistent with the express provisions of the Act. The article on Partnership in the ninth edition of this work contains a short account of the state of the law before the Act. The decisions which established that law show the principles which underlie the Act, and will be found useful as illustrations of its application and guides to its interpretation when its language is obscure. On all points specifically dealt with by the Act it is now the one binding authority. The Act has made no important changes in the law, except in respect of the mode of making a partner's share of the partnership assets available for payment of his separate debts. This change does not affect Scotland. The Act is divided into the four main divisions mentioned below.

I. *Nature of Partnership.*—Partnership is defined to be the "relation which subsists between persons carrying on a business in common with a view of profit." From this definition corporations and companies, such as joint-stock companies and cost-book mining companies, which differ from ordinary partnerships in many important respects, are expressly excluded. The Act also contains several subsidiary rules for determining the existence of a partnership. These rules are of a fragmentary nature, and for the most part are expressed in a negative form; they have not introduced any change in the law. Co-ownership of property does not of itself create a partnership, nor does the sharing of gross returns. The sharing of profits, though not of itself sufficient to create a partnership, is *primâ facie* evidence of one. This means that if all that is known is that two persons are sharing profits, the inference is that such persons are partners; but if the participation in profits is only one amongst other circumstances, all the circumstances must be considered, and the participation in profits must not be treated as raising a presumption of partnership, which has to be rebutted. To illustrate the rule that persons may share profits without being partners, the Act gives statutory expression to the decision in *Cox* v. *Hickman* (1860, 8 House of Lords Cases, 268), viz., that the receipt by a person of a debt or other fixed sum by instalments, or otherwise, out of the accruing profits of a business does not of itself make him a partner; and it re-enacts with some slight modification the repealed provisions of Bovill's Act (28 and 29 Vict. c. 86). Whenever the question of partnership or no partnership arises, it must not be forgotten (though this is not stated in the Act) that partnership is a relation arising out of a contract; regard must be paid to the true contract and intention of the parties as appearing from the whole facts of the case. If a partnership be the legal consequence of the true agreement, the parties thereto will be partners, though they may have intended to avoid this consequence (*Adam* v. *Newbigging*, 1888, L.R. 13 App. Cas. 315). Partners are called collectively a "firm"; the name under which they carry on business is called the firm name. Under English law the firm is not a corporation, nor is it recognized as distinct from the members composing it; any change amongst them destroys the identity of the firm. In Scotland a firm is a legal person distinct from its members, but each partner can be compelled to pay its debts.

II. *Relations of Partners to Persons dealing with them.*—Every partner is an agent of the firm and of his co-partners for the purpose of the partnership business; if a partner does an act for carrying on the partnership business in the usual way in which businesses of a like kind are carried on—in other words, if he acts within his apparent authority—he thereby *primâ facie* binds his firm. The partners may by agreement between themselves restrict the power of any of their number to bind the firm. If there be such an agreement, no act done in contravention of it is binding on the firm with respect to persons who have notice of the agreement. Such an agreement does not affect persons who have no notice of it, unless indeed they do not know or believe the person with whom they are dealing to be a partner; in that case he has neither real, nor, so far as they are concerned, apparent authority to bind his firm, and his firm will not be bound. If a partner does an act, *e.g.*, pledges the credit of the firm, for a purpose apparently not connected with the firm's ordinary course of business, he is not acting in pursuance of his apparent authority, and whatever liability he may personally incur, his partners will not be bound unless he had in fact authority from them.

Apart from any general rule of law relating to the execution of deeds or negotiable instruments, a firm and all the partners will be bound by any act relating to the business of the firm, and done in the firm name, or in any other manner showing an intention to bind the firm, by any person thereto authorized. An admission or representation by a partner, acting within his apparent authority, is evidence against his firm. Notice to an acting partner of any matter relating to the partnership affairs is, apart from fraud, notice to his firm.

A firm is liable for loss or injury caused to any person not a partner, or for any penalty incurred by any wrongful act or omission of a partner acting in the ordinary course of the partnership business, or with the authority of his co-partners; the extent of the firm's liability is the same as that of the individual partner. The firm is also liable to make good the loss (*a*) where one partner, acting within his apparent authority, receives money or property of a third person and misapplies it; and (*b*) where a firm in the course of its business receives money or property of a third person, and such money or property while in the custody of the firm is misapplied by a partner. It is not sufficient, in order to fix innocent partners with liability for the misapplication of money belonging to a third party, merely to show that such money was employed in the business of the partnership, otherwise all the members of a firm would in all cases be liable to those beneficially interested therein for trust money improperly employed in this manner by one partner. This is not the case. To fix the other partners with liability, notice of the breach of trust must be brought home to them individually.

The liability of partners for the debts and obligations of their firm arising *ex contractu*, is joint, and in Scotland several also; the estate of a deceased partner is also severally liable in a due course of administration, but subject, in England or Ireland, to the prior payment of his separate debt. The liability of partners for the obligations of their firm arising *ex delicto*, is joint and several.

The authority of a partner to bind his co-partners commences with the partnership. A person therefore who enters into a partnership does not thereby become liable to the creditors of his partners for anything done before he became a partner. But a partner who retires from a firm does not thereby cease to be liable for debts or obligations incurred before his retirement. He may be discharged from existing liabilities by an agreement to that effect between himself and the members of the firm as newly constituted and the creditors. This agreement may be either express or inferred as a fact from the course of dealing between the creditors and the new firm. The other ways in which a partner may be freed from partnership liabilities incurred before his retirement are not peculiar to partnership liabilities, and are not therefore dealt with by the Partnership Act.

A continuing guaranty given to a firm, or in respect of the transactions of a firm, is, in the absence of agreement to the contrary, revoked as to the future by a change in the firm. The reason is that such a change destroys its identity.

Any person, not a partner in the firm, who represents himself, (or, as the phrase is, "holds himself out") or knowingly suffers himself to be represented, as a partner, is liable as a partner to any person who has given credit to the firm on the faith of the representation. The representation may be by words spoken or written, or by conduct. The liability will attach, although the person who makes the representation does not know that the person who has acted on it knew of it. The continued use of a deceased partner's name does not impose liability on his estate.

III. *Relations of Partners to one another.*—The mutual rights and duties of partners depend upon the agreement between them. Many of these rights and duties are stated in the Partnership Act; but, whether stated in the Act or ascertained by agreement, they may be varied by the consent of all the partners; such consent may be express or inferred from conduct. Subject to any agreement, partners share equally in the capital and profits of their business, and must contribute equally to losses, whether of capital or otherwise; they are entitled to be indemnified by their firm against liabilities incurred in the proper and ordinary conduct of the partnership business, and for anything necessarily done for its preservation; they are entitled to interest at 5 per cent. on their advances to the firm, but not on their capital. Every partner may take part in the management of the partnership business, but no partner is entitled to remuneration for so doing. The majority can bind the minority in ordinary matters connected with the partnership business, but cannot change its nature nor expel a partner, unless expressly authorized so to do. No partner may be introduced into the firm without the consent of all the partners. The partnership books must be kept at the principal place of business, and every partner may inspect and copy them. Partners must render to each other true accounts and full information of all things affecting the partnership. A partner may not make use of anything belonging to his firm for his private purposes, nor may he compete with it in business. If he does so he must account to his firm for any profit he may make.

Partners may agree what shall and what shall not be partnership property, and can by agreement convert partnership property into the separate property of the individual partners, and *vice versâ*. Subject to any such agreement, all property originally brought into the partnership stock, or acquired on account of the firm or for the purposes and in the course of its business, is declared by the Act to be partnership property. Property bought with money of the firm is *primâ facie* bought on account of the firm. Partnership property must be applied exclusively for partnership purposes and in accordance with the partnership agreement. Co-owners of land may be partners in the profits of the land without the land being partnership property; if such co-owners purchase other lands out of the profits, these lands will also belong to them (in the absence of any agreement to the contrary) as co-owners and not as partners. The legal estate in partnership land devolves according to the general law, but in trust for the persons beneficially interested therein. As between partners, and as between the heirs of a deceased partner and his executors or administrators, such land is treated as personal or movable estate, unless a contrary intention appears.

When no fixed term has been agreed upon for the duration of the partnership, it is at will, and may be determined by notice at any time by any partner. If a partnership for a fixed term is continued after the term has expired without any express new agreement, the rights and duties of the partners remain as before, so far as they are consistent with a partnership at will.

A partner may assign his share in the partnership either absolutely or by way of mortgage. The assignee does not become a partner; during the continuance of the partnership he has the right to receive the share of profits to which his assignor would have been entitled, but he has no right to interfere in the partnership business, or to require any accounts of the partnership transactions, or to inspect the partnership books. On a dissolution he is entitled to receive the share of the partnership assets to which his assignor is entitled as between himself and his partners, and for this purpose to an account as from the date of dissolution.

Since the Act came into operation no writ of execution may issue in England or Ireland against any partnership property, except on a judgment against the firm. If in either of these countries a judgment creditor of a partner wishes to enforce his judgment against that partner's share in the partnership, he must obtain an order of court charging such share with payment of his debt and interest. The court may appoint a receiver of the partner's share, and may order a sale of such share. If a sale be ordered the other partners may buy the share; they may also at any time redeem the charge. The mode of making a partner's share liable for his separate debts in Scotland has not been altered by the Act.

IV. *Dissolution of Partnership.*—A partnership for a fixed term, or for a single adventure, is dissolved by the expiration of the term or the termination of the adventure. A partnership for an undefined time is dissolved by notice of dissolution, which may be given at any time by any partner. The death or bankruptcy of any partner dissolves the partnership as between all its members. If a partner suffers his share in the partnership to be charged under the Act for his separate debts, his partners may dissolve the partnership. The foregoing rules are subject to any agreement there may be between the partners. A partnership is in every case dissolved by any event which makes the partnership or its business unlawful. The court may order a dissolution in any of the following cases, viz.:—When a partner is found lunatic or is of permanently unsound mind, or otherwise permanently incapable of performing his duties as a partner; when a partner has been guilty of conduct calculated to injure the partnership business, or wilfully or persistently breaks the partnership agreement, or so conducts himself in partnership matters that it is not reasonably practicable for his partners to carry on business with him; when the partnership can only be carried on at a loss; and lastly, whenever a dissolution appears to the court to be just and equitable. The Act is silent as to the effect of the assignment by a partner of his share in the partnership as a cause of dissolution; probably it is now no more than a circumstance enabling the court, if it thinks fit, to grant a dissolution on the ground that it is just and equitable to do so. A dissolution usually is not complete as against persons who are not partners, until notice of it has been given; until then such persons may treat all apparent partners as still members of the firm. Consequently, if notice is not given when it is necessary, a partner may be made liable for partnership debts contracted after he ceased to be a partner. Notice is not necessary to protect the estate of a dead or bankrupt partner from partnership debts contracted after his death or bankruptcy; nor is notice necessary when a person not known to be a partner leaves a firm. If a person not generally known to be a partner is known to be so to certain individuals, notice must be given to them. Notice in the *Gazette* is sufficient as regards all persons who were not previously customers of the firm; notice in fact must be given to old customers. On a dissolution, or the retirement of a partner, any partner may notify the fact and require his co-partners to concur in doing so.

After a dissolution, the authority of each partner (unless he be a bankrupt) to bind the firm, and the other rights and obligations of the partners, continue so far as may be necessary to wind up the partnership affairs and to complete unfinished transactions. The partners are entitled to have the partnership property applied in payment of the debts of the firm, and to have any surplus divided between them. Before a partner can receive any part of the surplus, he must make good whatever may be due from him as a partner to the firm. To enforce these rights, any partner or his representatives may apply to the court to wind up the partnership business. It was well established before the Act, and is still law, that in the absence of special agreement the right of each partner is to have the partnership property—including the goodwill of its business, if it be saleable—realized by a sale. The value of the goodwill depends largely on the right of the seller to compete with the purchaser after the sale. The Act makes no mention of goodwill, but the rights of a seller in this respect were fully discussed in the House of Lords in *Trego* v. *Hunt* (L.R. 1896, App. Cas. 7). In the absence of special agreement, the seller may set up business in competition with, and in the immediate neighbourhood of, the purchaser, and advertise his business and deal with his former customers, but may not represent himself as carrying on his former business, nor canvass his former customers. The purchaser may advertise himself as carrying on the former business, canvass its customers, and trade under the old name, unless that name is or contains the name of the vendor, and the purchaser by using it without qualification would expose the vendor to the liability of being sued as a partner in the business. If, on a dissolution or change in the constitution of a firm, the goodwill belongs under the partnership agreement exclusively to one or more of the partners, the partner who is not entitled to the goodwill has the rights of a seller, and those to whom the goodwill belongs have the rights of a purchaser.

When a partner has paid a premium on entering into a partnership for a fixed term, and the partnership is determined before the expiration of the term, the court may, except in certain cases, order a return of the premium or of some part of it. In the absence of fraud or misrepresentation, the court cannot make such an order when the partnership was at will, or, being for a fixed term, has been terminated by death or by reason of the misconduct of the partner who paid the premium; nor can it do so if terms of dissolution have been agreed upon, and the agreement makes no provision for the return of premium. When the court makes an order it usually orders the return of so much of the premium as bears the same proportion to the whole as the actual bears to the agreed duration of the partnership.

When a person is induced by the fraud or misrepresentation of others to become a partner with them, the court will rescind the contract at his instance (*Adam* v. *Newbigging*, 1888, R. 13 App. Cas. 308). Inasmuch as such a person is under the same liability to third parties for liabilities of the firm incurred before rescission as he would have been under had the contract been valid, he is entitled on the rescission to be indemnified by the person guilty of the fraud or making the representation against these liabilities. He is also entitled, without prejudice to any other rights, to receive out of the surplus assets of the partnership, after satisfying the partnership liabilities, any money he may have paid as a premium or contributed as capital, and to stand in the place of the creditors of the firm for any payments made by him in respect of the partnership liabilities.

If a partner ceases to be a member of a firm, and his former partners continue to carry on business with the partnership assets without any final settlement of accounts, he, or, if he be dead, his estate, is, in the absence of agreement, entitled to such part of the subsequent profits as can be attributed to the use of his share of the partnership assets, or, if he or his representatives prefer it, to interest at 5 per cent. on the amount of his share. If his former partners have by agreement an option to purchase his share, and exercise the option and comply with its terms, he is not entitled to any further or other share in profits than that given him by the agreement. If, however, his former partners, assuming to exercise such an option, do not comply with its terms, they are liable to account for subsequent profits or interest to the extent mentioned above. Subject to any agreement between the partners, the amount due from the surviving or continuing partners to an outgoing partner, or the representatives of a deceased partner, in respect of his share in the partnership, is a debt accruing at the date of the dissolution or death.

In the absence of any special agreement on a final settlement of accounts between partners, losses (including losses of capital) are paid first out of profits, next out of capital, and lastly by the partners in the proportions in which they share profits. The assets of the firm, including all sums contributed to make up losses of capital, are applied in paying the debts and liabilities of the firm to persons who are not partners; then in paying to each partner rateably what is due from the firm to him, first for advances and next in respect of capital; and the ultimate residue (if any) is divisible among the partners in the proportion in which profits are divisible.

See Sir NATHANIEL LINDLEY. *A Treatise on the Law of Partnership*, 6th edition. London, 1893.—Sir FREDERICK POLLOCK. *A Digest of the Law of Partnership, incorporating the Partnership Act, 1890*, 6th edition. London, 1895.—Also article on "Partnership" in the *Encyclopædia of the Laws of England*, to the publishers of which (Messrs Sweet and Maxwell, Limited, London, and Messrs W. Green and Sons, Edinburgh) the writer's thanks are due. (W. B. L.)

The following points in United States law may be added. An ordinary partnership between miners for working a mine is not dissolved by the death of one of the partners, nor by the transfer by one of his interest in the concern. Contract is not deemed the basis of the relation between the partners, but rather a common property and co-operation in its exploitation (Parsons, *Principles of Partnership*, sect. 15). A corporation cannot become a partner in any mercantile adventure, unless specially authorized by charter or general statute. If it could, the management of its affairs would no longer be exclusively in the hands of its directors, to whom the law has entrusted it. Hence, corporations cannot associate for the formation of a "trust" to be managed by the associated partners. (S. E. B.)

Pasadena, a city of Los Angeles county, California, U.S.A., at the base of the San Gabriel Mountains, in southern California, at an altitude of 827 feet. It is 9 miles north-east of Los Angeles, with which it is connected by lines of steam and trolley cars. It is on the Southern Pacific and the Southern California (Atchison, Topeka, and Santa Fé) railways. Its site is level, its plan regular. It has an excellent water-supply, and is well sewered. The surrounding country is to a large extent highly cultivated, producing sub-tropical fruits in great variety and quantity. Pasadena is noted for its mild, soft climate, especially in winter, and for the beauty of its surroundings, with the San Gabriel range rising to the north, and southwards the beautiful valley, rendered fruitful by hundreds of artesian wells and irrigation ditches. On these accounts it has become a very popular winter resort, especially for consumptives. The Mount Low railway, partly trolley, partly cable, ascends the San Gabriel range from this point. Population (1880), 391; (1890), 4882; (1900), 9117, of whom 1278 were foreign-born and 336 coloured, including 218 negroes.

Pasages, a town and seaport of Spain, province of Guipuzcoa, 10 miles from the mouth of the river Urumen, with a station on the railway from the French frontier to Madrid. This seaport, of which the population was only 1744 in 1887 and 2501 in 1897, has developed very considerably in importance since 1890. The town only consisted until 1875 of two comparatively unimportant but picturesque groups of houses or "carrios." Vessels find a good anchorage in 30 feet of water in the centre of the land-locked bay and near the quays built along the shore opposite. An attempt has been made to dredge the bay and turn it into a port of refuge and emporium of trade. On the peak of San Marcos is the modern fortress erected to command all the approaches to San Sebastian and Pasages. The new town of Pasages contains liqueur factories, cellars for the preparation of wines, the famed "coupage" of the product of the French vineyards with strongly alcoholic Navarre and Aragon wines or alcohol now manufactured in Spain on a large scale. In 1897, 41,500 tons of British coal were landed at Pasages. Forty British vessels entered and cleared in the same year.

Pas-de-Calais, a department on the northern coast of France, bordering on the English Channel.

Area, 2606 square miles. From 819,022 in 1881 the population increased to 949,968 in 1901. Births in 1899, 28,384, of which 2994 were illegitimate; deaths, 19,119; marriages, 7809. There were in 1896, 1785 schools, with 158,000 pupils, the illiterate constituting 7 per cent. of the population. The area under cultivation measured (1896) 1,531,400 acres, of which 1,230,060 acres were plough-land. Wheat, which, relatively to its size, this department grows in considerably more than average quantity, returned in 1899 the value of £2,040,000; rye, £136,000; barley, £192,000; oats, £1,360,000; potatoes, £441,000; mangold-wurzel, £245,000; garden-poppy, £68,000; beetroot, £1,208,000; tobacco, £78,000; apples, £44,000. The live stock comprised in 1899, 76,480 horses, 220,540 cattle, 217,650 sheep, 164,780 pigs, and 23,460 goats. The production of milk amounted (1899) to the value of £1,680,000. Pas-de-Calais surpasses all the other departments of France in the abundance and extent of its coalfields. In 1898 it produced not less than 12,800,000 metric tons of fuel, valued at £5,000,000, nearly half of the total output of France. Yet the industry in metals is much less active in this department than in Nord. Its production in 1898 amounted to 90,000 metric tons of cast-iron and 63,000 tons of steel, which, with the other minerals added, were valued at £995,000. The sugar refineries yielded in 1898, 1,820,000 cwt., and the distilleries 7,200,000 gallons of alcohol. Calais (population, 59,793 in 1901) is celebrated for its lace. Spinning is likewise a source of revenue to the department. Arras, the capital, had 25,813 inhabitants in 1901, and Boulogne 49,083 in the same year.

Pasewalk, a town of Prussia, province of Pomerania, 26 miles west-north-west of Stettin by rail. It is an old and historically interesting town, having been frequently burnt and sacked in the 17th and 18th centuries. A bronze statue was erected to the Emperor Frederick III. in 1895. It manufactures tobacco, beer, and iron, and has various mills. Population (1885), 9514; (1900), 10,300.

Pasig, a town on the Pasig river, near the Laguna de Bay, Luzon, Philippine Islands. It was almost completely destroyed by fire in 1899 during the insurrection, but has since been rebuilt, and was made the capital of the province of Manila in June 1901. It is an important commercial centre for the whole lake region, as its inhabitants are largely engaged in transporting the products of the neighbouring towns to Manila. Large quantities of fresh-water fish are taken in the shallow waters of the marshes. Although built on low ground, the town is fairly healthy. The language is Tagalog. Population, 22,000.

Passaglia, Carlo (1812–1887), Roman Catholic divine, was born at Lucca on 2nd May 1812. Passaglia was soon destined for the priesthood, and was placed under the care of the Jesuit body at the age of fifteen. He became successively Doctor in Mathematics, Philosophy, and Theology in the University of Rome. In 1844 he was made professor in the Collegio Romano, the well-known Jesuit college in Rome. In 1845 he took the vows as a member of the Jesuit order. In 1848, during the expulsion of the Jesuits from Rome which followed on the revolutionary troubles in the Italian peninsula, he paid a brief visit to England. On his return to Italy he founded, with the assistance of Father Curci and Robert Tapparelli d'Azeglio, the celebrated organ of the Jesuit order entitled the *Civiltá Cattolica*. In 1854 came the decision of the Roman Church on the long-debated question of the Immaculate Conception of the Virgin. Into the agitation for the promulgation of this dogma Passaglia threw himself with great eagerness, and by so doing recommended himself strongly to the then Pope, Pius IX. But his favour with the Pope was of short duration. In 1859, when the war between Austria and France (the first step towards the unification of Italy) broke out, Passaglia espoused the popular side. He took refuge at Turin, and under the influence of Cavour he wrote an *Epistola ad Episcopos Catholicos pro causa Italica*, in which, like Liverani before him, he boldly attacked the temporal power of the Pope. For this he was expelled from the order of Jesuits, his book was put on the *Index*, and his figure struck out, by the Pope's order, from a picture painted to commemorate the proclamation of the Dogma of the Immaculate Conception. A refuge from the anger of the Pope was afforded him in the Casa Cavour, of Turin, the house in which Cavour was born. There he laboured for Italian unity with indomitable energy in the north of Italy, in conjunction with Cardinal d'Andrea in the south, and he collected the signatures of 9000 priests to an address to the Pope in opposition to the temporal power, and in favour of abandoning all resistance to the union of Italy under a king of the House of Savoy. He and the 9000 priests were excommunicated on 6th October 1862. Passaglia disregarded his excommunication, and continued his work as professor of moral philosophy at Turin, to which he had been appointed in 1861, and commenced a series of Advent addresses in the church of San Carlo at Milan. But on arriving in order to preach his second sermon, he found himself met by an inhibition on the part of Mgr Caccia, the administrator of the archdiocese of Milan. Elected deputy in the Italian Parliament, he still advocated strongly the cause of Italian independence, and at a later period wrote a defence of the rights of the Episcopate under the title of *La causa di sua eminenza il Cardinale d'Andrea*. He also (1864) wrote against Renan's *Vie de Jésus*. The later years of his life were spent in obscurity. Eight days before his death he endeavoured to be reconciled to the Pope, and made a full retractation. He died at Turin, 12th March 1887. (J. J. L*.)

Passaic, a city of Passaic county, New Jersey, U.S.A., on the west bank of the Passaic river, in the north-eastern part of the state, at an altitude of 100 feet. Its site is hilly and its plan irregular. It is divided into four wards, and has a water-supply derived from Passaic river above the falls. In 1900 it contained 185 manufacturing establishments, employing 7102 hands, and having a capital of $23,279,421 and an output valued at $14,031,254. To some extent it serves as a residence suburb to New York. Population (1880), 6532; (1890), 13,028; (1900), 27,777, of whom 12,900 were foreign-born and 443 negroes. There were 9274 persons of school age (5 to 20 years). Of 7552 males, 21 years of age and over, 1011 were illiterate (unable to write).

Passau, a town and episcopal see of Bavaria, Germany, district of Lower Bavaria, on both banks of the Danube, at the confluence of the rivers Inn and Ilz, 74 miles by rail south-east of Ratisbon. The towers of the cathedral were finished in 1896–98. The church of St Gertrude, in Innstadt, restored in 1888; the votive church (1564), restored in 1864; the pilgrimage church of Our Lady of Succour; and St John's Hospital church, with its wood carvings, are all noteworthy. The town hall was enlarged in 1888–93. Two scholastic institutes of the English Sisters, an agricultural school, a textile school, and a theological seminary are the chief educational institutions. Population (1885), 15,583; (1900), 17,988.

Pastel.—Since 1870 there has been a revival of the art of pastel, the result of a better understanding and appreciation on the part of the public. Grimm's denunciation of it to Diderot—"every one is agreed that pastel is unworthy the notice of a great painter"—which for many years found general acceptance, is now seen to have been based on ignorance of the virtues of the method. Artists have always recognized its beauties, but the prejudice and indifference of the public and even of "connoisseurs" had up to recent years rendered fruitless their efforts to restore its practice. It was thought that "coloured chalks," as it used to be called, promised nothing but sketches of an ephemeral kind, so fragile that they were at the mercy of every chance blow or every touch of dampness. The fact is, that with care no greater than is accorded to every work of art, pastel properly used is not more perishable than the oil-painting or the water-colour. Damp will affect it seriously, but so also will it ruin the water-colour; and violence is to be feared for the oil-picture not less than for the pastel. Moreover, pastel possesses advantages that can be claimed by neither oil-painting nor water-colour. That is to say, if pictures in these three mediums be hung side by side for a hundred years in a fair light and in a dry place, the oil-painting will have darkened and most probably have cracked; the water-colour will have faded; but the pastel will remain as bright, fresh, and pure as the day it was painted. If Time and Varnish, which Hogarth and Millais declared the two greatest of the old masters, will do nothing to "improve" a pastel, neither will they ruin it; so that the pastel-painter, having no adventitious assistance to hope for, or to fear, must secure at once the utmost of which his method is capable.

The advantages of pastel are threefold: those of working, those of results, and those of permanence. The artist has at his command, without necessity of mixing his colours, every hue to be found in nature, so that freshness and luminosity can always be secured without fear of that loss of brilliancy commonly attendant on the mixing of colour on the palette. Moreover, the fact of pastel being dry permits the artist to leave his work and take it up again as he may choose; and he is free from many of the technical troubles and anxieties natural to oil and water-colour painting. Applied with knowledge, pastel, which has been likened for delicacy of beauty to "the coloured dust upon the velvet of butterflies' wings," will not fall off. It can, if desired—though this is hardly necessary or even desirable—be "fixed," most commonly by a *fixatif*. If intending so to treat his work, the artist must paint in a somewhat lighter key, as the effect of the fixing medium is slightly to lower the general tone. But whether it be fixed or left unfixed, the unfettered artist who employs pastel has been enabled to enjoy the advantages it offers of rapidity, spontaneity, directness, adaptability, and variety—conveniences to be sought for in vain in other colour mediums.

The inherent qualities of pastel are those of charm, of subtlety, softness, and exquisite depths of tone, unsurpassable harmonies and unique freshness of colour, sweetness, delicacy, mystery—all the virtues sought for by the artist of daintiness and refinement. Pastel-painting is essentially, therefore, the art of the colourist. Now, these very qualities suggest its limitations. Although it is unfair to relegate it—as fashion has foolishly done for so long—to the bunch of pretty triflings which Carlyle called "Pompadourisms," we must recognize that a medium which suggests the bloom upon the peach is not proper to be employed for rendering "grand," or even *genre* subjects, or for the covering of large surfaces of canvas. It is inappropriate to the painting of classic compositions.

although in point of fact it has been so used, not without success. It is best adapted to the rendering of still life, of landscape, and of portraiture. But in these cases it is not advisable to aim at that solidity which is the virtue of oil-painting, if only because oil can bring about a better result. The real reason is that, in securing solidity, pastel tends to forfeit that lightness and grace which constitute its especial charm and merit. Strength belongs to oil, tenderness and subtlety to pastel, together with freshness and elegance.

The pre-eminent technical advantage, in addition to those already mentioned, is the permanence of the tones. In water-colours there is an admixture of gum and glycerine which may attract moisture from the air; and, besides, the pigment is used in very thin washes. In oil-painting, not only does the oil darken with age, but sometimes draws oxygen from a pigment and changes its hue. In pastel the colour is put on without any moist admixture, and can be laid on thick. Moreover, the permanence may arise from the method of manufacture. In a very rare work, *The Excellency of the Pen and Pencil* (1668), a chapter on "how to make pastils" (*sic*) "of several colours, for drawing figure, landskip, architecture, &c., on blew paper," describes the manner of grinding up the pigments with grease. This used to be the secret of pastel—that every grain of colour was separately and securely locked up in grease, and so was rescued from any chemical change that might have come about through contact of the colours with one another or with the atmosphere. Thus, for example, if in water-colour indigo be mixed with Indian red (as for the painting of a sky), in course of time the indigo will be chased off the paper and a red sky be left. This is often seen in the works of the earlier water-colour painters. With pastel nothing of the kind could occur; and the works of Quentin Latour, Perroneau, Watteau, St Jean, and Chardin, in France, and Russell and Cotes, in England—to name no others—testify to the permanency of the colours. Some manufacturers nowadays employ gum as the binding medium; others beeswax (which at one time was more frequently used than it is at present); others, again, a very small proportion of tallow, and sometimes a little soap. But this introduction of binding medium is now adopted only in the case of certain colours. Whether the point or edge of the stick be used (as in pastel *drawing*), or the side of it, helped with the tips of the fingers (as in pastel *painting*), the result is equally permanent; and if, when the work is done, it be struck two or three times, and then touched up by hand-crayons, no dropping of colour from the paper will ever occur. The drawing is made on a grained paper that will hold the chalk, or on a specially manufactured toothed cloth. The crisp touches of the pastel can be placed side by side, or the "vibrations" which the artist seeks may be obtained by glazes and superposed tones.

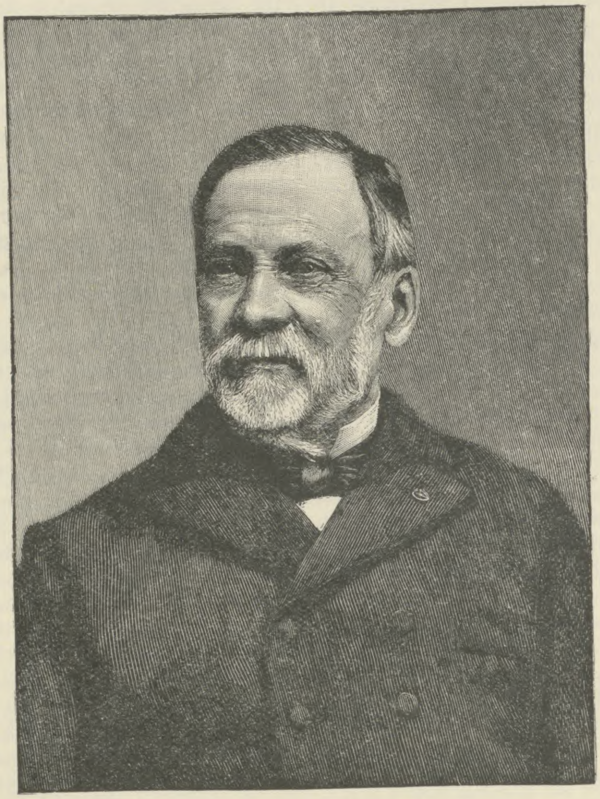
The art of pastel, as M. Roger Ballu expressed it, "was slumbering a little," until in 1870 the Société des Pastellistes was founded in France and met with ready appreciation. With many artists it was a matter of "coloured chalks," as, for example, with Millet, Lhermitte, and Degas in France, and with Whistler in England. With the majority the full possibilities were seized, and a great number of artists abroad then practised the art for the sake of colour, among whom may be mentioned Adrien Moreau, A. Besnard, Émile Lévy, Machard, Pointelin, Georges Picard, Iwill, René Billotte, and Lévy-Dhurmer, in France; in Belgium, Émile Wauters (who has produced a great series of life-sized portraits of amazing strength, vitality, and completeness) and Fernand Khnopff; in Italy, C. Laurenti, P. Fragiacomo, and the late Giovanni Segantini; in Holland, Josselin de Jong; in Germany, F. von Lenbach, Max Liebermann, and Franz Stück; and in Norway, Fritz Thaulow.

In England the revival of pastel dates from 1880, when the first exhibition of the Pastel Society was held in the Grosvenor Gallery. The exhibition was a *succès d'estime*, but after a while the society languished until, in 1899, it was reconstituted, and obtained the adhesion of many of the most distinguished artists practising in the country, as well as of a score of eminent foreign painters. In that year, and since, it has held exhibitions of a high order, and intelligent public appreciation has been directed to the work of the most noteworthy contributors. Among these are E. A. Abbey, R.A., M'Lure Hamilton, J. M. Swan, A.R.A., J. Lorimer, R.S.A., A. Peppercorn, Anning Bell, J. J. Shannon, A.R.A., James Guthrie, H. Brabazon, Walter Crane, Melton Fisher, Edward Stott, S. J. Solomon, A.R.A., and W. Rothenstein.

See KARL ROBERT [GEORGES MEUSNIER]. *Le Pastel.* Laurens, Paris, 1890.—J. L. SPRINCK. *A Guide to Pastel Painting.* Rowney, London. (M. H. S.)

Pasteur, Louis (1822–1895), French chemist, was born, on 27th December 1822, at Dôle, Franche Comté, where his father carried on the business of a tanner. Shortly afterwards the family Pasteur removed to Arbois, where Louis attended the école primaire, and later the "collège" of that place. Here he apparently did not especially distinguish himself, belonging to the class of "bons ordinaires." Fortunately at Arbois he came under the influence of an excellent teacher in the person of the director of the "collège," who must have discerned in the quiet boy the germs of greatness, as he constantly spoke to him of his future career at the École Normale in Paris. In October 1838 Louis was sent with a friend to the metropolis, to a school in the Quartier Latin, preparatory to the École Normale. But he did not remain long in Paris, for, being a nervous and excitable boy, his health broke down, and he yearned for his home in Franche Comté. "If only I could smell the tannery once more," said he to his companion, "I should feel well." So home he went, though not for long, as his ambition was still to become a "normalien," and to this end he entered the Royal College of Besançon, "en attendant l'heureux jour où je serai admis à l'École Normale." Step by step he attained his end; in 1840 he won his "bachelier ès lettres," and shortly afterwards he received an appointment as assistant mathematical master in the college. Two years later he passed the examination for the "bacalaureat ès sciences" enabling him to become candidate for the École Normale. But here something (probably the examiner) was at fault, for a note was attached to Pasteur's diploma stating that he was only "mediocre" in chemistry. In those early days and early trials the dominant note of Pasteur's life was sounded. To his sisters he writes: "Ces trois choses, la volonté, le travail, le succès, se partagent toute l'existence humaine. La volonté ouvre la porte aux carrières brillantes et heureuses; le travail les franchit, et une fois arrivé au terme du voyage, le succès vient couronner l'œuvre." Throughout his life, and to the very end, "work" was his constant inspiration. On his deathbed he turned to the devoted pupils who watched over their master's last hours. "Où en êtes-vous?" he exclaimed, "Que faites-vous?" and ended by repeating his favourite words, "Il faut travailler."

The first incentive to his serious study of chemistry was given by hearing Dumas, the most celebrated chemist of the time, lecture at the Sorbonne; and ere long he broke new ground for himself, Balard having given him an opportunity for chemical work by appointing him to the post of laboratory assistant. A few words of explanation concerning Pasteur's first research are necessary to give the key to all his future work. What was the secret power which enabled him to bring under the domain of scientific laws phenomena of disease which had so far baffled human endeavour? It simply consisted in the application to the elucidation of these complex problems of the exact methods of chemical and physical research. Perhaps the most remarkable discovery of modern chemistry is the existence of compounds, which, whilst possessing an identical composition, are absolutely different bodies, judged of by their properties. The first of the numerous cases of isomerism now known was noted, but unexplained, by Berzelius. It was that of two tartaric acids, deposited from wine-lees. The different behaviour of these two acids to a ray of polarized light was subsequently observed by Biot. One possessed the power of turning the plane of the polarized ray to the right; the other possessed no rotary power. Still no explanation of this singular fact was forthcoming, and it was reserved for the young chemist from Franche Comté to solve a problem which had baffled the greatest chemists and physicists of the time. Pasteur proved that the inactivity of the one acid depended upon the fact that it was composed of two isomeric constituents: one the ordinary or dextro-rotary acid, and the other a new acid which possessed an equally powerful left-handed action. The veteran Biot, whose acquaintance Pasteur had made, was incredulous. He insisted on the repetition of the experiment in his presence; and when convinced of the truth of the explanation he exclaimed to the discoverer, "Mon cher enfant, j'ai tant aimé les sciences dans ma vie que cela me fait battre le cœur." Thus at one step Pasteur gained a place of honour among the chemists of the day, and was immediately appointed professor of chemistry at the Faculté of Science at Strasburg, where he soon afterwards married Mlle Laurent, who proved herself to be a true and noble helpmeet. Next he sought to prepare the inactive form of the acid by artificial means; and after great and long-continued labour he succeeded, and was led to the commencement of his classical researches on fermentation, by the observation that when the inactive acid was placed in contact with a special form of mould (*penicillium glaucum*) the right-handed acid alone was destroyed, the left-handed variety remaining unchanged. So well was his position as a leading man of science now established that in 1854 he was appointed professor of chemistry and dean of the Faculté des Sciences at Lille. In his inaugural address he used significant words, the truth of which was soon manifested in his case, "In the field of observation chance only favours those who are prepared." The diseases or sicknesses of beer and wine had from time immemorial baffled all attempts at cure. Pasteur one day visited a brewery containing both sound and unsound beer. He examined the yeasts under the microscope, and at once saw that the globules from the sound beer were nearly spherical, whilst those from the sour beer were elongated; and this led him to a discovery, the consequences of which have revolutionized chemical as well as biological science, inasmuch as it was the beginning of that wonderful series of experimental researches in which he proved conclusively that the notion of spontaneous generation is a chimera. Up to this time the phenomenon of fermentation was considered strange and obscure. Explanations had indeed been put forward by men as eminent as Berzelius and Liebig, but they lacked experimental foundation. This was given in the most complete degree by Pasteur. For he proved that the various changes occurring in the several processes of fermentation—as, for example, in the vinous, where alcohol is the chief product; in the acetous, where vinegar appears; and in the lactic, where milk turns sour—are invariably due to the presence and growth of minute organisms called ferments. Exclude every trace of these organisms, and no change occurs. Brewers' wort remains unchanged for years, milk keeps permanently sweet, and these and other complex liquids remain unaltered when freely exposed to air from which all these minute organisms are removed. "The chemical act of fermentation," writes Pasteur, "is essentially a correlative phenomenon of a vital act beginning and ending with it."



Louis Pasteur.
(From a photograph by Pierre Petit et Fils, Paris.)

But we may ask, as Pasteur did, why does beer or milk become sour on exposure to ordinary air? Are these invisible germs which cause fermentation always present in the atmosphere? or are they not generated from the organic, but the non-organized constituents of the fermentable liquid? In other words, are these organisms not spontaneously generated? The controversy on this question was waged with spirit on both sides; but in the end Pasteur came off victorious, and in a series of the most delicate and most intricate experimental researches he proved that when the atmospheric germs are absolutely excluded no changes take place. In the interior of the grape, in the healthy blood, no such germs exist; crush the grape, wound the flesh, and expose them to the ordinary air, then changes, either fermentative or putrefactive, run their course. But place the crushed fruit or the wounded animal under conditions which preclude the presence or destroy the life of the germ, and again no change takes place; the grape juice remains sweet and the wound clean. The application of these facts to surgical operations has, in the able hands of Lister, been productive of the most beneficent results, and has indeed revolutionized surgical practice.

Pasteur was now the acknowledged head of the greatest chemical movement of the time, the recipient of honours both from his own country and abroad, and installed at the École Normale in Paris in a dignified and important post. Not, however, was it without grave opposition from powerful friends in the Academy that Pasteur carried on his work. Biot—who loved and admired him as a son—publicly announced that his enterprise was chimerical and the problem insoluble; Dumas evidently thought so too, for he advised Pasteur not to spend more of his time on such a subject. Yet he persevered: "Travailler, travailler toujours" was his motto, and his patience was rewarded by results which have not merely rendered his name immortal, but have benefited humanity in a way and to a degree for which no one could have ventured to hope. To begin with a comparatively small, though not unimportant, matter, Pasteur's discoveries on fermentation inaugurated a new era in the brewing and wine-making industries. Empiricism, hitherto the only guide, if indeed a guide at all, was replaced by exact scientific knowledge; the connexion of each phenomenon with a controllable cause was established, and rule of thumb and quackery banished for ever by the free gift to the world of the results of his researches.

But his powers of patient research and of quick and exact observation were about to be put to a severe test. An epidemic of a fatal character had ruined the French silk producers. Dumas, a native of the Alais district, where the disease was rampant, urged Pasteur to undertake its investigation. Up to that time he had never seen a silkworm, and hesitated to attempt so difficult a task; but at the reiterated request of his friend he consented, and in June 1865 went to the south of France for the purpose of studying the disease on the spot. In September of the same year he was able to announce results which pointed to the means of securing immunity from the dreaded plague. The history of this research, of the gradual elimination of the unimportant conditions, of the recognition of those which controlled the disease, is one of the most fascinating chapters of scientific discovery. Suffice it here to say that careful experiment and accurate observation succeeded in ascertaining the cause of the disease and in preventing its recurrence, thus bringing back to prosperity the silk trade of France, with all that this entails. "There is no greater charm," says Pasteur, "for the investigator than to make new discoveries; but his pleasure is heightened when he sees that they have a direct application to practical life." Pasteur had the good fortune, and just reward, of seeing the results of his work applied to the benefit both of the human race and of the animal world. The starting-point of all his investigations in preventive medicine was the original observation of Jenner, that of vaccination, or the replacement of a slight disease for a serious one, by which the subject was rendered immune. But Jenner's discovery was up to recent times an isolated one, and it is to Pasteur that the world is indebted for the generalization of Jenner's discovery, and for the introduction of methods which have already worked wonders, and bid fair to render possible the preventive treatment of all infectious diseases. Just as each kind of fermentation possesses a definite organized ferment, so each disease is dependent on the presence of a distinct microbe; and just as the gardener can pick out and grow a given plant or vegetable, so the bacteriologist can (in most cases) eliminate the adventitious and grow the special organism—in other words, can obtain a pure cultivation which has the power of bringing about the special disease. But by a process of successive and continued artificial cultures under different conditions, the virus of the organism is found to become attenuated; and when this weakened virus is administered, only a slight attack of the disease occurs, but the animal is rendered immune from further attacks. The virus has become a vaccine. The first disease investigated by Pasteur was that of chicken cholera, an epidemic which destroyed 10 per cent. of the French fowls; after the application of the preventive method the death-rate was reduced to below 1 per cent. Next came the successful attempt to deal with the fatal cattle scourge known as anthrax. This is also caused by the presence of a microbe, of which the virus can also be attenuated, and by inoculation of this weakened virus the animal rendered immune. Many millions of sheep and oxen all over the world have thus been treated, and the rate of mortality reduced from 10 to less than 1 per cent. As to the money value of these discoveries, Huxley has given it as his opinion that it was sufficient to cover the whole cost of the war indemnity paid by France to Germany in 1870.

The most interesting of Pasteur's investigations in preventive and curative medicine remains to be told. It is no less than a cure for the dread disease of hydrophobia in man and of rabies in animals; and the interest of the achievement is not only that he successfully combated one of the most mysterious and most fell diseases to which man is subject, but also that this was accomplished in spite of the fact that the special microbe causing the disease has not been isolated. To begin with, Pasteur, in studying the malady in dogs, came to the conclusion that the virus had its seat in the nerve centres, and he proved that the injection of a portion of the matter of the spinal column of a rabid dog into the body of a healthy one produces in the latter with certainty the symptoms of rabies. The next step was to endeavour so to modify and weaken the virus as to enable it to be used as a preventive or as an antitoxin. This, after long and serious labour, he effected: the dog thus inoculated proved to be immune when bitten by a rabid animal. But this was not enough. Would the inoculation of the attenuated virus have a remedial effect on an animal already bitten? If so, it might be possible to save the lives of persons bitten by mad dogs. Here again experiment was successful. A number of dogs were inoculated, the same number were untreated, and both sets were bitten by rabid animals. All the treated dogs lived; all the untreated died from rabies. It was, however, one thing to experiment on dogs, and quite another to do so on human beings. Nevertheless Pasteur was bold enough to try. The trial was successful, and by doing so he earned the gratitude of the human race. Then the Institut Pasteur was founded. Thousands of people suffering from bites from rabid animals, from all lands, have been treated at this institute, and the death-rate from this most horrible of all diseases has been reduced to less than 1 per cent. Not only in Paris, but in many cities throughout the world, institutes on the model of the original one have been set up and are doing beneficent work, all arising from the genius and labours of one man. At the inauguration of the institute Pasteur closed his oration with the following words:—

"Two opposing laws seem to me now in contest. The one, a law of blood and death, opening out each day new modes of destruction, forces nations to be always ready for the battle. The other, a law of peace, work, and health, whose only aim is to deliver man from the calamities which beset him. The one seeks violent conquests, the other the relief of mankind. The one places a single life above all victories, the other sacrifices hundreds of thousands of lives to the ambition of a single individual. The law of which we are the instruments strives even through the carnage to cure the wounds due to the law of war. Treatment by our antiseptic methods may preserve the lives of thousands of soldiers. Which of these two laws will prevail? God only knows! But of this we may be sure, that science, in obeying the law of humanity, will always labour to enlarge the frontiers of life."

Rich in years and in honours, but simple-minded and affectionate as a child, this great benefactor to his species passed quietly away near St Cloud on 28th September 1895.

Mention need only be made of Pasteur's chief works, as follows:—*Études sur le vin* (1866), *Études sur le vinaigre* (1868), *Études sur la maladie des vers à soie* (1870), *Études sur la bière* (1876). He began the practice of inoculation for hydrophobia in 1885.

See *Vie de Pasteur*, par René Vallerey-Radot. Hachette. Paris, 1900. (H. E. R.)

Patagonia, the name given to that portion of South America which, to the east of the Andes, lies south of the Rio Negro (41° S.), and to the west of the Andes, south of the Chilian province of Chiloe (42° S.). The Chilian portion embraces the two provinces of Llanquihué and Magallanes. East of the Andes the Argentine portion of Patagonia is divided into four territories, viz. :—(1) Neuquen, 80,000 square miles approximately, with 9261 inhabitants in 1895, formed by a portion of the triangle situated to the west of the rivers Limay and Neuquen, between the northern shore of Lake Nahuel-Huapi (41° S.) and Rio Barrancas (37° S.); (2) Rio Negro, 44,000 square miles approximately, with a population of 14,517 in 1895, extending from the Atlantic to the Cordillera of the Andes, to the north of 42° S.; (3) Chubut, 95,000 square miles approximately, with a population of 3748 (1895), embracing the regions between 42° and 46° S.; and (4) that portion of the province of Santa Cruz which stretches from the last-named parallel as far south as the dividing line with Chile, and between Dungeness Point and the water-shed of the Cordillera, an area approximately of 106,000 square miles, with a population (1895) of 1058. The general character of the Argentine portion of Patagonia is for the most part a region of vast steppe-like plains rising in a succession of abrupt terraces about 300 feet at a time, and covered with an enormous bed of shingle almost bare of vegetation. This peculiar tract of shingle is of Tertiary marine origin, and has been designated by geologists the Patagonian formation. Beneath the shingle is a vast deposit of sands and clays of marine and lacustrine origin, and volcanic lavas and tuffs. In the hollows of the plains are ponds or lakes of brackish and fresh water. Towards the Andes the shingle gives place to porphyry, granite, and basalt lavas, animal life becomes more abundant and vegetation more luxuriant, acquiring the characteristics of the flora of the western coast, principally the beech and conifers.

Exploration.

Since 1880 explorations of a scientific character have been carried on in both the interior and coast regions of Patagonia by Moreno, Moyano, Rogers, Lista, Bertrand, Ziemiradzky, Steffen, Kruger, Stange, Hauthal, Wherti, Burckhardt, Nordenskiöld, Hatcher, and the surveyors of the Argentine and Chilian Boundary Commissions, and an appreciable modification of current ideas has been effected. Although the general character of the country is that of table-land, diversified by the beds of former lakes and rivers, the examination of the region close to the Cordillera has revealed striking features that give it a peculiar and interesting character.

Physiography.

Among the depressions by which the plateau is intersected transversely, the principal is the Hualichu, south of the Rio Negro, the Maquinchau and Balcheta (through which previously flowed the waters of Lake Nahuel-Huapi, which now feed the river Limay); others between the latter and the Chubut, Senguerr, Chico, Deseado; others between the Desire and the San Julian, now totally disappeared, the Shehuen depression, and those of Santa Cruz—Coile and Gallegos. Besides these transverse depressions (some of them marking lines of ancient inter-oceanic communication), there are others which were occupied by more or less extensive lakes, such as the Yagagtoo, Musters, and Colhue, and others situated to the south of Port Desire, in the centre of the country. Over the greater part of its surface the plateau is covered by a loose glacial, and in some parts fluvio-glacial, gravel, which barely supports the growth of herbage. Good pastures are found only on the watered lowlands, where bushes are more numerous, and where, by irrigation, extensive areas can be cultivated, and in the neighbourhood of the Andes, where are situated extensive tracts of land suitable for cultivation. In the central region volcanic eruptions, which have taken part in the formation of the plateau from the Tertiary period down to the present era, cover a large part with basaltic lava-caps; and in the western third more recent glacial deposits appear above the lava. There, in contact with folded Cretaceous rocks, uplifted by the Tertiary granite, erosion, caused principally by the sudden melting and retreat of the ice, aided by tectonic changes, has scooped out a deep longitudinal depression, which generally separates the plateau from the first lofty hills, the ridges generally called the Pre-Cordillera, while on the west of these there is a similar longitudinal depression all along the foot of the snowy Andean Cordillera. This latter depression contains the richest and most fertile land of Patagonia.

Geology.

The geological constitution is in accordance with the orographic physiognomy. The Tertiary plateau, flat on the east, gradually rising on the west, shows Upper Cretaceous caps at its base. First come Lower Cretaceous hills, raised by granite and dioritic rocks, undoubtedly of Tertiary origin, as in some cases these rocks have broken across the Tertiary beds, so rich in mammal remains; then follow, on the west, metamorphic schists of uncertain age; then quartzites appear, resting directly on the primitive granite and gneiss which form the axis of the Cordillera. Porphyritic rocks occur between the schists and the quartzites. These Upper Cretaceous and Tertiary deposits have revealed a most interesting vertebrate fauna. These, together with the discovery of the perfect cranium of a chelonian of the genus *Myolania*, which may be said to be almost identical with *Myolania oweni* of the Pleistocene age in Queensland, form an evident proof of the connexion between the Australian and South American continents. The Patagonian *Myolania* belongs to the Upper Chalk, having been found associated with remains of *Dinosauria*. Other specimens of the interesting fauna of Patagonia, belonging to the Middle Tertiary, are the gigantic wingless birds, exceeding in size any hitherto known, and the singular mammal *Pyrotherium*, also of very large dimensions. In the Tertiary marine formation a considerable number of cetaceans has been discovered. In deposits of much later date, formed when the physiognomy of the country did not differ materially from that of the present time, there have been discovered remains of pampean mammals, such as *Glyptodon* and *Macrauchenia*, and in a cave near Last Hope Inlet, a gigantic ground sloth (*Grypotherium listai*), an animal which lived contemporaneously with man, and whose skin, well preserved, showed that its extermination was undoubtedly very recent. With the remains of *Grypotherium* have been found those of the horse (*Onoshippidium*), which are known only from the lower pampas mud, and of the *Arctotherium*, which is found, although not in abundance, in even the most modern Pleistocene deposits in the pampas of Buenos Aires. It would not be surprising if this latter animal were still in existence, for footprints, which may be attributed to it, have been observed on the borders of the rivers Tamango and Pista, affluents of the Las Heras, which run through the eastern foot-hills of the Cordillera in 47° S. Glaciers occupy the valleys of the main chain and some of the lateral ridges of the Cordillera, and descend to lakes San Martin, Viedma, Argentino, Dickson, Hauthal, and Tyndall, strewing them with icebergs. Several of the high peaks are still active volcanoes, amongst which may be mentioned three that have not been definitely located, or are little known, viz., one which, according to the Indians, is situated to the west of Lake Dickson; the second is Fitzroy volcano; and the third lies about 47° 30′ S., and was observed from the sea by the Argentine vessel *Azopardo*. In Patagonia an immense ice-sheet extended to the east of the present Atlantic coast during the first ice age, at the close of the Tertiary epoch, while, during the second glacial age in modern times, the terminal moraines have generally stopped, 30 miles in the north and 50 miles in the south, east of the summit of the Cordillera. These ice-sheets, which scooped out the greater part of the longitudinal depressions, and appear to have rapidly retreated to the point where the glaciers now exist, did not, however, in their retirement fill up with their detritus the fjords of the Cordillera, for these are now occupied by deep lakes on the east, and on the west by the Pacific channels, some of which are as much as 250 fathoms in depth, and soundings taken in them show that the fjords are deeper in the vicinity of the mountains than to the west of the islands. In so far as its main characteristics are concerned, Patagonia seems to be a portion of the Antarctic continent, the permanence of which dates from very recent times, as is evidenced by the apparent recent emergence of the islets around Chiloe, and by the general character of the pampean formation. Some of the promontories of Chiloe are still called "huapi," the Araucanian equivalent for "islands"; and this may perhaps be accepted as perpetuating the recollection of the time when they actually were islands. They are composed of caps of shingle, with great, more or less rounded boulders, sand, and volcanic ashes, precisely of the same form as occurs on the Patagonian plateau. From an examination of the pampean formation it is evident that in recent times the land of the province of Buenos Aires extended farther to the east, and that the advance of the sea, and the salt-water deposits left by it when it retired, forming some of the lowlands which occur on the littoral and in the interior of the pampas, are much more recent phenomena; and certain caps of shingle, derived from rocks of a different class from those of the neighbouring hills, which are observed on the Atlantic coasts of the same province, and which increase in quantity and size towards the south, seem to indicate that the caps of shingle which now cover such a great part of the Patagonian territory recently extended farther to the east, over land which has now disappeared beneath the waves, from which it formerly emerged, while other marine deposits along the same coasts became converted into bays during the subsequent advance of the sea. There are besides, in the neighbourhood of the present coast, deposits of volcanic ashes, and the ocean throws up on its shores blocks of basaltic lava, which in all probability proceed from eruptions of submerged volcanoes now extinct. One fact, however, which apparently demonstrates with greater certainty the existence in recent times of land that is now lost, is the presence of remains of pampean mammals in Pleistocene deposits in the bay of San Julian and in Santa Cruz. The animals undoubtedly reached these localities from the east; it is not at all probable that they advanced from the north southwards across the plateau intersected at that time by great rivers and covered by the ice-sheet. With the exception of the discoveries at Last Hope Inlet, in close communication with the Atlantic valley of Gallegos, none of these remains have been discovered in the Andean regions.

On the upper plains of Neuquen territory thousands of cattle can be fed, and the forests around Lakes Traful and Nahuel-Huapi yield large quantities of valuable timber. The Neuquen river is not navigable, but as its waters are capable of being easily dammed in places, large stretches of land in its valley are utilized; but the lands on each side of its lower part are of little commercial value. As the Cordillera is approached the soil becomes more fertile, and suitable districts for the rearing of cattle and other agricultural purposes exist between the regions which surround the Tromen volcano and the first ridges of the Andes. Chosmalal, the capital of the territory, is situated in one of these valleys. More to the west is the mining region, as yet almost unexplored, but which contains deposits of gold, silver, copper, and lignite. In the centre of the territory, also in the neighbourhood of the mining districts, are the valleys of Norquin and Las Lajas, the general camp of the Argentine army in Patagonia, with excellent timber in the forest on the Andean slope. The regions of Las Lajas, Alumine, Pulmary, Rucachoroy, Quillen, Tromen, and Huechulafquen are extremely picturesque, being overlooked on the west by the snows of the Lonquimay, Villarica, Yaimas, Quetropillan and Lanin volcanoes, which are scored by deep ravines and their sides dotted with araucaria (*A. imbricata*) and an abundant crop of strawberries (*Fragaria chilensis*). The wide valleys occur near Rio Malleco, Lake Huechulafquen, the river Chimehuin, and Vega de Chapelco, near Lake Lacar, where are situated villages of some importance, such as Junin de los Andes and San Martin de los Andes. Close to these are the famous apple orchards supposed to have been planted by the Jesuits in the 17th and 18th centuries. These regions are drained by the river Collon-Cura, the principal affluent of the river Limay. Lake Lacar is now a contributary of the Pacific, its outlet having been changed to the west, owing to a passage having been opened through the Cordillera. To the south of the valley of the Chimehuin are the depressions of the rivers Caleufu and Traful, also tributaries of the Limay, which receive the waters of the eastern slope of the Cordillera and of Lakes Hermoso, Metiquina, Villarino, Falkner, Traful, and Tilohuehuen. Lakes Espejo and Carrentoso originally formed part of Lake Nahuel-Huapi, but now empty their waters into that lake by a narrow channel. The landscape around these lakes is very beautiful, and the forest very rich in timber.

Neuquen.

The Rio Negro runs along a wide transverse depression, now followed by the railway which goes to the confluence of the rivers Limay and Neuquen, and in this depression are several settlements, among them Viedma, the capital of the Rio Negro territory, Pringles, Conesa, Choele Choel and Roca. To the south of the Rio Negro the Patagonian plateau is intersected by the depressions of the Gualicho and Maquinchau, which in former times directed the waters of two great rivers (now disappeared) to San Antonio Bay, the first-named depression draining the network of the Collon-Cura and the second the Nahuel-Huapi lake system. To the south of the second of these valleys rises a volcanic plateau, with small craters perfectly preserved; and in the centre of the territory a longitudinal granite chain, with porphyritic trachitic rocks, runs southwards, being the end of the northern chains of central Argentina hidden under the Tertiary sandstone as far south as 38° S. This chain continues towards the centre of the Chubut territory, ending in porphyritic rocks at Atlas Point and Port Desire on the Atlantic coast. In the valleys and depressions amongst these rocks there are beautiful tracts of country, which are now beginning to be inhabited. In 42° S. there is a third broad transverse depression, apparently the bed of another great river, now perished, which carried to the Atlantic the waters of a portion of the eastern slope of the Andes, between 41° and 42° 30′ S. The soil of this depression close to the Atlantic, near the eruptive mountains of San Antonio, and of the central part is of relatively small value as pasturage, but towards the Cordillera the soil becomes richer and the scenery grand. The network of small lakes, *e.g.*, Hess, Fonck, Vidal Gormaz, Mascardi, Gutierrez, Guilielmo, Martin, and Steffen, survivals of a former extension of Lake Nahuel-Huapi, drain excellent districts, all alike picturesque, over the whole of the Valle Nuevo, which extends between Lake Nahuel-Huapi and Lake Puelo. In this region two recent breaches through the Andes carry off the waters of these eastern valleys to the Pacific.

Rio Negro.

Chubut territory presents the same characteristics as the Rio Negro territory. Rawson, the capital, is situated at the mouth of the river Chubut on the Atlantic (42° 30′ S.), and is connected by railway with Golfo Nuevo at Port Madrin. The town was founded in 1865 by a group of colonists from Wales, assisted by the Argentine Government; and its prosperity has led to the foundation of other important centres in the valley, such as Treleu and Gaiman. Here is the seat of the governor of the territory, and in 1895 the inhabitants of this part of the territory, composed principally of Argentines, Welsh, and Italians, numbered 2585. The valley has been irrigated and cultivated, and produces the best wheat of the Argentine Republic. At 75 miles from its mouth the river Chubut receives the Rio Chico del Chubut, which was formerly a considerable river, but is now diminished on account of the waters of the Rio Senguerr having ceased to feed it. The latter river is the outflow of Lakes La Plata and Fontana, and receives the waters of the rivers Tenca, Mayo, Chalia, and Guenguel. It is finally absorbed in Lakes Musters and Colhue, and from 1888 its flow into the Rio Chico grew gradually less and less, until in 1896 it ceased altogether. Between the Chubut and the Senguerr there are vast stretches of fertile land, spreading over the Andean region to the foot of the Cordillera and the lateral ridges of the Pre-Cordillera, and filling the basins of some desiccated lakes, which have been occupied since 1885, and farms and colonies founded upon them. The chief of these colonies is that of 16 de Octobre, formed in 1886, mainly by the inhabitants of Chubut colony, in the longitudinal valley which extends to the eastern foot of the Cordillera. In 1895 its population numbered 1164; they devote themselves to cattle-rearing and agriculture, for which some of the valleys are admirably adapted. Other rivers in this territory flow into the Pacific through breaches in the Cordillera, *e.g.*, the upper affluents of the Fetaleufu, Palena, and Rio Cisnes. The first is formed by the waters of the Cholila, Rivadavia, Fetalafquen, and other smaller lakes lying at the eastern foot of the main chain. To the north of these, and separated from them by an extensive moraine, lies Lake Epuyen, which empties into Lake Puelo and is the source of the river Puelo, which flows into the Pacific at Reloncavi Bay. Fetaleufu river also receives the Corinto river, which issues from the lateral cordon of the Andes and flows into the fluvio-glacial plains of Esquel through the valley of 16 de Octobre, which it also irrigates. The principal affluent of the Palena, the Carrenleufu, carries off the waters of Lake General Paz, situated on the eastern slope of the Cordillera. Rio Pico, an affluent of the same river and of the Rio Cisnes, receives nearly the whole of the waters of the extensive undulating plain which lies between the Rio Teka and the Rio Senguerr to the east of the Cordillera, whilst the remainder are carried away by the affluents of Rio Jehua, viz., the Cherque, Omkel, and Appeleg. This region, representing a pre-Glacial lacustrine basin, is being occupied by Argentine cattle-breeders. It likewise contains auriferous drifts, but these, like the auriferous deposits, veins of galena and lignite in the mountains farther west which flank the Cordillera, have not been properly investigated. At Lake Fontana there are auriferous drifts and lignite deposits which abound in fossil plants of the Cretaceous age. The Rio Senguerr, a river of considerable volume, but not navigable, flows out of this lake, and when it reaches the plain breaks up into a number of small channels. The valley of the Rio Verde, an affluent of the Senguerr, contains rich soil, and is the site of several prosperous Argentine farms. To the south of the Senguerr stretches the Patagonian plain in all its monotony, and there the continental watershed, which is distinct from and independent of the Cordillera, frequently changes, so that it is not possible to determine it with certainty. The streams which form the rivers Mayo and Chalia, affluents of the Senguerr, join the tributaries of the Rio Aisen, which flows into the Pacific, watering in its course extensive and valuable districts where colonization has been initiated by Argentine settlers. Colonies have also been formed in the basin of Lakes Musters and Colhue; and on the coasts near the Atlantic, between Bahia Camarones, Tilly Road, and the Gulf of Saint George, there are extensive farms.

Chubut.

The territory of Santa Cruz is arid along the Atlantic coast and in the central portion between 46° and 50° S. With the exception of certain valleys at Port Desire and in the transverse basins which occur as far south as Puerto San Julian, and which contain several cattle farms, few spots are capable of cultivation, the pastures being poor, water insufficient, and salt lagunas fairly numerous. Port Desire is the outlet for the produce of the Andean region situated between Lakes Buenos Aires and Pueyrredon. Into this inlet there flowed at the time of the conquest a voluminous river, which subsequently disappeared, but returned again to its ancient bed, owing to the river Fenix, one of its affluents, which

Santa Cruz.

had deviated to the west, regaining its original direction. Lake Buenos Aires, the largest lake in Patagonia, measuring 75 miles in length, poured its waters into the Atlantic even in post-Glacial times by means of the river Desire, and it is so depicted on the maps of the 17th and 18th centuries; and so too did Lake Pueyrredon, which, through the action of erosion, now empties itself westwards, through the river Las Heras, into the Calen inlet of the Pacific, in 48° S. Port San Julian, where Hernando de Magallanes wintered, has lately been colonized by cattle farmers, who are also pushing into the interior up the valley of a now extinct river which in comparatively recent times carried down to Port San Julian the waters of Lakes Volcan, Belgrano, Azara, Nansen, and of some other lakes which now drain into the river Mayer and so into Lake San Martin. The Rio Chico, which represents the large extinct river just mentioned, empties itself into Santa Cruz Bay a little to the south of San Julian, after receiving the Rio Shehuen, a former outlet of Lake San Martin and of Lake Viedma. The latter now sends its waters to Lake Argentino by the Rio Leona, while the waters of Lake San Martin pierce the Cordillera of the Andes and empty westwards into the southern arm of Calen inlet. The valleys of the Rio Chico throughout their whole extent, as well as those of Lake Shehuen, afford excellent grazing, and around Lakes Belgrano, Burmeister, and Rio Mayer and San Martin there are spots suitable for cultivation. In the Cretaceous hills which flank the Cordillera important lignite beds and deposits of mineral oils have been discovered. The Rio Santa Cruz, originally explored by Captain Fitzroy and Charles Darwin, is an important artery of communication between the regions bordering upon the Cordillera and the Atlantic. It has been ascended at various times in small craft to its source in Lake Argentino, and by the river Leona as far as Lake Viedma. Upon the southern border of Lake Argentino there are cattle-rearing settlements, as well as on the banks of the Rio Santa Cruz. In the bay an important trade centre has been established. But the present cattle region *par excellence* of Patagonia is the department of Rio Gallegos, the farms extending from the Atlantic to the Cordillera. Gallegos itself is an important business centre, which bids fair to rival the Chilian colony of Punta Arenas. The western region of this department, as well as the remainder of the Andean region, contains several lakes, the principal one being the picturesque Maravilla. The others, *e.g.*, Lakes Dickson, Nordenskiöld, Sarmiento, Paine, Hauthal, and Tyndall, are smaller. Glaciers come down to as far as the waters of the first two of these lakes, and the waters of the whole series are received by the Rio Serrano, which passes through the Cordillera from the east, by means of a narrow breach, to Last Hope Inlet. Owing to the produce of the cattle farms established there, the working of coal in the neighbourhood, and the export of timber from the surrounding forests, the town of Punta Arenas is in a flourishing condition. Its population numbers about 4000. But the colonization of the western (Chilian) coast has failed, principally owing to the adverse climatic conditions of the Cordillera in those latitudes.

Magallanes. In the extreme south (Magallanes) the existence of fossils and other features in the Cordillera similar to those in the more northern Andes gives support to the supposition that the upheaval of at least a portion of this territory took place at a very modern epoch; there is also additional evidence of this in the fact that the country at the present day differs from that depicted by the early navigators. The recent volcanic eruptions in this territory extend from 41° S. up to the straits in the same zone, Mount Aymond being the principal crater.

Natives. The natives of Patagonia are nearly extinct. Here and there one may find a Tehuelchian or Gennaken encampment, but natives of pure race are now very scarce, and the two races all told probably do not number more than 100 male individuals. The remaining population is composed of Araucanians, a mixture of the Tehuelches and Gennaken. But these are not the only type of people who have dwelt in Patagonia. The ancient burial-places have yielded the bones of other races quite distinct from the present inhabitants, some of them having greatly resembled the primitive types which are met with more to the north, in the Argentine Chaco and in Brazil; while others, again, strongly resembled certain of the Pacific races, in that they possessed ethnic characteristics which have not been observed elsewhere in South America. Among these remains every type of artificial deformity of the skull hitherto known has been found, while at the present time the natives only practise the occipital deformation which is so common among the western tribes of America.

Communications. Patagonia has ceased to be isolated from the rest of America, and the influx of population has led to navigation being established on the Rio Negro, on Lake Nahuel-Huapi, and on the Rio Santa Cruz; and communication is regularly maintained on the first-named river as far as the confluence of the Limay and the Neuquen, to which point also the railway reaches. The telegraph extends to Chosmalal, the capital of Neuquen territory, and to San Martin de los Andes on the west and to Bahia Camarones, near 46° S., and is being extended to the colony of 16 de Octobre and to Cape Virgenes, at the eastern entrance of Magellan Strait. As already mentioned, a small railway connects Puerto Madrin in Golfo Nuevo with Rawson. Between Buenos Aires and the principal ports of the Atlantic coast as far as Punta Arenas and Tierra del Fuego a monthly service of steamers exists, and surveys have been commenced for the laying of light railways between the port of San Antonio on the Atlantic coast to San Martin and Junin de los Andes, Nahuel-Huapi, and 16 de Octobre; also from Tilly Road in Saint George Gulf to Lake Buenos Aires and 16 de Octobre, and from Rio Gallegos up to the slope of the Cordillera. Various other parts are in communication by roads. Surveys for utilizing the waters of Lakes Nahuel-Huapi and Argentino for the irrigation of land near the Rio Negro and the Santa Cruz were made in 1898.

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Patel, Framjee Nasarwanjee (1804–1894), Parsee merchant and philanthropist, was born in 1804, and had a sound vernacular education, with a smattering of English received during a short period of study in the then solitary English school in Bombay. At the age of fifteen he entered upon a business career, and its pursuit proved so congenial that by 1827 he had worked his way to a partnership in the firm of Frith, Bomanjee, and Co. The Parsees of those days evinced a great aptitude for commerce, and their simple manner of life, frugal habits, business capacity, and strict honesty made them desirable coadjutors with the mercantile firms which by that time had opened a regular and growing business with England. Banking facilities being then exceedingly scanty, such Parsees as had any capital at command acted as bankers and brokers to the rising English firms. Patel's experience enabled him in a few years to raise the status of his compatriots to the higher level of independent merchants, and he founded in 1844 a business house under the name of Wallace and Co., in which he was himself a partner with the English members of the firm. When he retired in 1858 he had amassed a large competence, and in the following year he established a firm on the same lines under the style of Framjee, Sands and Co., of which the members were some of his sons, together with English partners. This system of partnership with English merchants was a landmark in the business history of the Parsees, though it has not been much developed owing to the preference of the younger men for professional and official pursuits. The improvement effected in the commercial status of the Parsees in Bombay is none the less to the credit of Framjee Nasarwanjee Patel. It was, however, not so much for his success as a merchant, as for his spirit and liberality as an educationist, reformer, and philanthropist, that his name is notable in the annals of western India. He entered on his civic labours in 1837, and in all public movements figured prominently as an accredited representative of his community. As a pioneer of education, both for boys and girls, his example inspired the younger men of his time, like Dadabhoy Naoroji, formerly member of the Imperial Parliament for East Finsbury, and the late Naoroji Fardoonjee and Sorabjee Shapurjee Bengallee. When Mountstuart Elphinstone, during his governorship, conceived the idea of concentrating the literary and educational activity which had arisen from isolated efforts on the part of men who had themselves been brought into contact with Western culture, among his chief collaborators were Framjee Cowasjee Banajee and Framjee Patel. To their initiative was due the establishment of the Elphinstone Institution, which comprised a high school and, after some years, a college, which continue to hold foremost rank among the similar academies since established in western India. But Mr Patel's most remarkable public service was performed in connexion with the Parsee Law Association, of which he was president. Since their exodus from Persia the domestic affairs of the Parsees had been in a very unsettled state. Matrimonial obligations and the rights of succession in cases of intestacy had fallen into hopeless confusion, and the adjudication of disputes in relation thereto was effected by certain elders of the community, who had neither the knowledge and help of fixed principles to guide their judgments, nor any authority to enforce their decisions. The case of *Ardesir Cursetjee* v. *Peeroxebai*, which came up on appeal before the Privy Council in England, brought to light the strange fact that even the Supreme Court of Bombay had no jurisdiction over matrimonial and ecclesiastic disputes among Parsees. This state of lawlessness was recognized by that community as intolerable, and the agitation which ensued thereupon led to the appointment of a commission, of which the distinguished jurist Sir Joseph Arnould was the president and Mr Framjee Patel the chief Parsee member. The Parsee Law Association, under the guidance of Mr Patel and Mr Sorabjee Bengallee, rendered invaluable help to the commission, and their joint efforts resulted in the passing by the Government of India of the Parsee Marriage and Divorce Act and the Parsee Intestate Succession Act (15 and 21 of 1865). These Acts form the charter of matrimonial and ecclesiastical status for the Parsees. At the time of his death in 1894, at the ripe age of nearly ninety years, Mr Framjee Patel was the most revered and best beloved of the distinguished natives of India, having during an eventful public life extending over sixty years worked in co-operation with three generations of the most prominent of his compatriots to better the condition of their country. During that period Framjee Patel was *primus inter pares* among a succession of enlightened and public-spirited Parsees, who, under the guidance and encouragement of men like the Rev. Dr John Wilson, Sir Bartle Frere, and Sir George Birdwood, brought about the regeneration of the old civilization of western India by British methods. He thus fully justified the term applied to him by the last-named, in the dedication to him of his work on the old records of the India Office, of "the Nestor of the Parsees." His family surname refers to the title of Patel, that is, "Mayor," of Bombay, conferred on its founder for services rendered to the English in 1692. (M. M. BH.)

Patents (see also LETTERS PATENT).—In this article patents for inventions alone are considered. Few material alterations in the English law have been made since the article Patents in the ninth edition of this work was published, and the account there given of the subject-matter of valid letters patent, and of legal proceedings for the infringement and revocation of patents, is still substantially correct. But the following points deserve notice.

(i.) *Exhibitions.*—The exhibition of an invention at an industrial or international exhibition certified as such by the Board of Trade, or the publication of any description of the invention during the period of the holding of the exhibition, or its use for the purpose of the exhibition in the place where it is held, or during the period of the exhibition by any person elsewhere, without the privity or consent of the inventor, is not to prejudice the right of the inventor or of his legal personal representative to apply for and obtain a patent, or the validity of any patent granted on the application, provided that two conditions are complied with, viz., (*a*) the exhibitor must, before exhibiting the invention, give the Comptroller-General a prescribed notice of his intention to do so; and (*b*) the application for the patent must be made before or within six months from the date of the opening of the exhibition (Patents Act, 1883). The Patents Act, 1886, enables the Sovereign, by Order in Council, to extend the provision above mentioned to industrial and international exhibitions held out of the United Kingdom.

(ii.) *Prior Publication.*—Whereas "user" in public is sufficient prior publication to invalidate a subsequent patent for the invention so used, publication in books, &c., will not be a bar to novelty unless its effect is to make the invention actually a part of public knowledge; and in dealing with alleged anticipations by patents that have never come into general use the courts will not invalidate a subsequent patent unless a person of ordinary knowledge of the subject, on having the alleged anticipation brought under his notice, would at once perceive, understand, and be able practically to apply the invention without making experiments or seeking for further information.

(iii.) *Variance or Disconformity.*—Since the introduction of the patent specification, it has been necessary that an invention protected by patent should be accurately described by the inventor. Formerly, when the condition on which letters patent issued was that the patentee should file a specification completely describing the nature of his invention within a certain time after the grant, the function of giving the necessary preliminary information on the subject was to some extent discharged by the title; at any rate, the validity of the grant was liable to be objected to on the ground of the title being too general. Under the present law the task of preliminary disclosure falls to the provisional specification, introduced by the Patent Law Amendment Act, 1852, and continued by the Patents Act of 1883, although a patentee may, under the latter statute, dispense with a provisional specification if he thinks proper to file a complete one in the first instance. Where, however, these two specifications are filed, it becomes of vital moment to an inventor that the true relation between them should be maintained. That relation, as settled by recent cases, may be stated thus: It is the duty and the office of the provisional specification to declare the nature of the invention in general terms. The function of the complete specification subsequently filed is to explain the invention in detail, and to show how it is to be carried out. The object of the provisional specification is to secure immediate protection, and to enable a patentee to work at and improve his invention without the risk of his patent being invalidated by premature publication. He is therefore entitled to embody in his complete specification any improved method of working his invention which he may discover in the interval; and he is indeed bound to do so, since the price that a man who desires a patent has to pay to the public for the privilege is that he should make a full disclosure of his invention in his complete specification. But there is a limit to what the patentee may do in this respect. He must not describe in his complete specification an invention different from that declared in the provisional. If he falls into this error there is said to be a "variance" or "disconformity" between the two specifications, and the patent will be bad. The Patents Act, 1883, § 9, made it the duty of the examiners of the Patent Office to consider the question of disconformity between specifications on applications for patents, and it was thought at one time that if the Comptroller-General accepted a patent after the examiner had reported on it, there could no longer be any objection on the ground of disconformity. But this view has been rejected, and disconformity is still a good answer to an action for infringement and makes a patent void.

(iv.) *Compulsory Licences.*—For about fifteen years the provisions introduced into the Patents Act, 1883, for the compulsory licensing of patents under the authority of the Board of Trade, remained practically a dead letter. Up to the end of 1887 there had been only one informal application, which was by leave withdrawn. In 1888 there was also one application. Probably the fact that the compulsory licence provisions did not apply to patents granted, or applications pending, before the Patents Act, 1883, came into operation, may account for this circumstance. There have been several cases since 1897. It may be noted at this point that by English patent law a patentee is not obliged to bring his invention into practice within a specified time (compulsory working, or *exploitation*): there is no preliminary examination into, or guarantee of, novelty by the Patent Office; and a patentee is not prohibited from importing into the country articles manufactured under his patent abroad. The law is different, as will be seen by reference to the headings (x.) and (xi.) *infra*, in many British colonies and foreign countries. With reference to preliminary examination in England, however, it should be added that the Board of Trade recently appointed a strong committee, with Sir Edward Fry as its chairman and Lord Alverstone and Mr Fletcher Moulton, K.C., among its members, to inquire into and report upon, *inter alia*, the question whether any, and, if so, what, additional powers should be given to the Patent Office to (*a*) control, (*b*) impose conditions on, or (*c*) otherwise limit the issue of letters patent in respect of inventions which are obviously old, or which the information recorded in the office shows to have been previously protected by letters patent in Great Britain.

(v.) *Legal Remedies.*—Several additional forms of legal proceedings in connexion with patents should be noted. (*a*) At common law a person who, alleging that he has a patent, threatens his rivals in trade, is liable to an action for damages, but the plaintiff cannot succeed without showing that the threats were made maliciously. (*b*) The Patents Act, 1883, provides another remedy—what is known as "the threats action" (see sec. 32). The statute makes the good faith of the patentee threatening legal proceedings no answer to an action brought against him by any person aggrieved by his threats if the acts complained of are not in fact an infringement of the patent, and if the patentee fails with due diligence to commence and prosecute an action for infringement. (*c*) The point has recently been raised whether a patentee threatening legal proceedings for infringement could not be sued under section 4 of the Statute of Monopolies, which gives to any person "hindered, grieved, disturbed or disquieted . . . by occasion or pretext of any monopoly or letters patent," a right to treble damages.

(vi.) *Extent and Construction.*—The patent when sealed is to have effect in the United Kingdom and the Isle of Man. The present Act, unlike the Patent Law Amendment Act of 1852, does not extend the monopoly to the Channel Islands. The statutory form of letters patent for inventions provides that "These our letters patent shall be construed in the most beneficial sense for the advantage of the said patentee." It is now settled, however, after considerable judicial discussion, that a specification should be subjected neither to what was once called a "benevolent" construction nor to a strict one, but that the language should be construed according to its ordinary meaning.

(vii.) *Fees.*—By an order of the Board of Trade which came into operation on 1st October 1892, the following important reductions in the renewal fees payable on patents were made. Before the expiration of the 4th year from the date of the patent, £5 instead of £10; of the 5th year, £6 instead of £10; of the 6th year, £7 instead of £10; of the 7th year, £8 instead of £10; of the 8th year, £9 instead of £15; of the 10th year, £11 instead of £20; of the 11th year, £12 instead of £20; of the 12th year, £13 instead of £20; and of the 13th year, £14 instead of £20. The preliminary fees amounting to £4 were left untouched by the order, the result of which was to reduce the entire cost of a patent from £154 to £99.

(viii.) *Business.*—A new Patent Office has been constructed in London on the site of the old buildings, the frontage extending from Southampton Buildings into Staple Inn. The number of applications for patents, which sprang from 5993 in 1883 to 17,110 in 1884, culminated in a total of 30,952 for the year 1892, since which date a steady decline has set in. The number of patents sealed on application for a given year shows less variation, the minimum being 8775 for 1885 against 14,465 for 1897. The proportion of seals to applications varied from 46 to 50 per cent. during 1890–1900. The receipts from patent fees in 1899 were £202,977, against a total expenditure of £123,216. The latter sum includes £24,118 expended chiefly on the new office.

The official publications of the Patent Office deserve some notice, as, in the absence of official investigation into novelty, the onus of search rests with the applicant or his agent. The procedure has been greatly simplified by the publication, on a uniform system and at a low rate (1s. per volume), of illustrated abridgments of specifications. From 1877 practically to date the searcher obtains a chronological digest of all specifications falling within a given class. To these classes there is a reference index, known as the "abridgment class and index key," which at once directs the searcher to his proper class and index heading. The periods already issued in volume form are 1877–83, 1884–88, 1889–92, 1893–96. The series for 1897–1900 was issued sheet by sheet to subscribers. The first sheets of a similar series for 1867–76 have also been published, while it is proposed to reissue on similar lines abridgments of all specifications filed since the initiation of the English patent system.

(ix.) *Patent Agents.*—The position of patent agents is now regulated by statute. By the Patents Act, 1888, it was provided that no person should, after 1st July 1889, be entitled to describe himself (and whoever does so knowingly incurs liability to a maximum penalty of £20) as a patent agent whether by advertisement, description on his place of business, or otherwise, without being registered as such in pursuance of the Act. But the Act preserves the right to registration of every person who, to the satisfaction of the Board of Trade, shows that he had been *bonâ fide* practising as a patent agent before it passed. The Board of Trade is empowered by this statute to make from time to time general rules for the purpose of carrying out its provisions, and by rules issued in 1889, and reissued in 1891, the Board of Trade delegated to the Institute of Patent Agents (which obtained a royal charter in 1891) the care of the register of patent agents and the duty of holding the necessary examinations for entrance into the profession.

(x.) *India and the British Colonies* [see also (vi.) and (xii.)].—Little more can be attempted under the present heading or the following one—(xi.) *Foreign Patent Laws*—than to touch upon a few distinctive features, such as duration, fees, preliminary examination into novelty, &c.

Australian States.—In New South Wales the regulating Act is No. 19 of 1899. It amends the law on a variety of matters, provides for the appointment of an examiner of patents, and is practically a transcript of the provisions of the Imperial Patents Act, 1883, as to amendment of specifications, disclaimers, and revocation of patents. It appears that there may be a preliminary examination as to novelty (see §§ 5 (1) and 22). The duration is not less than 7 nor more than 14 years. In Queensland the Patents Acts are No. 13 of 1884, No. 5 of 1886, and No. 8 of 1890. The provisions of these statutes closely follow the Imperial legislation on the subject. But there is a preliminary examination as to novelty (see No. 5 of 1886). In South Australia the latest Act is No. 421 of 1887. A preliminary examination as to novelty may be ordered (see No. 78 of 1877). Patent law is now regulated in Victoria by No. 1123 of 1890, which is modelled on the English Acts. There is a preliminary examination as to novelty. The fees payable before the expiration of the 3rd and 7th years are now respectively reduced from £15 and £20 to a sum in each case of £2 10s. In West Australia the governing Acts are now No. 5 of 1888, No. 15 of 1892, and No. 4 of 1894. There is apparently no preliminary examination as to novelty. The general provisions are similar to those of the English statutes. The renewal fees are prescribed by the Patent Rules 1898, and amount to a sum of £5 before the end of the 4th year and £10 before the end of the 7th year from the date of the patent. See also *New Zealand* and *Tasmania*.

Bahama Islands.—The law is regulated by the following Acts of the colony:—52 Vict. c. 23, 53 Vict. c. 2, and 54 Vict. c. 12. Duration of patent 7 years, with power in governor to renew for another 7 years, and thereafter for a third period of 7 years. The fees are £3 on filing specification, £10 for second renewal, and £20 for third. Apparently there is no preliminary examination as to novelty.

Barbados.—Cp. Acts of Colony of 12th December 1883 and No. 37 of 1892–93. Duration of patent 7 years, with possible extensions for two further periods of 7 years each, but no more. Fees are £3 6s. 8d. on filing specification, £10 for second renewal, and £20 for third. No preliminary examination as to novelty.

Bermuda.—There is apparently no statutory patent law in this colony.

British Guiana.—The law is still regulated by ordinance No. 1 of 1861. It may be noted in addition that there is no preliminary examination for novelty.

British Honduras.—The law of 10th September 1862 has been re-enacted with slight modifications (see supplement to *Patent Laws of the World*, No. 4). There is no examination as to novelty.

British India.—The law is now governed by Act 5 of 1888, which applies to the whole of British India. Duration of patent is 14 years. A preliminary examination into novelty might apparently be ordered. The following taxes are payable:—Annual sums of Rs.50 from the 4th to the 8th year, and of Rs.100 from the 8th to the 13th year of the term.

British New Guinea.—The Queensland Patents Acts, No. 13 of 1884 and No. 5 of 1886, have been adopted. See British New Guinea Ordinance No. 6 of 1889, Schedule A.

British North Borneo.—Straits Settlements law (No. 12 of 1871), adopted by Patents Proclamation 1887 (No. 1 of 1887).

Canada.—Patent legislation belongs exclusively to the Dominion Parliament [B.N.A. Act, 1867, § 91 (22)]. The existing Acts are c. 61 of 1886; 55 and 56 Vict. c. 24, and 56 Vict. c. 34. The duration of the patent is 18 years. At the time of application the applicant may pay the full fee required for that term (viz., 60 dollars) or the partial fee required for the term of 6 years (20 dollars) or for the term of 12 years (40 dollars). If a partial fee only is paid, the amount is stated in the patent, and the patent ceases at the end of the term covered by such partial payment, unless before the expiration of such term the patentee pays the fee required for the further term of 6 or 12 years, viz., 20 dollars in the former case and 40 in the latter. There is a preliminary examination into novelty by examiners, with an appeal from the decision of the Commissioner of Patents to the Governor in Council. The patent is void unless it is worked in Canada within 2 years, or if after the expiration of 12 months, or any authorized extension of either of these periods, the patentee imports the invention into Canada.

Cape of Good Hope.—The law is still regulated by Act No. 17 of 1860. There is no preliminary examination into novelty, and the Act contains no provisions for compulsory working, or as to the importation of patented articles from abroad.

Ceylon.—The law is now regulated by Act 16 of 1892. The duration of the patent is 14 years, with power vested in the governor in council to grant extensions of 7 and 14 years. There is no preliminary examination as to novelty, and there are no provisions as to compulsory working or the importation of patented articles from abroad. The renewal fees are Rs.50 annually from before the expiration of the 4th to before the expiration of the 8th year from the filing of the specification, and Rs.100 annually from before the expiration of the 9th to before the expiration of the 13th year. See also No. 6 of 1897.

Channel Islands.—These are not now included in grant of letters patent. See form of grant, schedule I., Form D, Patents Act, 1883.

Falkland Islands.—No regulations exist.

Fiji Islands.—The law depends on ordinances No. 3 of 1879 and 7 of 1882, and Order of 29th December 1890. The duration of the patent is 14 years. There is no preliminary examination, and there are no provisions as to compulsory working or importation from abroad. The patent is not subject to any payment after issue. A fee of 5 guineas is payable on deposit of petition and specification. The fee for provisional protection is 5 guineas; on obtaining letters patent the applicant pays 10 guineas.

Gambia.—No regulations exist. An ordinance practically identical with that of the Gold Coast is being adopted.

Gibraltar.—There is no patent law in Gibraltar, but special ordinances are sometimes passed extending the privileges of British patentees to the dependency for the unexpired residues of the original terms. See as examples No. 5 of 1890, No. 1 of 1896, and No. 1 of 1898.

Gold Coast.—The law is now regulated by ordinance No. 1 of 1900, which closely resembles the Imperial Act.

Hong Kong.—The law is regulated by ordinance No. 2 of 1892. The inventor or assignee of any invention patented in England may obtain protection in the colony for the unexpired residue of the original term. If the English patent is extended by the advice of the Judicial Committee, an extension of the colonial patent may be obtained, or a new patent granted for the extended period. A fee of 25 dollars is payable on grant of patent, and another fee of the same amount on grant of extension or original letters in lieu of extension. There is no preliminary examination, and there are no provisions as to compulsory working or importation from abroad.

Jamaica.—The law is still in substance governed by c. 30 of 1857. But under ordinance No. 15 of 1891 the stamp duty on letters patent is now £2 instead of £6 10s., and there is no longer any fee payable on the reference to the Attorney-General. There is no preliminary examination as to novelty, and there are no provisions as to importation from abroad.

Lagos.—No regulations exist, but an ordinance practically identical with that of the Gold Coast is being adopted.

Leeward Islands.—The principal Acts still are No. 12 of 1876 and No. 16 of 1878. There is no preliminary examination into novelty, and there are no provisions as to compulsory working or importation from abroad. A retrospective power of granting extensions of time for any Act or payment is conferred on the governor in council by No. 2 of 1891.

Malta.—The law is governed by ordinance No. xi. of 1899, the duration of the patent is 14 years. There is no express provision for a preliminary examination into novelty. Provision is made for compulsory assignation or licence, where the invention has not been put into use within 12 months subsequent to the grant or its working has been suspended for 12 months continuously. The annual fees are £5 before the expiration of the 4th year from the date of the patent; £6 before the expiration of the 5th; £7 and £8 respectively before the expiration of the 6th and 7th years; £9 and £10 before the expiration of the 8th and 9th; and from £11 to £14 before the expiration of the 10th, 11th, 12th, and 13th years.

Mauritius.—The law is still regulated by ordinance No. 16 of 1875. There is no preliminary examination as to novelty, and there are no provisions for compulsory working or importation from abroad.

Natal.—The law is still regulated by No. 4 of 1870. But certain details of practice are amended by No. 2 of 1895. There is no preliminary examination as to novelty, and there are no provisions as to compulsory working or importation from abroad.

Newfoundland.—The law is contained in the Consolidated Statutes, Title xii. c. 109. There is no preliminary examination into novelty. In addition to the office fees, the patentee is required to deposit with the Colonial Secretary the sum of 25 dollars, to be paid by him to the Receiver-General for the use of the colony.

New Zealand.—The law now depends on No. 12 of 1889, amended in details by No. 8 of 1897. The duration of a patent is 14 years. There is no preliminary examination as to novelty, and there are no provisions as to compulsory working or importation from abroad. The following fees are payable:—£2 on obtaining letters patent, £5 before the expiration of the 4th year, and £10 before the expiration of the 7th.

St Helena.—The law is regulated by ordinance No. 3 of 1872. The grantee of an English patent, or his representatives, can have the grant extended to the colony. All cases of doubt and difficulty not provided for by the laws of the colony are governed by the law in force in England. A fee of one guinea is payable on filing copy of letters patent and specification with the registrar of the Supreme Court.

Sierra Leone.—No special regulations exist, but an ordinance practically identical with that of the Gold Coast is being adopted.

Straits Settlements.—The law is prescribed by ordinance No. 12

of 1871. The duration of a patent is 14 years. There is no preliminary examination as to novelty, and there are no provisions as to compulsory working or importation from abroad. There is a stamp duty of 50 dollars on the petition. No renewal fees are payable.

Tasmania.—The law is now regulated by Act No. 6 of 1893. The duration of the patent is 14 years. There is no preliminary examination as to novelty (but see § 110), and there are no provisions as to compulsory working or importation from abroad. The fees payable are £2 on obtaining patent, £15 at or before the expiration of the 3rd year, and £20 at or before the expiration of the 7th.

Trinidad and Tobago.—The law is regulated by ordinance No. 10 of 1900. The duration of the patent is 14 years. There is no preliminary examination into novelty, and there are no provisions as to compulsory working or importation from abroad. A fee of £10 is payable on application for a patent.

Turks and Caicos Islands.—The law of Jamaica has been extended to these islands by No. 7 of 1897. See supplement to *Patent Laws of the World*, No. 3.

Windward Islands.—In the Windward Islands other than Barbados, viz., Grenada, St Lucia, and St Vincent, patents for invention were granted until recently only by special ordinances. See, *e.g.*, St Lucia, ordinance No. 41 of 1875 (Tooth's patent). A stamp duty of £10 was payable in this island on letters patent for inventions (No. 6 of 1881, schedule). But ordinances based on the Imperial Act have now been passed, St Vincent (No. 5 of 1898), Grenada (No. 4 of 1898), and St Lucia (No. 14 of 1899).

(xi.) *Foreign Patent Laws.*—For the text of these see *Patent Laws of the World*, ed. 1899. But the following are the essential facts.

Algeria.—French law applied by decree of 5th June 1850.

Argentine Republic.—The law of 11th October 1864 is still in force. There is no provision as to importation from abroad.

Austria.—A new law (11th January 1897) came into force on 1st January 1899. The principal changes introduced by this measure are these: There is now a strict preliminary examination into novelty. The term of the patent is now fixed at 15 years, and besides an application fee of 10 florins, there are annual fees rising from 20 florins for the first year to 340 florins for the fifteenth. The period for compulsory working is raised from 1 year to 3 years from the date of the publication of the grant of the patent in the patent journal. Provision is made for the conversion of patents under the old law of 15th August 1852 (extended to Hungary by law of 27th June 1878, and to Bosnia and Herzegovina by law of 20th December 1879) into patents under the new law.

Belgium.—The law is still governed by the law of 24th May 1854. Patents are granted, as in France, without guarantee of novelty.

Bolivia.—The patent law depends on a law of 8th May 1858. The duration of the grant is in the case of a patent of invention not less than 10 nor more than 15 years; in the case of an imported invention, 3 years if its establishment requires an outlay of 25,000 dollars, if it reaches 50,000 dollars, 6 years, and if 100,000 or more, 10 years. The novelty neither of patents for invention nor of patents for imported inventions is guaranteed. The patent lapses unless the invention is put into complete practice within a year and a day from the date of the privilege, unless the omission is excused by justifiable causes according to law.

Brazil.—Patents are granted under the law of 14th October 1882. The patent lapses unless the invention is brought into effective use within 3 years from the date of the grant, or if such use is suspended for more than a year, except by reason of *force majeure* admitted by Government to be a sufficient excuse. Besides expenses and fees, patents of invention are subject to an annual and progressive tax, commencing at 20 dollars and increasing at the rate of 10 dollars a year. The patents issued are without guarantee of novelty or utility.

Chile.—The law is regulated by the law of 9th September 1840, decree of 1st August 1851, and laws of 25th July 1872, 20th January 1883, and 20th January 1888. There is a preliminary examination as to novelty and utility. Though the duration of a patent does not ordinarily exceed 10 years, the term may be extended to 20 years by the President of the Republic, if the report of the experts on the nature and importance of the invention seem to justify it. There are no provisions as to importation from abroad.

Colombia.—Patents are granted under law No. 35 of 1869. The term varies from 5 to 20 years at the option of the applicant. There is no preliminary examination as to novelty, and there is no provision as to importation from abroad. A patent for a new industry is void when such industry is idle for a whole year, unless inevitable circumstances have intervened. An applicant pays a sum of 10 pesos, which is forfeited if the patent is refused, and taken in part payment of the patent fee if it is granted. The patent tax is from 5 to 10 pesos a year for every year of the privilege.

Congo.—Patents are issued under a law of 29th October 1886 and a decree of 30th October 1886. They are of three kinds, patents of invention, of importation, and of improvement. There is no preliminary examination as to novelty, and the patent expressly mentions that the grant is made without guarantee. The term of a patent of invention is 20 years. A patent of importation or of improvement expires in the former case with the foreign, in the latter with the principal patent. Patents of improvement are not liable to any tax; on other patents a payment of 100 francs is required. There are no provisions as to compulsory working or prohibiting the importation of patented articles.

Costa Rica.—Prior to 26th June 1896, applications for patents had to be made to the Constitutional Congress. The matter is now dealt with by a law of the above-mentioned date. The duration of the term is 20 years. There is apparently no preliminary examination into novelty. The period for compulsory working is 2 years, and a patent which ceases to be worked during any 3 consecutive years becomes public property.

Denmark.—Patents are now granted under a law of 28th March 1894. The duration of the patent is 15 years, and no extension can be granted. There is a preliminary examination into novelty. The patent may, on terms, be appropriated by the State if the public interest demands it. The period for compulsory working is 3 years, and the patent will also lapse if the exercise of the invention is discontinued for more than a year. The patent commission may release the patentee from the obligation of manufacturing the patented article in Denmark, if satisfied that the cost of such manufacture would be unreasonable, on condition that the patented article is always kept on sale in Denmark. The tax is an annual fee of 25 kroner for the first 3 years, 50 kroner for the next 3, 100 for the following 3; then for 3 years 200 kroner yearly, and for the last 3, 300 kroner yearly.

Ecuador.—Patents are granted under a law of 18th October 1880. The provisions are identical with those given for Bolivia.

Finland.—The law is regulated by ordinances of 21st January 1898. The term of the patent is 15 years. There is a preliminary examination into novelty. The period for compulsory working is 3 years, the penalty for non-compliance being an obligation on the part of the patentee to grant compulsory licences. The tax consists of annual fees, commencing with the second year of the patent, and of the following amounts:—20 marks yearly for the 2nd and 3rd years; 40 marks from the 4th to and including the 6th year; 50 marks from the 7th to and including the 9th; 60 marks from the 10th to and including the 12th year; and 70 marks from the 13th to and including the 15th.

France.—The law is still regulated by the law of 5th July 1844. The following additional points should be noted:—The term of a patent of invention is 5, or 10, or 15 years, at the option of the patentee. Every such patent is subject to the following taxes, payable by annual instalments of 100 francs:—500 francs for a patent of 5 years, 1000 francs for a patent of 10 years, and 1500 francs for a patent of 15 years. A tax of 20 francs is payable on application for a patent of addition. Patents of addition are not subject to annual taxes. There is no preliminary examination as to novelty. A patentee is not obliged to mark patented articles as such, but, if he does, the words *Sans Garantie du Gouvernement*, or the initial letters of these words—S. G. D. G.—must be added, under liability to a penalty for omission of from 50 francs to 1000 francs. The provisions as to compulsory working (*exploitation*) are in the main so interpreted as to strike only at voluntary and calculated inactivity. The law of 5th July 1844 is applied to the French colonies by a decree of 21st October 1848, and as to French Indo-China, see decree of 24th June 1893.

Germany.—Patents (the law as to which is not affected by the new civil code) are granted under a law of 7th April 1891. The duration of the patent is 15 years. There is a strict preliminary examination into novelty. The period for compulsory working is 3 years, but it is sufficient if the patentee has done everything that is necessary to ensure the carrying out of the invention. A tax of 30 marks has to be paid before the grant. In addition to this there has to be paid at the commencement of the second and every following year of the term a tax amounting to 50 marks for the first year and increasing by 50 marks every subsequent year.

Greece.—No special patent law apparently exists. A private Act is required, which can be introduced by a deputy and is treated like any other Bill.

Guatemala.—Patents are granted under the law of 21st May 1886 and a decree of 17th December 1897. The term of the patent ranges from 5 to 15 years. An annual tax of 30 pesos is payable. The period of compulsory working is 1 year, and abandonment of working for a year forfeits the patent. There is apparently a preliminary examination as to novelty (see Art. 16 of the decree of 17th December 1897), but there is no prohibition of the importation of patented articles.

Hawaiian Islands.—Patents were issued till recently under the civil code (§§ 255, 256) and a law of 29th August 1884, which were not at first affected by the annexation of the islands by the United States. There was a preliminary examination as to novelty. The maximum duration of the patent was 10 years. On application a fee of 5 dollars was payable, the Commissioner of Patents received 20 dollars for his examination, and a fee of 5 dollars was payable when the patent was issued. No further payments. Now the United States law applies.

Honduras.—No. 177 of 10th March 1898. Term not to exceed 20 years. Annual tax 5 to 10 *silver* pesos; in the case of foreigners 10 to 50 *gold* pesos.

Hungary.—The law in force is that of 7th July 1895. The duration of the patent is 15 years. The period for compulsory working is ordinarily 3 years. The annual taxes range from 40 kroner for the 1st year to 500 for the 15th.

Italy.—The law is still governed by that of 31st January 1864, extending the Sardinian law of 30th October 1859 to the whole kingdom. There is no preliminary examination into novelty, and there is no provision prohibiting the importation of patented articles. Patents are subject (i.) to a proportional tax of as many times 10 lire as the years for which the patent is applied for, and (ii.) to an annual tax of 40 lire for the first 3 years; 65 lire for the following 3; 90 lire for the 7th, 8th, and 9th; 115 lire for the 10th and 11th; and 140 lire for the remaining 3 years.

Japan.—Patents are issued under an Act which came into operation on 16th July 1899. The law as to subject-matter resembles that of England and the United States. The term of a patent is 15 years from the date of registration. The patent may be annulled if the patentee has not worked his invention within 3 years from the date of the certificate of grant, or if, having discontinued such use for 3 years, he has refused a reasonable request by a third party for an assignment or a licence. An applicant not domiciled in the empire must appoint within 6 months a duly qualified agent by power of attorney. There is apparently a preliminary examination into novelty. The patent owner must affix his mark to the patent. The fees are calculated on a gradually ascending scale.

Liberia.—Patents are issued under a law of 23rd December 1864. The maximum term is 20 years. There is a preliminary examination as to novelty. A sum of 25 or 50 dollars is payable on application, according as the applicant is a citizen or an alien. An invention patented by an alien must be put in practical operation within 3 years. There is no prohibition of the importation of patented articles.

Luxembourg (law of 30th June 1880).—The term of the patent is 15 years. There is no preliminary examination as to novelty, and the importation of patented articles is not prohibited. An annual and progressive tax, commencing at 10 francs and increasing by 10 francs annually, is payable in advance. The period for compulsory working is 3 years, and after the expiration of that period compulsory licences may be ordered.

Mexico (laws of 7th June 1890 and 2nd June 1896).—The duration of a patent is 20 years, with possible extension for another 5 years. There is no preliminary examination as to novelty or utility. There are apparently no provisions as to compulsory working (but compulsory licences may be ordered) or prohibiting the importation of patented articles. The tax ranges from 50 to 150 dollars. The patentee must also at the end of each 5 years of the grant, in order to keep the patent in force for another 5 years, pay 50 pesos at the end of the first 5 years, 75 pesos at the end of 10 years, and at the end of 15 years, 100 pesos.

Nicaragua.—Patents were, as a general rule, until recently, granted only by special Act of Congress. But see now supplement 720, No. 15, *Patent Laws of the World*.

Norway (law of 10th June 1885).—The term of the patent is 15 years. There is a preliminary examination into novelty. The invention must be worked within 3 years, and the working must not be discontinued for a year on pain of forfeiture. For each patent an annual tax is payable amounting to 10 crowns for the second year and increasing by 5 crowns each year.

Orange River Colony, formerly *The Orange Free State.*—Up to the outbreak of war in 1899 the law was regulated by ordinance No. 10 of 1888. The term of a patent was 14 years. No preliminary examination as to novelty. Compulsory licences might be obtained. No prohibition of the importation of patented articles. The fee for signing and sealing the patent was not less than £10 nor more than £50. Taxes of £5 and £10 were payable before or at the expiration of the 3rd and 7th years of the term respectively.

Peru (law of 28th January 1869 and law of 3rd January 1896).—The maximum term of the patent is 10 years, and the tax is an annual sum of 100 dollars. There is no preliminary examination into novelty. The period for compulsory working is 2 years, and the importation of patented articles from abroad (except models of machinery whose introduction is authorized by the Government) is prohibited.

Portugal (law of 15th December 1894).—The maximum term is 15 years. The patent tax is 3000 reis, payable in advance, for each year of the term for which the privilege is granted or renewed. There is no preliminary examination into novelty. The period for compulsory working is 2 years, and discontinuance of working for any 2 years at a stretch forfeits the patent unless the inaction can be justified. The importation of patented articles from abroad is not prohibited.

Russia (law of 20th May 1896).—The maximum term is 15 years; the tax ranges from 15 roubles for the 1st year to 400 roubles for the 15th. There is apparently (see Arts. 3 and 13) a preliminary examination into novelty, but none into utility. The period for compulsory working is 5 years. There is no prohibition of importation of patented articles.

Spain.—Patents are still issued under the law of 30th July 1878. There is no preliminary examination as to novelty, and the importation of patented articles is not prohibited.

Sweden (law of 16th May 1884).—The term is 15 years. The annual tax is 25 crowns for the 2nd, 3rd, 4th, and 5th years; 50 crowns for each of the following 5 years; and 75 crowns for each of the remaining 5 years. There is a preliminary examination as to novelty, the period for compulsory working is 3 years, and discontinuance during any entire year entails forfeiture. There is no prohibition of the importation of patented articles.

Switzerland (laws of 29th November 1888 and 23rd March 1893).—The term of the patent is 15 years. There is an annual and progressive tax, rising from 20 francs for the 1st year by an annual increase of 10 francs up to 160 francs for the 15th. There is no preliminary examination as to novelty. The patent is forfeited if the invention has not been carried into practice by the end of the 3rd year, or if patented articles are imported from abroad, while at the same time the proprietor has refused applications on equitable terms for Swiss licences. Patented articles must be marked with the Federal cross and the number of the patent.

Transvaal Colony, formerly *The South African Republic.*—At the outbreak of war in 1899 law No. 10 of 1898 was in force. Patents were granted on payment of prescribed fees ranging from £20 up to £200, according to duration, for periods of 3, 5, 8, and 11 years.

Tunis (law of 22nd Rabia-et-Tani, 1306; 26th December 1888).—The term is either 5 years (fee 500 piastres) or 10 years (fee 1000 piastres) or 15 years (fee 1500 piastres). There is no preliminary examination as to novelty. The period for compulsory working is 2 years, and two consecutive years' discontinuance of such working, unless justified, forfeits the patent. So also does the importation of patented articles, but the introduction may be authorized (i.) of models of machines, and (ii.) of articles, made abroad, intended for public exhibitions or for trials.

Turkey.—Patents are still granted under the law of 2nd March 1880. There is no preliminary examination as to novelty, and a patentee who mentions his title as such without adding the words "without guarantee of Government," is liable to a maximum penalty of 45 Turkish pounds.

United States.—The American law may be considered at greater length. The Federal Constitution empowered Congress "to promote the progress of science and useful arts by securing for limited times to . . . inventors the exclusive right to their . . . discoveries." The existing American patent law is based on a series of Acts of Congress passed in virtue of this provision in the constitution, and on the judicial interpretation of these statutes. Between American and English patent law there is, as will appear in the course of this sketch, a considerable degree of similarity. The fact is not surprising when it is remembered that the Statute of Monopolies (21 Jam. I. c. 3) was, except in limiting the maximum duration of letters patent for inventions at fourteen years, only declaratory of the common law, and therefore formed part of the original common law of America. The English and American patent systems further agree in this, that they contain no provision as to compulsory working, and no prohibition of the importation of patented articles. But there are important differences between the two systems, not merely in points of detail, but in matters affecting the theory and practical working of the law. In England the consideration for the grant of a patent has all along been mainly the benefit which the public derives from the introduction of a new manufacture. In America greater emphasis is placed on the right of an inventor to have his merits rewarded. Again, under the Statute of Monopolies an inventor's exclusive privilege arises only in regard to inventions not known or used at the date of the grant, although it should be observed that under the modern Patents Acts the date of a patent, once granted, relates back to the date of the application. In the United States, on the other hand, the right is conferred on inventors to an exclusive privilege in such inventions as were not known or used before their discovery by the patentees. The practical bearing of this difference is explained in an admirable note on "The Statute of Monopolies" in *Ruling Cases, sub tit.* "Patent" (vol. xx. p. 5):—"It shifts the point of view in the important question of novelty. Many good American inventions have been given away in England by the premature publication in America of the inventor's proceedings. He is interviewed, and an article in the New York *Sun*, or some other paper, in due time finds its way

American law and procedure.

to England. This does no harm in America; on the contrary, it is good evidence of the date of the actual invention. But it is fatal to a subsequent application in England."

Certain other differences between English and American patent law (such as the less generous provision by the former than by the latter for disclaimers, the preliminary examination into novelty in American law, and the statutory right of patentees whose inventions are used by the Government to fair compensation) owe their origin to the fact that in England a patent is, in legal contemplation, a grant made by "the especial grace" of the sovereign, whereas in American legislation it is treated as a right.

The definition of patentability in American law is contained in section 4886 of the Revised Statutes of the United States as amended by an Act of 3rd March 1897. In the following passage the amendments are indicated by italics:—

"Any person who has invented or discovered any new and useful art, machine, manufacture or composition of matter, or any new and useful improvement thereof, not known or used by others in this country *before his invention or discovery thereof*, and not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof *or more than two years prior to his application*, and not in public use or on sale for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law and other due proceedings had, obtain a patent therefor."

The effect of the two amendments made by the Act of 1897 should first be noted: (i.) The old law failed to state at what time the invention should be known or used by others in America so as to bar a patent; whether before the application or before the invention. This ambiguity is removed by the use of the words "before his invention or discovery thereof." (ii.) Under the old law a foreign patentee could take out a patent in America for the same invention at any time during the life of the foreign patent, provided it had not been in use in America more than two years prior to his application, unless anticipated by a prior invention or publication. The words "or more than two years prior to his application," merely give the same force to a foreign patent or publication that had previously been given to prior use. An invention to be patentable must, according to American law, be both novel and useful. Utility may be evidence of novelty and *vice versâ*, and commercial success is relevant evidence of utility. As in England, a bare principle is not patentable. A "process" is included under the words "useful art" in the above definition of patentability, and is good subject-matter for a patent when the term is used to represent a practical method of producing a beneficial result or effect. The word "machine" in the definition includes every mechanical device or combination of devices for producing certain results. Such a device or combination is patentable when it possesses utility and novelty, and produces either a new result or an old result in a better form.

Under the law of 1790, which was exclusively American in spirit, the duty of granting letters patent for inventions was discharged by the Secretary of State, the Secretary of War, and the Attorney-General, or any two of them. The law from 1793 to 1836 was exclusively English in spirit, and during that period the duty fell to the Secretary of State, subject to the Attorney-General's approval. It was in 1837 that the marked divergence between the English and American patent system began. In that year the patent business of the United States had attained to such dimensions that the powers and duties of the Secretary of State in regard to patents were transferred to a sub-department of the State department known as the Patent Office. The American Patent Office consists of a Commissioner of Patents, one assistant commissioner, and three examiners-in-chief, who are appointed by the President of the United States with the advice and consent of the Senate; and also of other examiners, and a staff of officers, clerks, and employés, appointed by the Secretary of the Interior on the nomination of the Commissioner of Patents. The Commissioner of Patents, under the direction of the Secretary of the Interior, is charged with the superintendence or performance of all duties respecting the grant and issue of patents, and has the control and custody of all books, records, papers, &c., belonging to the Patent Office. He is authorized to make, from time to time, regulations not inconsistent with law, for the conduct of proceedings in the Patent Office, and prepares an annual report which is laid before Congress, and which is framed on the same lines as that of the Comptroller-General in England. "He is the final judge, so far as the Patent Office is concerned, of all controverted questions arising in the office, and in granting or withholding patents he is not bound by the decisions of his inferiors" (Robinson on *Patents*, vol. i. p. 84). The examiners-in-chief are required to be persons of competent legal knowledge and ability. Their duties are:—On the written petition of inventors to revise and determine upon the validity of the adverse decisions of subordinate examiners, upon applications for patents, and for reissues of patents, and in interference cases, and, when required by the Commissioner of Patents, to hear and report upon claims for extension, and to do such other similar work as he may assign to them. The Patent Office publishes an *Official Gazette* corresponding to the English *Patent Office Illustrated Journal*, and discharges similar functions to those of the English Patent Office in regard to the public dissemination of information as to patented inventions. The number of original applications for patents in the period covered by the report of the Commissioner of Patents for 1898–99 was 35,352; the number of patents granted was 23,550; the receipts amounted to $1,209,554, the expenditure to $1,148,663, leaving a surplus of $60,891.

The first step in the procedure to obtain a patent is the lodging by the inventor at the Patent Office of a written application, together with a specification or particular written description of his invention, and a claim distinctly pointing out and claiming what he alleges to be his invention or discovery. The specification and claim are signed by the inventor and attested by two witnesses. Drawings, specimens of ingredients, and models may be required to be furnished. On the filing of each original application for a patent, a fee of fifteen dollars is payable. The applicant is required to verify his claim to the invention on oath, taken, if he resides within the United States, before any person authorized by American law to administer oaths; if he resides in a foreign country, before any diplomatic or commercial agent of the United States, or any notary public of the foreign country in which the applicant may be. The Commissioner of Patents then causes an examination to be made into the novelty of the invention, and if the result is satisfactory the patent issues. On the issuing of each original patent, a fee of twenty dollars is payable. A patent is issued in the name of the United States of America and under the seal of the Patent Office. It consists of a short title or description of the invention or discovery, correctly indicating its nature and design, and a grant to the patentee, his heirs and assigns. Patents, it may be observed in passing, may be granted and issued or reissued to the assignee of the inventor or discoverer, and every patent or any interest in it is assignable, the assignment being recorded in the Patent Office, for the term of seventeen years of the exclusive right to make use of and vend the invention or discovery throughout the United States and the territories thereof. The rights of property in patents granted in Cuba, Porto Rico, the Philippines, and other ceded territory under Spanish law, are to be respected in those territories as if that law were still in force there. A patent is dated as of a day not later than six months from the time at which it was passed, and if the fee is not paid within that time the patent is withheld. No fewer than 4021 patents were withheld, in the period covered by the report of the Commissioner of Patents for 1898–99, for non-payment of fees. In case, however, the issue of a patent has been prevented by a failure to pay the fee within the prescribed period, the application may be renewed within two years after the allowance of the original application. But the applicant has no right to damages for any use of the invention in the interval, and on the hearing of the renewed application abandonment may be considered as a question of fact. So far we have followed the procedure to obtain a patent where its course is uninterrupted. A double form of interruption is, however, possible. A claim for a patent may be rejected on the ground of want of novelty in the alleged invention. In this case, the fact of the rejection, together with the reasons for it, is communicated to the applicant by the commissioner; and if he persists in his claim, a re-examination is ordered. Or, again, an application may appear to the commissioner to interfere with a pending application,[1] or with any expired patent. In these circumstances, he gives notice to the applicant, and directs the primary examiner to proceed to determine the question of priority of invention. This interruption of the course of the proceedings to obtain a patent is called an "interference." In either of the cases above mentioned an appeal lies, on payment of a fee of ten dollars, from the primary examiner to the board of examiners-in-chief, and, on payment of a fee of twenty dollars, from the examiners-in-chief to the commissioner in person. An applicant for a patent, but not a party to an interference, may appeal from the decision of the commissioner to the Supreme Court of the District of Columbia sitting in *banc*. In interference cases the appeal lies to the District of Columbia Court of Appeals. There is an ultimate right of appeal, in cases involving the validity of a patent, to the Supreme Court of the United States. Patents are obtainable by Bill in equity, although the Commissioner of Patents (or, on appeal, the Supreme Court of the District of Columbia) may have refused them. The circuit courts of the United States have original jurisdiction in all patent suits. Appellate jurisdiction is vested in the circuit court of appeals; and on the certificate of that court, or by *certiorari*, an appeal may be brought to the Supreme Court of the United States.

[1] A citizen of the United States, or an alien who has within the preceding twelve months given notice of his intention to become one, may, by filing in the Patent Office a "caveat," the fee for which is ten dollars, secure for himself notice of possibly conflicting applications.

Section 4887 of the Revised Statutes provides that:—

"No person *otherwise entitled thereto* shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid by reason of its having been first patented or caused to be patented *by the inventor or his legal representatives or assigns* in a foreign country, *unless the application for the said foreign patent was filed more than seven months prior to the filing of the application in this country, in which case no patent shall be granted in this country.*"

The words italicized in the above section were added by an Amending Act of 3rd March 1897. In its original form the section provided that no person should be debarred from receiving a patent because the invention was first patented in a foreign country, whether he was otherwise entitled to the patent or not. The words "otherwise entitled to" merely postulate that no other bar to the issue of the patent shall exist. The words "by the inventor or his legal representatives or assigns" safeguard the inventor to some extent against fraud by third parties; while the provision requiring the application in the United States to be filed within seven months of the filing of the foreign patent is intended to carry out the provisions of the International Convention. It should be noted that the duration of an American patent for an invention already patented abroad is no longer limited by that of the prior foreign patent, but is granted for 17 years from the date of issue.

Patented articles are required to be marked as such, either by the word "patented," together with the day and the year the patent was granted, being affixed to them, or, when from the character of the article this cannot be done, by fixing to it, on the package containing one or more of such articles, a label containing the like notice; and in any suit for infringement by a party failing so to mark, no damages shall be recovered by the plaintiff, except on proof that the defendant was duly notified of the infringement, and continued after such notice to make, use, or vend the article so patented. A penalty of not less than 100 dollars is attached to falsely marking or labelling articles as patented.

When through inadvertence, accident, or mistake, and without fraudulent or deceptive intention, a patentee has claimed more than he is entitled to, his patent is valid for all that part which is truly and justly his own; provided this is a material or substantial part of the thing patented, and the patentee or his heirs or assigns, on payment of the prescribed fee (ten dollars), disclaim the surplusage. The disclaimer must be in writing, and attested by one or more witnesses; it is recorded in the Patent Office, and is thereafter considered a part of the original specification. But no disclaimer affects any action pending at the time of its being filed, except so far as may relate to the question of unreasonable neglect or delay in filing it.

In the same circumstances, or where a patent is inoperative or invalid by reason of a defective or insufficient specification, the patentee may surrender his patent, and the Commissioner of Patents may, on the application of the patentee and on payment of a fee of 30 dollars, issue a new patent in accordance with the amended specification.

Uruguay (law of 12th November 1885).—The term is 3, 6, or 9 years, at the option of the applicant. There is an annual tax of 25 dollars for every year of the privilege. The invention must be worked within a time fixed by the executive, and the working must not be discontinued for a year, on pain of forfeiture. There is no preliminary examination as to novelty.

Venezuela (law of 19th March 1900).—The term is 5, 10, or 15 years. The tax is 250 francs (bolivars) a year if the patent is for an invention or discovery, and 200 francs (bolivars) a year if it relates to an improved process. There is no preliminary examination as to novelty. The invention must be worked within the period fixed by the grant, and a year's discontinuance, unless the inaction is justified, entails forfeiture.

(xii.) *International Patents.*—The International Convention for the protection of industrial property was signed at Paris on 20th March 1883; the necessary ratifications were exchanged on 6th June 1884, and the Convention came into force a month later. Provision was made by sections 103 and 104 of the Patents Act, 1883, for carrying out the Convention in Great Britain by Orders in Council, applying it from time to time to (*a*) British possessions whose legislatures had made satisfactory arrangements for the protection of inventions patented in Great Britain; (*b*) foreign states with which the Sovereign had made arrangements for the mutual protection of inventions.

(*a*) The following is a list of the Orders in Council issued under the first category and now in force applying the provisions of the Patents Act, 1883, § 103, to British possessions:—

State.	Date of Order in Council.
New Zealand	February 8, 1890.
Queensland	September 17, 1885.
Tasmania	April 30, 1894.
West Australia	May 11, 1895.

(*b*) The following is a list of the Orders in Council issued under the second category and now in force applying the provisions of the Act of 1883, § 103, to foreign states:—

Foreign State.	Date of Order in Council.
Belgium	June 26, 1884.
Brazil	June 26, 1884.
Denmark (including the Faroe Islands)	November 20, 1894.
Dominican Republic	October 21, 1890.
France	June 26, 1884.
Italy	June 26, 1884.
Japan	October 7, 1899.
Mexico	May 28, 1889.
Netherlands	June 26, 1884.
,, (East Indian Colonies)	November 17, 1888.
,, (Curaçoa and Surinam)	May 17, 1890.
Paraguay	September 24, 1886.
Portugal	June 26, 1884.
Servia	June 26, 1884.
Spain	June 26, 1884.
Sweden and Norway	July 9, 1885.
Switzerland	June 26, 1884.
Tunis	June 26, 1884.
United States	July 12, 1887.
Uruguay	September 24, 1886.

Under the powers of the Foreign Jurisdiction Act, 1890, penalties have been imposed on British subjects committing offences against the Patents, &c., Acts, 1883–88, and the Orders in Council issued thereunder, in Africa, East Africa, Morocco, Persia, Persian coast, and Zanzibar.

An International Bureau in connexion with the Convention has been established at Bern, where an official monthly periodical, *La Propriété Industrielle*, is published. Conferences were held under the Convention at Rome in April and May 1886, and at Madrid in April 1890. At the latter conference an important article was adopted, under which it is left to each country to define and apply "compulsory working" (*exploitation*) for the purposes of the Convention in the sense that it chooses. In the year 1898 there were 264 applications in Great Britain for patents under the Convention.

AUTHORITIES.—In addition to the works noted incidentally above, see EDMUNDS, *Patents*, 2nd ed. London, 1897; WALLACE and WILLIAMSON, *Patents*, London, 1900; FROST, *Patent Law and Practice*, 2nd ed. London, 1898; TERRELL, *Letters Patent*, 3rd ed. London, 1895; CUNYNGHAME, *Patents*, London, 1894; LAWSON, *The Patents, &c., Acts*, 3rd ed. London, 1898. For the old law, WEBSTER, *Patent Cases*, London, 1844; HINDMARSH, *Patents*, London, 1846; and the very valuable Parliamentary Reports of 1829, 1851, 1865, 1872. GORDON, *Monopolies by Patents*, London, 1897; GOULD and TUCKER, *Notes on Rev. Stat. of the U.S.*, vol. ii. (1887–97); ROBINSON, *Patents*, 3 vols. Boston, U.S.A., 1890; WHITMAN, *Patent Laws*, Washington, 1871; LAW, *Copyright and Patent Laws of the United States*, 1790–1866, New York, 1866; CURTIS, *Law of Patents*, 4th ed. Boston and London, 1873; CAMPBELL, *U.S. Patent System: a History*, Washington, 1891. (A. W. R.)

Pater, Walter Horatio (1839–1894), English man of letters, was born at Shadwell, 4th August 1839. He was the second son of Richard Glode Pater, a medical man, of Dutch extraction, born in New York. Richard Pater moved to Shadwell early in the century, and continued to practise there among the poorer classes. He died while his son Walter was yet an infant, and the family then moved to Enfield, where the children were brought up.

In 1853 Walter Pater was sent to King's School, Canterbury, where he was early impressed by the æsthetic beauties of the cathedral. These associations remained with him through life. As a schoolboy he read *Modern Painters*, and was attracted to the study of art, but he did not make any conspicuous mark in school studies, and showed no signs of the literary taste which he was afterwards to develop. His progress was always gradual. He gained a school exhibition, however, with which he proceeded in 1858 to Queen's College, Oxford. His undergraduate life was unusually uneventful; he was a shy, "reading man," making few friends. Jowett, however, was struck by his promise, and volunteered to give him private tuition. But Pater's class was a disappointment, and he only took a second in Literæ Humaniores in 1862. After taking his degree he settled in Oxford and read with private pupils. As a boy he had cherished the idea of entering the Anglican Church, but, under the influence of his Oxford reading, his faith in Christianity became shaken, and by the time he took his degree he had thoughts of graduating as a Unitarian minister. This project, too, he resigned; and when, in 1864, he was elected to a fellowship at Brasenose, he had settled down easily into a university career. But it was no part of his ambition to sink into academic torpor. With the assumption of his duties as fellow the sphere of his interests widened rapidly; he became acutely interested in literature, and even began to write articles and criticisms himself. The first of these to be printed was a brief essay upon Coleridge, which he contributed in 1866 to the *Westminster Review*. A few months later (January 1867) appeared in the same review his now well-known essay on Winckelmann, the first expression of his idealism. In the following year his study of "Æsthetic Poetry" appeared in the *Fortnightly Review*, to be succeeded by essays on Lionardo da Vinci, Sandro Botticelli, Pico della Mirandula, and Michelangelo. These, with other studies of the same kind, were in 1878 collected in his *Studies in the History of the Renaissance*. Pater was now the centre of a small but very interesting circle in Oxford. Such men as cherished æsthetic tastes were naturally drawn to him; and, though always retiring and, in a sense, remote in manner, he was continually spreading his influence, not only in the university, but among men of letters in London and elsewhere. The little body of Pre-Raphaelites were among his friends, and by the time that *Marius the Epicurean* appeared he had quite a following of disciples to hail it as a gospel. This fine and polished work, the chief of all his contributions to literature, was published early in 1885. In it Pater displays, with perfected fulness and loving elaboration, his ideal of the æsthetic life, his cult of beauty as opposed to bare asceticism, and his theory of the stimulating effect of the pursuit of beauty as an ideal of its own. In 1887 he published *Imaginary Portraits*, a series of essays in philosophic fiction; in 1889, *Appreciations, with an Essay on Style*; in 1893, *Plato and Platonism*; and in 1894, *The Child in the House*. His *Greek Studies* and his *Miscellaneous Studies* were collected posthumously in 1895; his posthumous romance of *Gaston de Latour* in 1896; and his *Essays from the "Guardian"* were privately printed in 1897. A collected edition of Pater's works was issued in 1901. Pater changed his residence from time to time, living sometimes at Kensington and in different parts of Oxford; but the centre of his work and influence was always his rooms at Brasenose. Here he laboured, with a wonderful particularity of care and choice, upon perfecting the expression of his theory of life and art. He wrote with difficulty, correcting and recorrecting with imperturbable assiduity. His mind, moreover, returned to the religious fervour of his youth, and those who knew him best believed that had he lived longer he would have resumed his boyish intention of taking holy orders. He was cut off, however, in the prime of his powers. Seized with rheumatic fever, he rallied, and sank again, dying on the staircase of his house, in his sister's arms, on the morning of Monday, 30th July 1894. Pater's nature was so contemplative, and in a way so centred upon reflection, that he never perhaps gave full utterance to his individuality. His peculiar literary style, too, burnished like the surface of hard metal, was too austerely magnificent to be always persuasive. Since his death, Pater has exercised a remarkable and a growing influence, although this must always be restricted to those who have themselves something of his own love for beauty and the beautiful phrase. But the cumulative richness and sonorous depth of his language harmonized intimately with his deep and earnest philosophy of life; and those who can sympathize with a nervous idealism will always find inspiration in his sincere and sustained desire to "burn with a hard, gem-like flame," and to live in harmony with the highest. (A. WA.)

Paterson, a city of New Jersey, U.S.A., capital of Passaic county, in the north-eastern part of the state, on the Passaic river at the falls, at an altitude of 193 feet. It is entered by the Morris canal, and the Delaware, Lackawanna, and Western, the Erie, and the New York, Susquehanna, and Western railways. It is built partly upon a plain, from which it stretches up the slopes of the surrounding hills. Its plan is irregular. It is divided into eight wards, and its water-supply is obtained by pumping from the river. It is well sewered, but few of its streets are paved, except with macadam. Passaic Falls, 72 feet in height, furnish ample water-power, and have induced the concentration of manufactures here. Paterson is the centre of silk manufacture. In 1900 the census enumerated 995 manufacturing establishments, with a total capital of \$43,510,481. They employed 30,190 hands, and the product was valued at \$52,287,975. Of this large total almost exactly one-half, or \$26,006,156, consisted of silk goods. In this industry there were 136 establishments, with a capital of \$19,025,564, employing 15,943 hands. Of the other manufactures, foundry and machine-shop products were valued at \$5,906,517, dyeing and finishing textiles at \$3,836,409, and malt liquors at \$1,859,537. The assessed valuation of real and personal property in 1899 was \$47,575,563; the net debt, \$3,435,820; and the tax rate, \$25 per \$1000. Population (1890), 78,347; (1900), 105,171, of whom 38,791 were foreign-born and 1182 negroes.

Patey, Janet Monach (1842–1894), English vocalist, was born in London, 1st May 1842, her maiden name being Whytock. She had a fine alto voice, which developed into a contralto, and she studied singing under J. Wass, Pinsuti, and Mrs Sims Reeves in succession. Miss Whytock's first appearance, as a child, was made at Birmingham, and her first regular engagement was in 1865, in the provinces. From 1866, in which year she sang at the Worcester Festival, and married John Patey, a bass singer, she was recognized as one of the leading contraltos; and on the retirement of Mme Sainton-Dolby in 1870 succeeded her as the prime favourite of the public, whether in oratorio or in ballad music. She toured in America in 1871, sang in Paris in 1875, and in Australia in 1890. She kept her leading position until within a very short time of her death, which took place at Sheffield, 28th February 1894, after she had put too severe a strain upon her powers in order to give an encore to an importunate audience. Her voice had great power, sweetness, and compass, and she had a true instinct for the amount of dramatic effect that was legitimate on the concert platform.

PATHOLOGY.

I. General.

THE outstanding feature in the history of pathology during the 19th century, and more particularly of the latter half of it, was the completion of its rescue from the thraldom of abstract philosophy, and its elevation to the dignity of one of the natural sciences. Our forefathers, if one may venture to criticize them, were too impatient. Influenced by the prevailing philosophy of the day, they interpreted the phenomena of disease through its lights, and endeavoured from time to time to reduce the study of pathology to philosophical order when the very elements of philosophical order were wanting. The pathology of the present day is more modest: it is content to labour and to wait. Whatever its faults may be —and it is for our successors to judge of these—there is this to be said in its favour, that it is in nowise dogmatic. The eloquence of facts appeals to the scientific mind nowadays much more than the assertion of crude and unproven principles. The complexity and mystery of action inherent in living matter have probably been accountable for much of the vague philosophy of disease in the past, and have furnished one reason at least why pathology has been so long in asserting its independence as a science. This, indeed, holds good of the study of biology in general. There are other factors, however, which have kept pathology in the background. Its existence as a science could never have been recognized so long as the subjects of physics, chemistry, and biology, in the widest acceptation of the term, remained unevolved. Pathology, in fact, is the child of this ancestry; it begins where they end.

Recent progress. Since the article in the ninth edition of the *Encyclopædia Britannica* was written, progress in the study of pathology has been greatly facilitated by the introduction of improved methods of technique. The certainty with which tissues can now be fixed in the state they were in when living, and the delicacy with which they can be stained differentially, have been the means of opening up a new world for exploration. Experimental pathology has benefited by the use of antiseptic surgery in operations upon animals, and by the adoption of exact methods of recording; while the employment of solid culture media in bacteriology—the product of Koch's fertile genius—is responsible for a great part of the extraordinary development which has taken place in this department of pathological research. The discoveries made in pathological bacteriology, indeed, must be held to be among the most brilliant of the age. Inaugurated by Pasteur's early work, progress in this subject was first marked by the discovery of the parasite of anthrax, and of those organisms productive of fowl-cholera and septic disease. Then followed Koch's great revelation in 1882 of the bacillus of tubercle (Fig. 5, Plate III.), succeeded by the isolation of the organisms of typhoid, cholera, diphtheria (Fig. 6, Plate III.), actinomycosis, tetanus, &c. The knowledge we now possess of the causes of immunity from contagious disease has resulted from this study of pathological bacteriology, and the prosecution of that branch of treatment known as "serum-therapeutics," at the hands of Roux, Behring, Ehrlich, and others, has also followed upon it, accompanied by momentous practical issues. Before the discovery of the bacillus of tubercle, scrofula and tuberculosis were regarded as two distinct diseases, and it was supposed that the scrofulous constitution could be distinguished from the tubercular. It was always felt, however, that there was a close bond of relationship between them. The fact that the tubercle bacillus is to be found in the lesions of both has set at rest any misgiving on the subject, and put beyond dispute the fact that so-called scrofulous affections are simply local manifestations of tuberculosis. A knowledge of the bacteriology of scrofulous affections of bone and joints, such as caries and gelatinous degeneration, has shown that they also are tubercular diseases—that is to say, diseases due to the presence locally of the tubercle bacillus. At a very early period it was held by Virchow that the large cheesy masses found in tuberculosis of the lung are to be regarded as pneumonic infiltrations of the air-vesicles. Their pneumonic nature has been amply substantiated in later times; they are now regarded simply as evidence of pneumonic reaction to the stimulus of the tubercle bacillus. The caseous necrosis of the implicated mass of lung tissue, and indeed of tubercles generally, is held to be, in great measure, the result of the necrotic influence of the secretions from the bacillus. Tubercular pneumonia may thus be looked upon as comparable to pneumonia excited by any other specific agent (Fig. 3, Plate II.).

In the 'seventies, feeling ran somewhat high over the rival doctrines concerning the origin of pus-corpuscles, Cohnheim and his school maintaining that they were derived exclusively from the blood, that they were leucocytes which had emigrated through the walls of the vessels and escaped into the surrounding tissue-spaces, while Stricker and his followers, although not denying their origin in part from the blood, traced them, in considerable proportion, to the fixed elements, such as fibrous tissues and endothelia. Our present-day knowledge prompts the adoption of a middle course between the two theories. The cells found in an inflamed part are undoubtedly drawn from both sources, but while the blood leucocytes have a great tendency to become fatty and to die, those cells derived from the fixed tissues incline more to organization; the latter are, in fact, the source of the cicatrix which follows upon the cessation of suppuration (Figs. 7, 8, and 9, Plate III.). Organization and healing have been keenly inquired into, with results which seem to point the lesson that all methods of healing are to be regarded as extensions of the natural phenomena of growth. Normal cytology, of late, has become a science of itself, and has had a direct bearing upon that which is pathological.

At no time has so much been done to advance our knowledge of diseases of the nervous system as during the last thirty years of the 19th century. The localization of function in the cerebral and in the cerebellar cortex has doubtless been the main cause of this progress, and has proceeded *pari passu* with an extended insight into the structure and connexions of the parts concerned. The pathology of aphasia, as worked out by a combination of the experimental, the pathological, and the anatomical lines of inquiry, is a favourable example of what has been accomplished. The origin, nature, and propagation of neoplasms of all kinds, especially of those which are malignant, are engaging much attention. The tendency has been to refer these back to the influence of parasites,—a view, however, which has not met with universal acceptance. Much light has been thrown upon the functions and diseases of the blood-forming glands. The origin of the corpuscles, previously a matter of so much difference of opinion, is now pretty fairly set at rest, and has proved the key to the interpretation of the pathology of many diseases of the blood, such as the different forms of anæmia, of leucocythæmia, &c. The deleterious influence of high blood-pressure has engaged the attention of physicians and pathologists in later years, and the conclusion arrived at is, that although it may arise from accidental causes, such as malcomposition of the blood, yet that in many instances it is a hereditary or family defect, and is bound up with the tendency to gout and cirrhotic degeneration of the kidney. The pathology of intra-cardiac and vascular murmurs has also been inquired into experimentally, the general impression being that these abnormal sounds result, in most cases at least, from the production of a sonorous liquid vein. Pneumonia of the croupous type has been proved to be, as a rule, a germ disease, the nature of the germ varying according to circumstances. The structural changes occurring in the bronchi in catarrhal bronchitis have also been ascertained, and, as in the case of pneumonia, have been shown to be frequently excited by the presence of a microphyte. The vexed question of the diagnosis of diphtheria is now a thing of the past. Quite irrespective of the nature of the anatomical lesion, the finding of the diphtheria bacillus on the part affected, and the inoculability of this upon a suitable fresh host, are the sole means by which the diagnosis can be made certain.

The part played by the thyroid body in the internal economy of the organism has also received much attention. The gland evidently excretes, or at any rate gets rid of, a certain waste product of a proteid nature, which otherwise tends to accumulate in the tissues and to excite certain nervous and tissue phenomena. It wastes in the disease known as "myxœdema," and the above product gathers in the tissues, in that disease, to such an extent as to give rise to what has been termed a "solid œdema." It is questionable if the substance in question is mucoid. The pituitary body probably subserves a like purpose. When the pancreas is excised in an animal, or when it is destroyed in man by disease, grape-sugar appears in the urine. The gland is supposed to secrete a ferment, which, being absorbed into the portal circulation, breaks up a certain portion at least of the grape-sugar contained in the portal blood, and so prevents this overflowing into the circulation in general. The transplantation of a piece of living pancreas into

M'Lagan & Cumming, Lith., Edin.

PLATE II.

FIG. 1.—Genito-urinary Tuberculosis, showing cavities in the kidneys and miliary tubercles on mucosa of bladder.

FIG. 2.—Tubercular Disease of the Hip-joint, showing ulceration of the acetabulum and head of the femur.

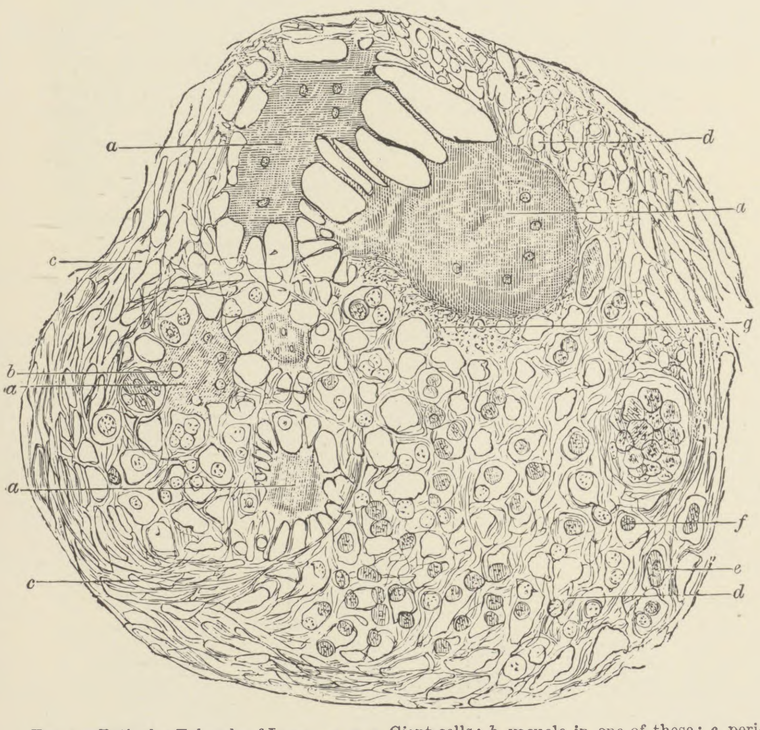


FIG. 4.—Reticular Tubercle of Lung. *a*, *a*, *a*, Giant-cells; *b*, vacuole in one of these; *c*, peripheral capsule-like condensation of reticulum; *d*, reticulum; *e*, endothelium-like cells; *f*, smaller lymphoid cells; *g*, peripheral fibrous-looking border of the giant-cell. (× 450 diams.)

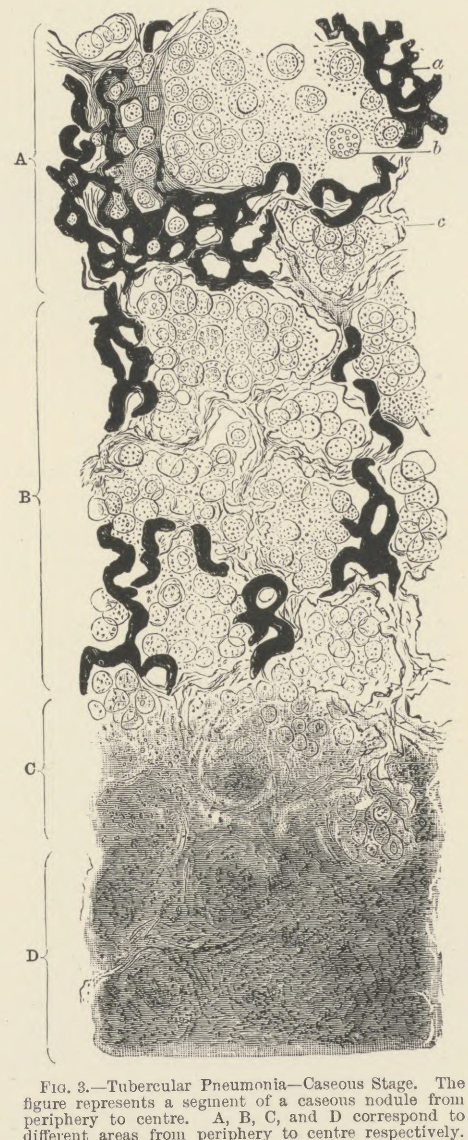


FIG. 3.—Tubercular Pneumonia—Caseous Stage. The figure represents a segment of a caseous nodule from periphery to centre. A, B, C, and D correspond to different areas from periphery to centre respectively. *a*, Injected capillaries of alveolar walls; *b*, catarrhal cells in alveolar cavities; *c*, an alveolar wall. (× 350 diams., injected.)

PLATE III.

FIG. 5.—Tubercular Meningitis. *a*, Arachnoid; *b*, small tubercle lying in trabeculæ between pia and arachnoid; *c*, effusion of fibrin and leucocytes into sub-arachnoid spaces; *d*, catarrhal-like cells derived from trabeculæ; *e*, tubercle bacillus lying in a tubercle of considerable size; *f*, small cell effusion; *g*, small blood-vessel obliterated by a thrombus; *h*, blood-vessel containing blood-corpuscles. (× 300 diams.)

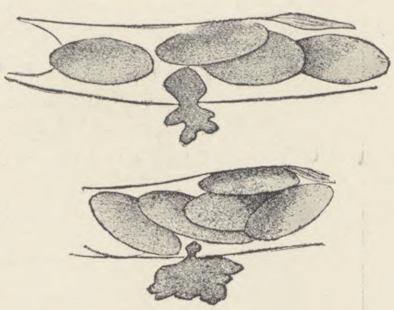


FIG. 7.—Diapedesis of a Leucocyte through the wall of a capillary, in which the blood is motionless. (Metchnikoff.)

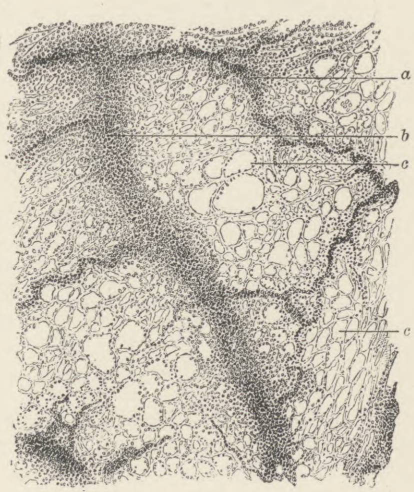


FIG. 8.—Omentum in state of acute inflammation. *a*, Small vein surrounded by escaped leucocytes; *b*, larger vein in same condition; *c*, *c*, fenestræ of membrane whose walls are covered by germinating (endothelial) cells. (× 50 diams., stained with silver.)

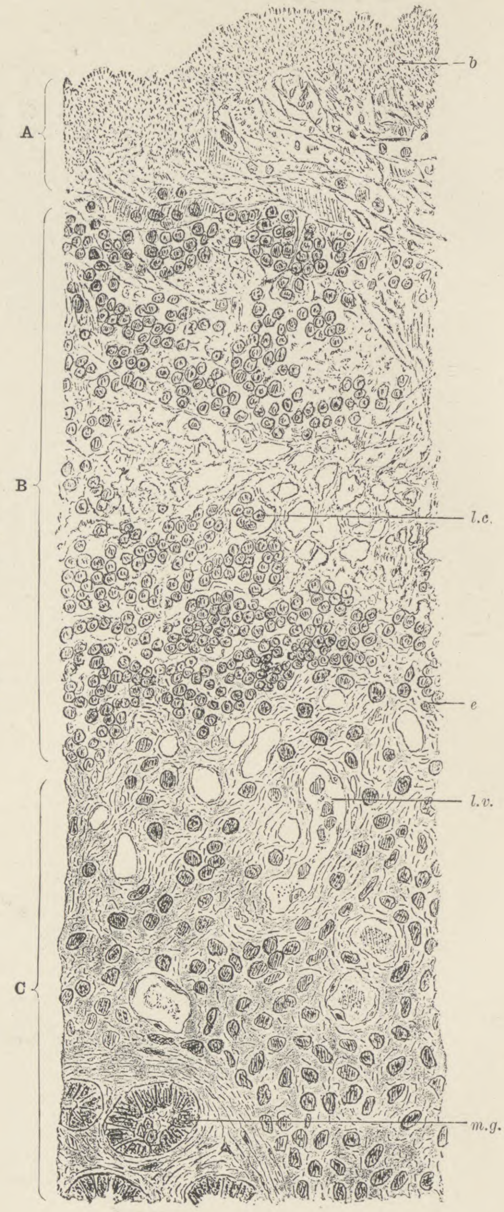


FIG. 6.—Free Surface of Diphtheritic Larynx. A, Deposit of diphtheria bacillus on surface of false membrane; B, false membrane; C, mucosa. *b*, diphtheria bacilli almost in pure culture; *l.c.*, lymph-cells in false membrane surrounded by network of fibrin; *e*, surface of mucosa deprived of its epithelium; *l.v.*, lymph-vessels containing shed endothelium; *m.g.*, mucous gland. (× 350 diams.)

FIG. 9.—Omentum in state of acute inflammation. *a*, Endothelium as yet unaltered; *b*, endothelium beginning to germinate; *c*, *c*, endothelium germinating actively. (× 300 diams., stained with silver.)

the tissues of an animal, thus rendered artificially diabetic, is said to restore it to health.

Pathological chemistry has been remarkable chiefly for the knowledge we have obtained of the nature of bacterial poisons. Certain of these are alkaloids, others appear to be albumoses. The publication of Ehrlich's chemical, or rather physical, theory of immunity has thrown much light upon this very intricate and obscure subject.

Germany and France have been in the van of progress during the period under contemplation. The success of the great pathologists of the United Kingdom has been the result of inborn merit and personal effort, rather than the outcome of a systematized method of training, whereas Continental nations have recognized the importance of fostering the subject by the endowment of centres of research and the equipment of laboratories. In Great Britain, on the other hand, pathologists have had, until quite lately, to fight the battle almost single-handed.

Pathology is the science of disease in all its manifestations, whether structural or functional, progressive or regressive. In times past it has been the habit to look upon its sphere as lying really within that of practical medicine, and human medicine more particularly; as something tagged on to the treatment of human disease, but unworthy of being studied for its own sake as a branch of knowledge. Such a view can recommend itself to only the narrowest of minds. A bearing, and of course an essential bearing, on the study of medicine it must always have. A system of medicine reared upon anything but a pathological basis would be unworthy of consideration. Yet it may well be asked whether this is the final goal to be aimed at. Our starting-point in this, as in all departments of biological study, must be the biological unit, and it is to the alterations to which this is subject, under varying conditions of nutrition and stimulation, that the science of pathology must apply itself. Man can never be the only object of appeal in this inquiry. The human organism is far too complex to enable us to understand the true significance of diseased processes. Our range must embrace a much wider area—must comprise, in fact, all living matter—if we are ever to arrive at a scientific conception of what disease really means. Hence not only must the study of our subject include the diseases peculiar to man and the higher animals, but those of the lowest forms of animal life, and of plant life, must be held equally worthy of attention. Modern research seems to show that living protoplasm, wherever it exists, is subject to certain laws and manifests itself by certain phenomena, and that there is no hard and fast line between what prevails in the two kingdoms. So it is with the diseased conditions to which it is a prey: there is a wonderful community of design, if the term may be used in such a sense, between the diseases of animals and plants, which becomes singularly striking and instructive the more they are inquired into. Utilitarian, or perhaps rather practical, considerations have very little to do with the subject from a scientific point of view—no more so than the science of chemistry has to do with the art of the manufacturing chemist. The practical bearings of a science, it will be granted, are simply, as it were, the summation of its facts, with the legitimate conclusions from them, the natural application of the data ascertained, and have not necessarily any direct relationship to its pursuit. It is when studied on these lines that pathology finds its proper place as a department of biology. Disease as an entity, as something to which all living matter is subject, is what the pathologist has to recognize and to investigate, and the practical application of the knowledge thus acquired follows as a natural consequence.

Connexion with biology.

Since pathology is the science of disease, we are met at the very threshold by the question: What is Disease? This may best be answered by defining what we understand by Health. What do we mean when we talk of a healthy organism? Our ideas upon the subject are purely arbitrary, and depend upon our everyday experience. Health is simply *that condition of structure and function which, on examination of a sufficient number of examples, we find to be commonest.* The term, in fact, has the same significance as "the normal." Disease we may define, accordingly, as *any departure from the normal standard of structure or function of a tissue or organ.* If, for instance, we find that instead of the natural number of Malpighian bodies in the kidney, there are only half that number, then we are entitled to say that this defect represents disease of structure; and if we find that the organ is excreting a new substance, such as albumen, we can affirm logically that its function is abnormal. Once grant the above definition of disease, and even the most trivial aberrations from the normal must be regarded as diseased conditions, quite irrespective of whether, when structural, they interfere with the function of the part or not. Thus an abortive supernumerary finger may not cause much, if any, inconvenience to the possessor, but nevertheless it must be regarded as a type of disease, which, trivial as it may appear, has a profound meaning in phylogeny and ontogeny.

Health and disease.

Classification.—From the foregoing it will be gathered that the problems in pathology are many-sided and require to be attacked from all points of vantage; and the subject falls naturally into certain great divisions, the chief of which are the following:—

I. Morbid Anatomy.
 (*a*) Naked-eye or macroscopic.
 (*b*) Morbid histology or microscopic.
II. Pathological Physiology.
III. Pathogenesis.
IV. Ætiology.
V. Pathological Chemistry.

The term "Pathogenesis" has reference to the generation and development of disease, and that of "Ætiology," in its present bearing, has to do with its causes. The use of the term "Pathological Physiology" may at first appear strange, for if we define physiology as the sum of the normal functions of the body or organism, it may be hard to see how there can be a physiology which is pathological. The difficulty, however, is more apparent than real, and in this sense, that if we start with a diseased organ as our subject of inquiry, we can quite properly, and without committing a solecism, treat of the functions of that organ in terms of its diseased state.

Influences working for Evil upon the Organism.

(1) *Malnutrition.*—When the blood supply is entirely cut off from a tissue, the tissue dies, and in the act of dying, or afterwards, it suffers certain alterations dependent upon its surroundings. Thus, when the circulation to an external part is obstructed completely, as in the case of a limb where the main artery has been occluded and where the anastomatic communications have not sufficed to continue the supply of blood, the part becomes gangrenous; that is to say, it dies and falls a prey to the organisms which excite putrefaction, just as would happen to any other dead animal tissue were it unconnected with the body. Fermentative changes are set up in it, characterized by the evolution of gas and the formation of products of suboxidation, some of which, being volatile, account for the characteristic odour. In the formation of these the tissues break down, and in course of time lose their characteristic histological features. The blood suffers first; its pigment is dissolved out and soaks into the surroundings, imparting to them the pink hue so diagnostic of commencing gangrene. Muscle and white fibrous tissue follow next in order, while elastic tissue and bone are the last to show signs of disintegration. The oil separates from the fat-cells and is

found lying free, while the sulphuretted hydrogen evolved as one of the products of putrefaction reacts upon the iron of the blood and throws down a precipitate of sulphide of iron, which in course of time imparts to the limb a range of colour commencing in green and terminating in black. The temperature at which the limb is kept, no doubt, favours and hastens the natural process of destruction, so that putrefaction shows itself sooner than would be the case with a dead tissue removed from the body and kept at a lower temperature. Nevertheless, gangrene is nothing more or less than *the putrefactive fermentation of an animal tissue still attached to the body.* If the amount of liquid contained in the tissue be small in quantity, the part mummifies, giving rise to what is known as "dry gangrene." If the dead part be protected from the ingress of putrefactive organisms, however, it separates from that which is living without the ordinary evidences of gangrene, and is then known as an "aseptic slough." Should the portion of tissue deprived of its circulation be contained in an internal organ, as is so often the case where the obstruction in the artery is due to embolism, it becomes converted into what is known as an "infarction." These infarcts are most common in organs provided with a terminal circulation, such as prevails in the kidney and spleen (Fig. 10, Plate IV.). The terminal branches of the arteries supplying these organs do not anastomose; therefore, when one of them is obstructed, the area irrigated by it dies from malnutrition. Being protected from the ravages of the organisms which induce putrefaction, however, it does not become gangrenous; it is only where the obstructing agent contains these organisms that a gangrenous slough follows, or, in the case of the contaminating organisms being of a suppurative variety, ends in the formation of a so-called "pyæmic abscess," followed by rapid dissolution of the dead tissue (Fig. 11, Plate IV.). In ordinary circumstances, where the artery is obstructed by an agent free from such organismal contamination, the part becomes hard and well defined from the precipitation of the fibrinogen contained in its liquids (coagulative necrosis), and at a later period assumes a yellow colour. Its condition, in fact, comes to resemble very closely, if it is not identical with, the caseation of a tubercular nodule. Examined microscopically, it is found to be very granular, and minute oil-globules show themselves within it, the result of a fatty degeneration of its tissue elements. Later, it is absorbed, and, as in the case of all such dead tissues left in the midst of living surroundings, apparently by a double agency—in the first place, by the histolytic influence of the tissue liquids, and, in the second place, by the phagocytal cells at its margin.

Where the malnutrition is the effect of poorness in the quality of the blood, the results are of course more widespread. The muscles suffer at an early period: they fall off in bulk, and later suffer from fatty degeneration, the heart being probably the first muscle to give way. Indeed, all tissues when undernourished, either locally as the result of an ischæmia, or generally as from some impairment of the blood, such as that prevailing in pernicious anæmia, tend to suffer from fatty degeneration; and at first sight it seems somewhat remarkable that undernourished tissues should develop fat in their substance (Figs. 12 and 13, Plate IV.). The fatty matter, however, it must be borne in mind, is the expression of dissimilation of the actual substance of the proteids of the tissues, not of the splitting up of proteid or other carbonaceous nourishment supplied to them.

A part deprived of its natural nerve-supply sooner or later suffers from the effects of malnutrition. When the trigeminus is divided (Majendie), or when its root is compressed injuriously, say by a tubercular tumour, the cornea begins to show points of ulceration, which, increasing in area, may bring about total disintegration of the eyeball. The earliest interpretation put upon this experiment was that the trophic influence of the nerve having been withdrawn, the tissue failed to nourish itself, and that degeneration ensued as a consequence. The subsequent experiments of Snellen, Senftleben, and, more lately, of Turner, seem to show that if the eyeball be protected from the impingement of foreign particles, an accident to which it is liable owing to its state of anæsthesia, the ulceration may be warded off indefinitely. The bed-sores which follow paralysis of the limbs are often quoted as proof of the direct trophic action of the nerve-supply upon the tissues, yet even here the evidence is somewhat contradictory. Still, there are facts which, for want of a better explanation, we are almost bound to conclude are to be accounted for on the direct nerve-control theory. Thus a fractured bone in a paralysed limb often fails to unite, while another in the opposite sound limb unites readily, and an ulcerated surface on a paralysed limb shows little healing reaction. A salivary gland degenerates when its nerve-supply is cut off; and the nerves leading up to the symmetrical sloughs in Raynaud's disease have been found in an advanced state of degeneration (Affleck and Wiglesworth). It is just a question, however, whether, even in instances such as these, the nutritional failure may not be explained upon the assumption of withdrawal of the local vasomotor control. There seems to be little doubt, notwithstanding, that one of the chief functions of the nerve cell is that of the propagation of a trophic influence along its axon. When a nerve-trunk is separated from its central connexion, the distal portion falls into a state of fatty degeneration (Wallerian or secondary degeneration). That special trophic nerves, however, exist throughout the body, seems to be a myth. It is much more likely, as Verworn alleges, that the nerves which influence the characteristic function of any tissue regulate thereby the metabolism of the cells in question—in other words, that every nerve serves as a trophic nerve for the tissue it supplies. It is a significant fact that neoplasms contain very few nerve-fibres, even although growing luxuriantly, and there is a doubt whether the few twigs contained in them may not merely have been dragged into their midst as the tumour mass expanded (Young).

(2) *Senile Decay.*—It may naturally be supposed that as old age is approached the tissues fail to regenerate themselves, so as to make up for the ordinary wear and tear to which they are subject, with the same readiness as in youth. They lose also a certain amount of their power of assimilation. From both these causes a certain shrinkage is liable to occur, more evident in some parts of the body than in others. Thus the brain falls off in bulk, and the muscles become attenuated, and in no muscle is this more notable than in the case of the heart. A tendency to pigmentation also develops in certain tissues of the body, such as the nerve and muscle cells. As a result of these various senile degenerations, the functions of the body deteriorate, the faculties become blunted, and the muscular energy of the body is below what it was in earlier life, while the secreting glands in certain instances become functionally obsolescent.

(3) *Overwork.*—The effect of overwork upon an organ or tissue varies in accordance with (*a*) the particular organ or tissue concerned, (*b*) the amount of nourishment conveyed to it, and (*c*) the power of assimilation possessed by its cells. In the case of muscle, if the available nourishment be sufficient, and if the power of assimilation of the muscle cells remain unimpaired, its bulk increases, that is to say, it becomes hypertrophied. The hypertrophy in this case is due chiefly to the numerical increase of the muscle fibres, partly to slight augmentation in their bulk. Where hypertrophy of muscle takes place from increased blood-supply, as sometimes happens, the enlargement is partly due to numerical increase, but chiefly to increase in bulk of the individual fibres (Zielonko).

It may be advisable to define exactly what is meant by "hypertrophy," as the term is often used in a loose and insignificant sense. Mere enlargement of an organ does not imply that it is in a state of hypertrophy, for some of the largest organs met with in morbid anatomy are in a condition of extreme atrophy. Some organs are subject to enlargement from deposition within them of a foreign substance (amyloid, fat, &c.). This, it need hardly be said, has nothing to do with hypertrophy; enlargement is simply one of the

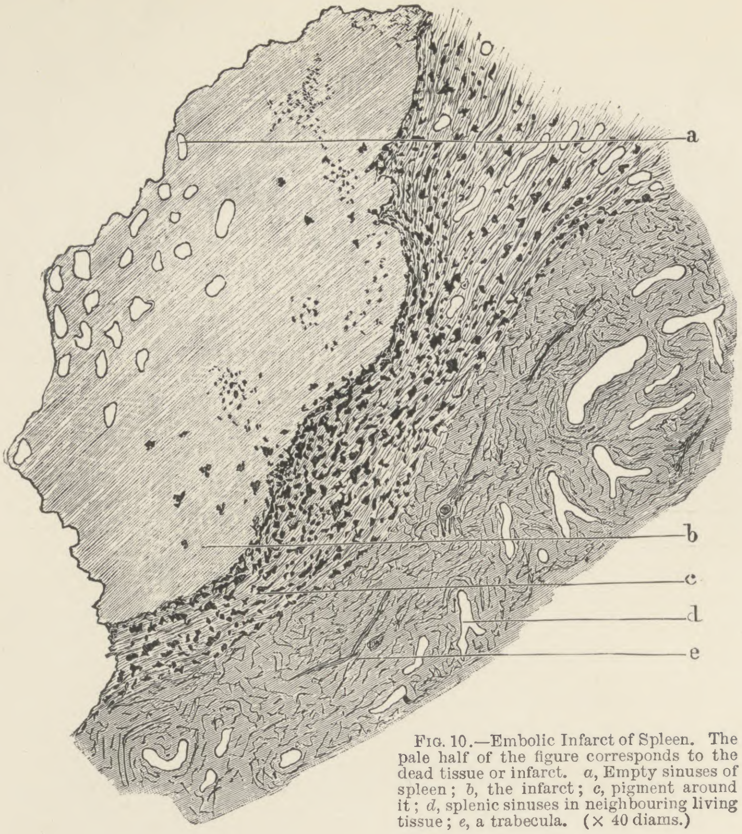


FIG. 10.—Embolic Infarct of Spleen. The pale half of the figure corresponds to the dead tissue or infarct. *a*, Empty sinuses of spleen; *b*, the infarct; *c*, pigment around it; *d*, splenic sinuses in neighbouring living tissue; *e*, a trabecula. (× 40 diams.)

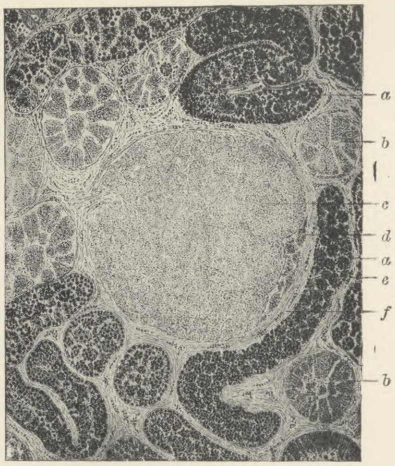


FIG. 12.—Catarrhal Nephritis, showing fatty degeneration of epithelium of the tubes of the kidney. *a*, *a*, Convoluted tubes filled with fatty epithelium; *b*, *b*, convoluted tubes with epithelium still in stage of cloudy swelling; *c*, glomerulus very swollen, granular, and probably œdematous; *d*, a few catarrhal cells in the intracapsular space; *e*, spindle-shaped lymph-spaces in interstitial tissue filled with oil globules; *f*, same in Bowman's capsule. (× 350 diams., stained with perosmic acid.)

FIG. 11.—Pyæmic Abscess of Lung. *a*, Walls of alveoli; *b*, effused small cells; *c*, fibrin lying in alveolar cavities; *d*, cell entangled in meshes of same; *e*, *e*, *e*, masses of micrococcus (staphylococcus) lying in the exudation; *f*, effused cell becoming fatty. (× 350 diams.)

FIG. 13.—Fatty Degeneration of Nerve-fibres of Phrenic Nerve in Diphtheria (Meyer).

PLATE V.

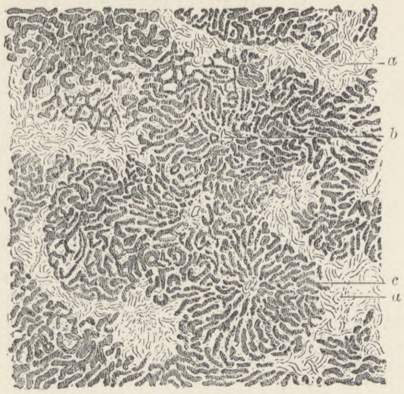
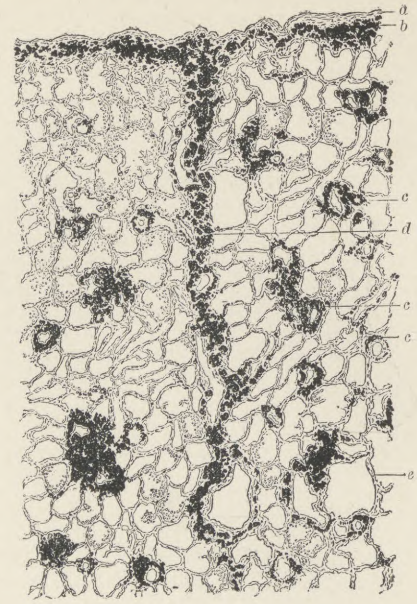


FIG. 14.—Atrophy of Liver from Valvular Disease of Heart. *a*, *a*, Distended capillaries of hepatic vein with entire disappearance of liver-cells from atrophy; *b*, branch of portal vein; *c*, liver-cells still left in portal vein area. (× 60 diams.)

FIG. 15.—Anthracosis. *a*, Superficial layer of pleura free from pigment; *b*, deep layer much infiltrated by it; *c*, *c*, *c*, accumulations of pigment round branches of pulmonary artery; *d*, interlobular septum, much pigmented; *e*, alveolar walls. (× 20 diams.)



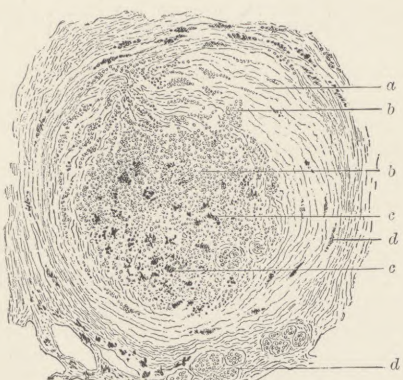


FIG. 16.—Lithosis or Stone-mason's Disease. Section through a nodule in the lung. *a*, Concentric fibrous tissue of the nodule; *b*, *b*, stone particles; *c*, *c*, soot particles mixed with those from stone; *d*, *d*, soot particles at periphery of nodule. (× 300 diams.)

FIG. 17.—Healing by First Intention. Cicatrix ten days old, Linea alba, ovariotomy. *a*, Neighbouring epidermis; *b*, corium continuous with cicatrix (*e*); *c*, *c*, neighbouring tissues; *d*, united epidermis; *f*, portion of same included in cicatrix; *g*, fat-cells in side of wound. (× 50 diams.)

FIG. 18.—Healing by Second Intention. Perpendicular section through edge of healthy granulating wound, old ulcer of leg. *a*, The discharge; *b*, the bluish-pink pellicle of young epidermis; *c*, older epidermis; *d*, granulation-tissue; *e*, injected blood-vessels; *f*, deep organizing layer beneath cicatrix; f_1, same beneath granulations. (× 50 diams.)

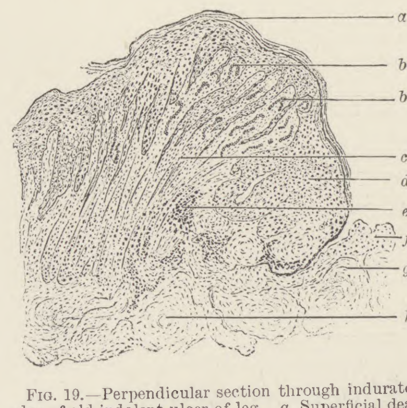


FIG. 19.—Perpendicular section through indurated edge of old indolent ulcer of leg. *a*, Superficial dead epidermis; *b*, *b*, granulation-loops; *c*, half-organized granulation-tissue beneath the edge; *d*, accumulated mass of epidermis; *e*, pigment from blood-extravasation; *f*, abortive granulation-surface; *g*, divided fibrous tissues of the leg forming practically the floor of the ulcer; *h*, small artery. (× 40 diams.)

attributes of a hypertrophied part. Hypertrophy in the scientific sense of the term may be defined as *a condition of parts where the normal bulk of an organ or other tissue is augmented universally by an additional number or by increased dimensions of its tissue elements.*

In order that the overgrowth of an organ may come under the designation of "hypertrophy," the enlargement must be universal; a local increase of its tissue is known as a *neoplasm* (myoma, adenoma). When epidermis is overworked by having to withstand intermittent pressure, as in the use of tools in various avocations, it certainly hypertrophies. The pressure, as probably is the case in all overwork causing hypertrophy, must be intermittent; continuous pressure on any part induces atrophy. Glands, however, do not seem to suffer hypertrophy when overworked. On the contrary, they tend rather to degenerate. There is no evidence to show that the liver, the pancreas, or a salivary gland ever becomes hypertrophied from having increased strain put upon it; the first response of the liver to such strain is derangement of structure and function. The compensatory enlargement of the kidney, when that on the opposite side is removed experimentally or by disease, is often quoted as evidence of a gland becoming hypertrophied from overwork. The enlargement here, however, is something quite different from what occurs in muscle or epidermis: it is apparently unaccompanied by increase in true gland tissue, and is accounted for by distension of blood-vessels and lymphatics.

(4) *Continuous Over-pressure.*—The tissues of an animal or plant are all under a certain pressure, caused, in the one case, by the expulsive action of the heart and the restraint of the skin and other elastic tissues, and, in the other case, by the force of the rising sap and the restraint of the periderm or bark. Under this normal amount of pressure they can live and grow. But whenever, from any cause, the degree of pressure which they are naturally intended to withstand is surpassed, they fail to nourish themselves, become granular, die, and, falling to pieces, are absorbed. This is what we see in a typically atrophic part such as a cirrhotic kidney, a muscle withered by the pressure of a contracting cicatrix, or a tissue like that of the liver (Fig. 14, Plate V.) subjected to unduly great pressure from distension of its own capillaries (cyanotic atrophy).

Here again it is necessary to define in strict terms what is meant by "atrophy," for as mere enlargement of an organ does not necessarily signify that it is hypertrophied, so diminution in size does not necessarily imply that it is in a state of atrophy; atrophied organs, as previously remarked, are sometimes much enlarged. *Atrophy is the diminution in size or partial destruction of a part which results from direct and continuous over-pressure where the blood-supply is not deficient.* The pressure must be continuous, otherwise the part may become hypertrophied. Intermittent pressure exerted upon the epidermis causes it to hypertrophy, while continuous pressure, such as that of a badly-applied splint, will induce atrophy. The soft texture of an aneurysmal sac will cause atrophy of a hard texture, such as bone, so long as the pressure it exerts is continuous; and the over-pressure of the hepatic capillaries in regurgitant valvular disease of the heart will induce the most typical atrophy of the liver cells lying between them. Atrophic organs usually contain abundant blood-vessels; the arteries of a cirrhotic liver are relatively more abundant than in health, and in the case of the atrophy of the liver resulting from regurgitant valvular disease the compressing agent is the blood itself. Hence the degeneration from which the tissue suffers cannot be due to deficient blood-supply, but, apparently, is consequent upon failure in the tissue cells to assimilate the nourishment supplied to them on account of the over-pressure to which they are subjected. This is borne out by the actual degeneration from which the tissue suffers. We have seen that when a tissue is undernourished it begins to suffer from fatty degeneration. This is not the form of degeneration found in truly atrophic parts: the cell simply shrinks, falls to pieces, and is removed, without necessarily any fatty matter resulting from the breaking down of its protoplasm. Atrophy is a true and distinct form of degeneration, as distinct as any of the other forms of degeneration to which tissues are liable.

(5) *Deleterious Surroundings.*—There can be little doubt that all unnatural and artificial modes of life tend to deterioration of the powers of resistance of the organism to disease. We see it exemplified in plant life in circumstances which are unnatural to the life of the plant, and the prevalence of certain constitutional tendencies among the inhabitants of crowded cities bears evidence to the same law. Man, like other animals, was naturally intended to lead an outdoor life. He was originally a hunter and a tiller of the ground, breathing a pure atmosphere, living on a frugal diet, and exercising his muscles. Whenever these conditions are infringed, his powers of resistance to disease are lessened, and certain tendencies begin to show themselves, which are generally termed constitutional. Thus the liability to tubercular infection is far commoner in the midst of a depraved population than in one fulfilling the primary laws of Nature; rickets is a disease of great cities rather than of rural districts; and syphilis is more disastrous and protracted in its course in the depraved in health than in the robust. Cattle kept within-doors are in a large proportion of cases tubercular, while those leading an outdoor life are much less liable to infection. The improvement which has taken place in the general health of the inhabitants of cities during recent years, concurrent with hygienic legislation, is ample proof of the above assertions. The diminution in the number of deaths from tuberculosis during the last forty to fifty years of the 19th century of itself points in this direction. Every living organism, animal and vegetable, tends to maintain a normal state of health; it is when the natural laws of health are violated that the liability to disease begins to assert itself. If, in these circumstances, the food supply be also insufficient, the combination of influences is sure, in course of time, to bring about a physical deterioration of the race. Certain avocations have a direct and immediate influence in causing diseased states of body. Thus workers in lead suffer from the effects of this substance as a poison, those who work in phosphorus are liable to necrosis of bone and fatty degeneration of the blood-vessels and organs, and the many occupations in which dust is inhaled (coal-mining, stone-dressing, steel-polishing, &c.; Figs. 15 and 16, Plate V.) are fraught with the greatest danger, owing to the destructive influence exerted upon the lungs by the inhaled particles. Among the most dangerous of the last class (the pneumokonioses) is perhaps that in which the dust particles take the form of finely-divided freestone, as in stone-dressing and the dry-polishing on the grindstone of steel. The particles in this case set up a form of fibrosis of the lung, which, either of itself or by rendering the organ liable to tubercular infection, is extremely fatal. The abuse of alcohol may also be mentioned here as a factor in the production of disease.

(6) *Parasitism.*—Of all external agents acting for evil, however, probably vegetable and animal micro-organisms with a pathological bent are most to be feared. The subject is considered *in extenso* under PARASITIC DISEASES, and the reader is referred to that section of this subject for specific information. When we consider that tuberculosis, diphtheria, cholera, tetanus, typhoid fever, anthrax, malaria, and a host of other contagious diseases have each been proved to be of parasitical origin, an idea may be conveyed of the range of the subject. The living organism may be regarded as constantly engaged in a warfare with these silent and apparently insignificant messengers of destruction and death, with the result that too often the battle ends in favour of the attacking enemy.

(7) *Heredity.*—The *tendencies* to disease are in great part hereditary. They probably express a variation which may have occurred in a far-back ancestor, or in one more recent, and render the individual vulnerable to the attacks of parasitic fungi, or, it may be, become manifest as errors of metabolism. The psychopathic, the tubercular, the rickety, and the gouty constitution may all be transmitted through a line of ascendants, and only require the necessary exciting agents to render them apparent. A distinction must be drawn between the above and diseases, like syphilis and small-pox, in which the contagion of, not the tendency to, the disease is transmitted directly to the fœtus *in utero* (see HEREDITY).

THE CELLULAR DOCTRINE IN PATHOLOGY.

The cellular pathology is the pathology of to-day; indeed, protoplasm—its vital characteristics under abnormal influences and its decay—will be regarded most likely as the basis of pathology in all time. Its history dates back to Virchow's great discovery. When Virchow wrote, in 1850, "every animal presents itself as a sum of vital unities, every one of which manifests all the characteristics of life," he expressed a doctrine whose sway since then has practically been uninterrupted. The somatic cells represent communities or republics, as it were, which we name organs and tissues, but each cell possesses a certain autonomy and independence of action, and exhibits phenomena which are indicative of vitality.

Still, it must be borne in mind that this alleged autonomy of action is said to be founded upon an erroneous supposition, on the supposition that each cell is structurally, and, it may be said, functionally, separated from those in its neighbourhood. It is well known that in the vegetable kingdom the protoplasm of one cell frequently overflows into that of cells adjacent—that there is, as it were, a continuous network of protoplasm (idioplasm of Nägeli) prevailing throughout vegetable tissues, rather than an aggregation of isolated units. The same intercommunication prevails between adjacent cells in some animal tissues, and more particularly in those which are pathological, as in the case of the epithelial cells of cancer. Assuming, with Sedgwick and others, this amassed and bound condition of the tissues to be true, it would be necessary to reject the cell-doctrine in pathology altogether, and to regard the living basis of the organism as a continuous substance whose parts are incapable of living independently of the whole. Until, however, further evidence is forthcoming in support of this syncytial theory of structure, it would be unwise to regard it as established sufficiently to constitute a serviceable working hypothesis; hence, for the time being, we must accept the assertion that the cell represents the ultimate tissue-unit.

The only definition of a cell permissible at the present day is that of *a nucleated mass of protoplasm*. The cells met with in morbid parts which are in a state of active vitality are built up of the same components as those found in normal tissues (Plate I.[1]). Thus they are provided with a nucleus in the midst of which are chromosomes, true nucleoli (plasmosomes), and netknots (karyosomes). Inside the nucleolus there may be a second body known as the nucleoluolus (Auerbach). Within the cytoplasm are the granular bodies known as microsomes, and, either lying within the nucleus or at one side of it, is the centrosome, which, during mitotic division, splits into two, each half becoming surrounded by an attraction-sphere (astrosphere) defining the polar limits of the achromatic amphiaster.

Structure of pathological cells.

Some pathological cells, such as the giant-cells of tumours, of bone, and those of tubercle, are polynucleated; in some instances they may contain as many as thirty or more nuclei. The only evidence we have in pathology of living structures in which apparently a differentiation into cell-body and nucleus does not exist, is in the case of bacteria, but then there comes the question whether they may not possess chromatin distributed through their substance, in the form of metachromatic points, as is the case in some infusoria (Trachelocerca, Gruber).

The nucleoli of pathological growths (*e.g.*, sarcomata) sometimes vary in shape. They are mostly round, but elliptical, elongated, and nail-shaped forms may be met with. They usually stain with acid aniline dyes, but occasionally lose this property and become sensitive to those which are basic, a transformation which probably indicates a retrograde or degenerate state (Trambusti). They may be located either at the centre or at the periphery of the nucleus. As a rule they vanish during indirect division. Under the title of "Slumber cells," Grawitz drew attention to certain cells which he supposes to exist in connective tissues, and which are invisible even with refined methods of histological demonstration. They come into view only when the connective tissue is stimulated, and he affirms that the cell-material found in the regeneration of tendons, &c., is derived partly from this source. Ehrlich described certain cells of the leucocyte type which are found in normal, and particularly in pathological, circumstances in the blood and connective tissues, and which he names "Mastzellen." The granules within them are large and are basophil in reaction. They are present in considerable numbers in the blood of leucocythæmia. They have also been found by Westphal in chronic inflammatory conditions of connective tissue, and in cancers, and he supposes that they are simply connective-tissue cells altered by abnormal conditions of nutrition. Under the title of "Plasma-cells" Unna drew attention to certain peculiar bodies found in lupus, in various skin affections, and in granulations. They are cells of round, oval, polygonal, or elongated shape, whose protoplasm is usually free from granules, and stains intensely with methylene-blue. The nucleus is placed excentrically, contains several large chromatin granules, and is surrounded by a clear area. Krompecher traces the most of them to lymphocytes, some to polymorphous-nucleated leucocytes, but states that they may become transformed into connective-tissue cells.

Although the methods of cell-division prevailing in normal structures are maintained generally in those which are pathological, yet certain modifications of these methods are more noticeable in the latter than in the former. Thus in the neoplasmata direct cell-division is more the rule than in healthy parts. In actively-growing neoplasmata, certainly, the indirect method prevails largely, but seems to go on side by side with the direct.

A curious and interesting modification of the indirect method, known as "asymmetrical division," occurs frequently in epitheliomata, sarcomata, &c. (Hansemann). It consists in an unequal number of chromosomes passing over to each of the daughter nuclei, so that one may become hypochromatic, the other hyperchromatic. When this happens, the resulting cleavage of the cytoplasm and nucleus is also unequal. Several explanations have been given of the meaning of these irregularly chromatic cells, but that which most lends itself to the facts of the case seems to be that they represent a condition of abnormal karyorhexis.

In many pathological cells undergoing indirect segmentation, centrosomes appear to be absent, or at any rate do not manifest themselves at the poles of the achromatic spindle. When they are present, that at one end of the spindle may be unusually large, the other of natural size, and they may vary in shape. In pathological cell-division it happens occasionally that the segmentation of the cytoplasm is delayed beyond that of the mitotic network. The daughter nuclei may have arrived at the anaphase stage, and have even gone the length of forming a nuclear membrane, without any equatorial depression having shown itself in the cell-body. Sometimes the equatorial depression fails entirely, and the separation, as in some vegetable cells, takes place through the construction of a cell-plate. Intranuclear plexuses are not usually found in giant-cells, but have been described in the giant-cells of sarcomata by Klebs and Hansemann, and in those of tubercle by Baumgarten. Some of the nuclei within multinucleated cells may occasionally be engaged in mitotic division, the others being in the resting state.

In the earlier accepted notion of direct segmentation, usually known as the schema of Remak, division was described as commencing in the nucleolus, as thereafter spreading to the nucleus, and as ultimately implicating the cell-substance. Trambusti,

[1] DESCRIPTION OF PLATE I.

SERIES OF FIGURES ILLUSTRATIVE OF IRREGULAR DIVISION OF CELLS.

Figs. A to F are from the epithelial cells of a cancer of the mamma. (After Galeotti.)

,, *G to W are from a sarcoma. (After Trambusti.)*

FIG. A.—Resting epithelial cell.
,, B.—Asymmetrical dyaster.
,, C.—Tripolar division in which the splitting of the loops has commenced.
,, D.—Tetrapolar karyokinesis.
,, E.—Another form of tetrapolar division.
,, F.—Cell in a state of degeneration and chromatolysis; the large rounded body in the cell is a cancer parasite.
,, G.—Polynucleated cell with nuclei of normal size arising from multiple karyokinetic division.
,, H.—Pigmented cell with resting nucleus. The attraction-sphere and centrosome lie in the cytoplasma in the neighbourhood of the nucleus.
,, I.—Hypertrophic nucleolus.
,, K.—Large cell with a single nucleus; nucleoli in a state of degeneration.
,, L.—Multinucleated giant-cell, the nuclei small and produced amitotically.
,, M.—Karyokinetic figure, the one centrosome much larger than the other.
,, N.—Cell in process of karyokinetic division with retention of the nucleolus during division.
,, O.—Division of the nucleolus and formation of nuclear plate. The nucleolus is elongated, and its longest measurement lies in the direction of the equatorial plane of the nucleus.
,, P.—Division of the nucleolus by elongation, constriction, and equilateral division of the nucleus.
,, Q.—Division of the nucleolus without any evidence of division of the nucleus.
,, R.—Nucleus with many nucleoli.
,, S.—Direct division of nucleus.
,, T.—Multiple direct division of the nucleus.
,, V.—Nail-like nucleolus.
,, W.—Fragmentation of the nucleus.

curiously, finds confirmatory evidence of this in the division of cells in sarcoma. Contrary, however, to the experience of others, he has never found that the attraction-spheres play an important part in direct cell-division, or, indeed, that they exert any influence whatever upon the mechanism of the process. Where pigment was present within the cells (sarcoma), the attraction-spheres were represented by quite clear unpigmented areas, sometimes with a centrosome in their midst.

Repair of Injuries.

Healing by First Intention.—After a linear incision has been made with a sharp knife into the young stem of a plant, and the severed edges of the wound brought together by the application of pressure, the few cells which are actually cut through by the instrument in making the incision die and are removed, a number of cells just sufficient to fill the gap is generated from cells of a like nature on each surface of the wound, and the wound heals by their coalescence among themselves and with those on the immediate surface of the severed tissues (Shattock). After a like incision has been made into an animal tissue, if the wound be kept free from organismal contamination and the surfaces placed in accurate contact by pressure, without blood-clot or excess of lymph intervening, exactly the same method of healing is pursued in closing the breach of continuity. Those cells which have been injured by the knife die and are absorbed, and a few new cells, springing from the adjacent white fibrous tissues, organize and become interwoven with the parts on each side. New epidermic cells thrown off from the old soon cover the young cicatrix, and in course of time develop a horny layer (Fig. 17, Plate V.). In each of these instances of healing, the one from the animal, the other from the vegetable kingdom, it is only the tissues lying in the immediate proximity of the wound which are stimulated to growth; those at even a short distance from the wound remain uninfluenced, and consequently in each case the cicatrix is extremely fine—so fine, indeed, as to be scarcely visible even with the aid of the microscope. The above is the simplest means of healing, and is the type upon which all repair of wounded parts is effected; it is, as will be observed, simply a method of growth, in which, as in all natural growth, each new tissue element of the cicatrix is reproduced from its like in the pre-existing parts. Any other appearances met with in the healing of an injury are epiphenomena, and bear witness to an interruption in the natural course of events. In the case of the vegetable organism, it is mainly the deep cambium layer from which the reparative parenchyma is derived for the closure of the vacuity, while the cork cambium on the surface renews the protective covering; in that of the animal organism, it is chiefly the white fibrous tissue which furnishes the bond of union, while the epidermis generated from pre-existing epidermis grows over this as its natural investment.

White fibrous tissue and epidermis have more power of regenerating than any other tissues in the adult body. Separately, or conjointly, they represent the materials out of which all cicatrices and all fibrous new formations are constructed. In like manner, the cambium layer in plants is the tissue of reaction. The wood of the tree has little power of regeneration, being composed mostly of cells which are dead or whose segmental capacity is exhausted. The few living cells it contains may be stimulated to activity, say, in grafting, where the cut surfaces of scion and stock are brought into intimate contact, and its exposed vessels may become occluded by the ingrowth of tyloses, but otherwise it shows little evidence of reaction under the influence of a stimulus.

Healing by Second Intention.—Should the wound of the plant be larger than in the case we have supposed, and should the margins of the cambium layer remain widely apart, as where, for instance, a branch of a tree has been lopped off, numbers of complications arise, for here the floor of the wound is composed mainly of wood and pith—tissues, as we have just seen, having a low power of reaction. The cambium margins are thus separated by a space whose floor is composed of material in great part useless in the effort at repair, while the absence of any lasting protective covering exposes the wound to excessive damp and the ravages of parasites.

Nature, so far, tends to protect such a surface artificially by the exudation of gum, resin, turpentine, &c., but this can be of only temporary efficacy, seeing that many of these large wounds of trees take years to heal. The healing is accomplished by the gradual encroachment of new tissue derived from the cambium at the margin. A cushion-like pad of callus, composed of cells traceable to those of the cambium, rises up at the circumference and gradually invests the exposed wood. If the exposed wood be surmounted by dead tissue, this may become encapsuled by the encroaching callus, very much as a piece of dead bone may become encysted in the tissues of a living animal. The wound, after a time, comes to resemble very closely an indolent ulcer in man. The floor is covered by dead or dying unorganizable materials, without any layer of regenerative cells, and over this naturally the reparative callus at the margin runs with difficulty, so that it tends to accumulate in a pad-like ring around the gap. In the case of the indolent ulcer this pad of callus is represented by the indurated and elevated edge (Fig. 19, Plate V.). The floor of such a wound is devoid of any layer of young growing cicatrix elements; the tendons and fasciæ of underlying parts may be exposed on it, and the surfaces of these may be dead or dying. Over such a surface the epithelium will not spread, and as a result accumulates with other (connective tissue) reparative material at the margin, thus giving rise to the pad-like indurated edge. It is not until, under appropriate treatment, such a surface becomes invested with embryonic connective tissue, and is provided with just sufficient vascularity to aid in repair, that the wound will close. When this happens, the epidermis spreads over the young connective tissue layer covering the floor, and reassumes its original vocation as a protective investment. The elevation and induration of the margin of the wound, which, as just said, are caused in great part by accumulated epidermis, vanish as a consequence, and the wound assumes a more uniform level (Fig. 18, Plate V.).

Where a large gap is made in an animal tissue, as, say, by an injury, and where the skin and subcutaneous areolar tissue have been removed, the exposed surface is liable to the same vicissitudes as in the like case in a plant. The floor may be constituted, in great measure, of tissues of low vital reaction, such as muscle; the epithelial margins are widely apart; and now that the surface is broken and the underlying vulnerable tissues and liquids are exposed, these become a prey to destructive vegetable parasites. The wound may be covered with lymph or blood-clot, but neither of these has much power of resisting germ invasion, and both are evanescent substances, incapable of generating cicatrix. Hence they can serve only a temporary and ephemeral purpose in protecting the exposed surface, and when they lie in any quantity within a wound they rather hinder than aid its healing. They must be removed before the true cicatrix-forming elements of the tissues can come into play.

Like all porous substances (sponge, elder-pith, &c.; Fig. 21, Plate VI.), the clot may act as a framework or mould in which the future cicatrix is cast (Fig. 20, Plate VI.), that is to say, its porosities may be penetrated by connective tissue and blood-vessels, and it may thus aid in the healing of the part; but of itself it has absolutely no more power of generating tissue than coagulated white-of-egg, which it closely resembles in composition. When blood-clot or other extraneous substance has complicated and retarded the natural course of events, the resulting cicatrix is unnecessarily abundant: what ensues is an avowal on Nature's part of a certain clumsiness of procedure; it is not instinct of her best effort.

Granulations.

Such gaping wounds tend to granulate, and the granulations are often regarded as a provision for aiding in organization (Fig. 18, Plate V.). This notion is diametrically opposed to all the facts of pathology bearing upon the matter. A certain amount of vascularity is of course necessary for organization, but anything in excess of what is absolutely necessary in all circumstances tends to favour disorganization rather than to aid organization. The parts which heal quickest in the animal body are those in which blood-vessels are either absent (cornea), or in which they are sparsely distributed (linea alba of abdomen). Indeed, the advent of granulation loops, as Hamilton has sought to demonstrate, is probably an accident of the part, conditional upon its surface restraint having been removed, and usually, when at all exuberant, such granulations are the chief means of retarding organization. In the healing of exposed wounds in plants, there is nothing exactly corresponding to the granulating surface in animals. The vessels are not driven out on the surface, possibly because they are more rigidly bound to their surroundings than the animal vessels are. Still the means by which vegetable callus is formed presents certain analogies. It begins in the soft bast and in the embryonic tissue lying along the edge of the wound, namely, the cambium. According to Hartig, the initiation of this callus-production is at first purely mechanical, and is consequent upon the pressure exerted naturally on the subjacent parts being reduced. In normal circumstances there is always a certain amount of tension in the cortical mantle, whereby a considerable pressure is exerted upon the cambium. Should this pressure be lessened by a wound reaching to the wood, cell-division within the cambium is accelerated not only along the edges of the wound, but for some distance around. This cell-division proceeds most energetically in the direction of the surface of the wound, where, of course, the restraining counter-pressure is least. Masses of new callus can be seen protruding from between cortex and wood, in these circumstances, quite comparable to the luxuriant cell-tissue of granulations. The plan of healing by granulation, or, rather, in spite of granulation, is essentially alike with that known as healing by first intention, and both are really extensions of natural growth.

Fibrosis.—Where a chronic inflammatory process has taken possession of an organ, or, let us say, has been located in periosteum or other fibrous part, there is a great tendency to the production of cicatricial fibrous tissue in mass. Thus it is laid down in large quantity in cirrhosis of the liver (Fig. 22, Plate VI.), kidney, or lung, and reacts upon these organs by contracting and inducing atrophy. The term "cirrhosis" or "fibrosis" is usually applied to such a condition of organs; that of "sclerosis" is used when such a deposition of fibrous tissue occurs within the central nervous system (Fig. 23, Plate VI.). Gull and Sutton asserted that in particular states of body, and more especially in the condition associated with cirrhotic kidney, such a fibrosis becomes general, running, as they alleged it does, along the adventitia of arteries and spreading to their capillaries. They supposed that it was accompanied by a peculiar hyaline thickening of the arterial wall, usually of the tunica intima, and hence they termed the supposed diseased state "arterio-capillary fibrosis," and gave the fibrous substance the name "hyaline-fibroid." They held that the cirrhotic kidney is simply a local manifestation of a general fibrous disease. Their theory, however, has fallen into disfavour of late years.

Ætiology of Malignant Neoplasms.

Cancer. For long it has been suspected that malignant tumours are contagious, and that the contagion depends upon a micro-parasite. Cases of the supposed transference of cancer from one individual to another have been put on record from time to time, and it has been alleged that sarcoma has been successfully transplanted into the tissues of animals of the same species. Most of the cancer experiments, however, in this direction have proved negative. Still, the parasitical theory has gained a strong hold on the minds of pathologists, and has been reinforced by the discovery of bodies in cancer tumours which are not only alleged to be parasitical, but, it is asserted, are capable of communicating cancer afresh to suitable hosts. The bodies in question (Fig. F, Plate I.) for the most part inhabit the cytoplasm of the epithelial cells, but are also found in the nucleus. They are discovered in greatest abundance in the actively-growing parts of the tumour, and in these regions are present sometimes in almost every individual cell, and occasionally in great numbers in a single cell. In their youngest state they appear to be rounded bodies which are refractile and stain differentially with certain reagents such as Biondi's fluid. Later, they develop a double-contoured capsule with clear contents and a body which is generally called a nucleus. A peculiar radiate arrangement of their substance is noticed occasionally in hardened preparations. Plimmer stated that he had cultivated them artificially, and that on inoculation he produced an eruption of tumours having an endothelial structure. They have been referred to the protozoa (Metchnikoff), but Plimmer looks upon them rather as being related to the saccharomycetes.

Russell's fuchsin-bodies are peculiar structures—round, homogeneous, and refractile—which occur in various kinds of neoplasm. They range in size from about that of a coloured blood-corpuscle up to six, eight, or more times as large. They probably have no ætiologial relationship to the tumours in which they occur, although Russell supposed that they were the infective agents in cancer. They have variously been supposed to be protozoa, degenerated blood-corpuscles, yeast-cells, &c. None of these theories has been conclusively established.

Secondary cancer tumours present the same variety of epithelium as that which prevails in the primary tumour. Hence it is in a manner proved that, whatever the actual agency at work in their production, a transportation of the epithelial element of the tumour must take place, and that it is from this as a nucleus that the secondary tumour springs. That cells and actual fragments of an organ can be transported by the blood-vessels into the lung, has been demonstrated by Turner, Jürgens, Lubarsch, Maximoff, and others; and there is every reason to believe, from collateral observations on the production of metastatic tumours by Zahn and Ernst, that, in the case of the neoplasms, individual cells and small portions of the primary tumour are carried along in the blood-current and give rise to an auto-infection of distant parts. It is curious, in view of this, that there should be such difficulty in reproducing the tumour by transplantation into a fresh host.

Pathological Tissue Products.

Colloid.—This term is usually applied to a semi-solid substance of homogeneous and gelatinous consistence formed in certain pathological circumstances. It results from a degeneration of cellular structures, and more particularly of those of an epithelial type. Hence cancer tumours, especially those of the stomach and intestine, are liable to give rise to it, and the cysts in ovarian adenomata usually contain a ropy gelatinous substance which falls under this designation. In various diseases of the kidney there is often found within the urinary tubules a hyaline structureless substance in the form of a tube-cast, which, in certain instances at least, is to be reckoned as a degeneration of the epithelium, and as of the nature of colloid. The catarrhal cells in certain varieties of tubercular pneumonia are sometimes destroyed by colloid degeneration. Colloid degeneration of cancerous tumours appears to implicate exclusively the epithelial cells of the tumour (Fig. 24, Plate VI.). The stroma of the tumour remains unaffected, and lies dissected out in the surrounding homogeneous glassy substance.

Within the thyroid vesicles there accumulates a homogeneous and gelatinous product which often goes by the name of "colloid." The usual idea of its origin is that it is secreted by the thyroid. Notkin, however, takes a different view of the matter. He names the substance in question thyro-proteid, and looks upon it as an excrementitious substance formed in the tissues and merely removed from the blood by the thyroid. When the thyroid is destroyed in myxœdema, or when it is removed artificially in a healthy animal, this substance, thyro-proteid, accumulates in the soft tissues and occasions a characteristic swelling. He looks upon the substance as quite different from mucoid. As regards the composition of colloid found in other situations, it appears to vary—to be, in fact, a mixture of albuminoid substances. Scherer found a peculiar albumen-like constituent in the ropy viscid fluid from an ovarian cyst, to which he gave the name of *paralbumin*.

Mucoid.—By this is understood a gelatinous substance something like the foregoing in its physical characters, but differing from it in the fact of its being a substance of connective tissue origin, and in containing a large

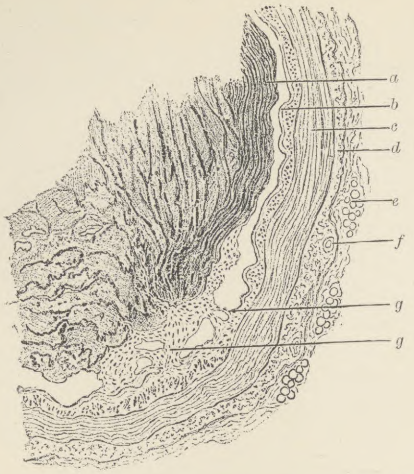


FIG. 20.—Organizing Thrombus. Internal saphenous vein. *a*, Laminæ of thrombus; *b*, tunica intima from which processes (*g*, *g*,) are being projected into the thrombus; *c*, muscularis; *d*, areolar coat; *e*, fat outside same; *f*, small artery. (× 50 diams.)

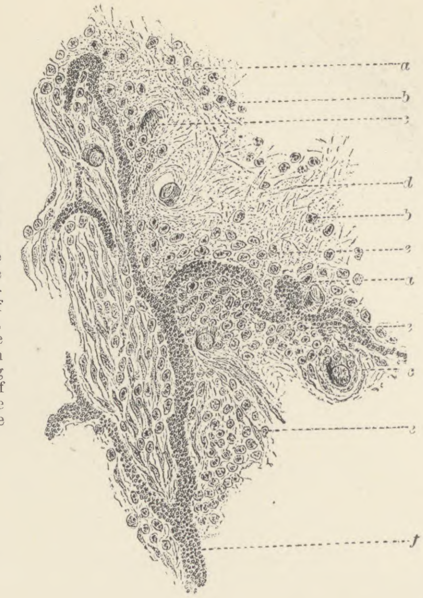


FIG. 21.—Organization of Sponge. Section through piece of sponge placed in abdomen for ten days, which had become adherent to the bowel. *a*, *a*, Loops of blood-capillaries pushed into the sponge from surface of the bowel; *b*, *b*, colourless blood-corpuscles lying in meshes of sponge frame-work (*c*, *c*); *d*, fibrin in same; *e*, *e*, *e*, true organizing cells derived from the bowel and supplanting the fibrin (*d*); *f*, stem of capillary-loops which are being projected into the sponge. (× 300 diams.)

FIG. 22.—Cirrhotic Liver, showing Fibrosis. *a*, Superficial layer of capsule not much altered; *b*, deep layer very much thickened; *c*, *c*, islands of liver tissue surrounded by fibrous bands; *d*, small congested blood-vessel; *e*, *e*, depôts of small round cells in the fibrous bands; *f*, *f*, fibrous bands; *g*, branch of portal vein. (× 50 diams.)

FIG. 23.—Sclerosis of Spinal Cord. *l.c.*, A sclerotic patch in lateral column; *p.c.*, same in posterior column. (× 50 diams.)

FIG. 26.—Four Leucocytes from the frog, enclosing anthrax bacilli.

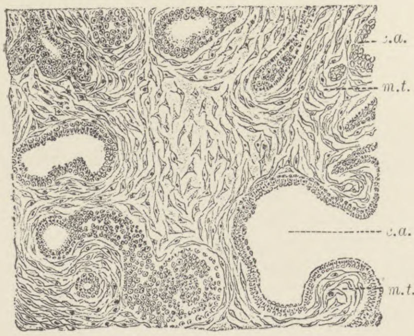


FIG. 25.—Myxomatous (cystic) Tumour of the Mamma. *m.t.*, Myxomatous tissue; *c.a.*, cystic acini. (× 300 diams.)

FIG. 24.—Colloid Degeneration of the Epithelial Cells of a Cancerous Tumour of the Mamma. (× 400 diams.)

percentage of mucin. Mucin is either absent from true colloid, or is present only in small quantity. Mucoid is met with in pathology chiefly as a constituent of connective tissue tumours—myxo-sarcomata (Fig. 25, Plate VI.), myxo-lipomata, fibromata, enchondromata, &c. The substance is either quite homogeneous and structureless, or is faintly stringy. The cells of the tumour lie embedded in it, and begin to throw out processes in all directions, which by anastomosing constitute a network. The processes are said by Kickhefel to constitute a system of plasma canals. The mucoid appears to result from a partial liquefaction of the fibrous stroma of the tumour, such as that contained in the adventitia of blood-vessels, partly also from a mucoid transformation of the bodies of the cells of the growth (Kickhefel). It may be mentioned that some holothurians have the remarkable property of converting their tough, brown, leather-like skin into mucoid within a few hours, on their being brought into air. The whole skin may undergo this viscous transformation.

Hyaloid.—The hyaloid degeneration seems to be closely related to the mucoid, and affects chiefly lymphatic glands (Wieger and Schüppel), the vessels and neuroglia of the brain (Arndt), and the stroma of epithelial tumours (Malassez). The part becomes infiltrated with a transparent homogeneous substance—particularly within and around blood-vessels—which does not give the reactions of amyloid, and does not exhibit the histological characters of the mucoid degeneration. It differs from the colloid in being a degeneration chiefly of fibrous tissues. In the brain-cortex it sometimes gives rise to deposits of a cartilage-like lustre and consistence.

Amyloid.—The wax-like or amyloid substance has a certain resemblance to the colloid, mucoid, and hyaloid. It has a firm gelatinous consistence and wax-like lustre, and microscopically is found to be homogeneous and structureless, with a translucency like that of ground-glass. The name "amyloid" was applied to it by Virchow on account of the blue reaction which it gives occasionally with iodine and sulphuric acid, resembling that given with vegetable cellulose. It is now known to have nothing in common with vegetable cellulose, but is regarded as one of the many albuminoid substances existing in the body under pathological conditions. Its percentage composition, according to Friedreich and Kekule, is C53–6, H7·0, N15·0, and O and S24·4. It is quite insoluble in water, resists putrefaction, and is not acted upon by pepsin- or trypsin-ferment in solution at a body-temperature. This last circumstance has been taken advantage of in the isolation of the substance in a pure condition. Unlike the colloid, it appears always to take on the character of a true infiltrate. The albumen (possibly serum-albumen), of which it is a derivative, is most likely poured into the affected organ in a soluble form, and subsequently becomes insoluble. There appears, however, to be a preamyloid stage, or several of them, leading up to the construction of the completely developed amyloid, in which the substance does not give the diagnostic colour reactions. These colour reactions are forthcoming only in the fully formed amyloid, and are as follows: (1) Watery solution of iodine imparts to it a deep mahogany brown colour; (2) iodine and sulphuric acid give occasionally, but not always, an azure-blue colour; (3) methyl-violet imparts to it a brilliant rose-pink; (4) methyl-green gives a reaction very much like that of methyl-violet, but not so vivid. The reaction with iodine is seen best with direct light, the reactions with the other substances are visible only with transmitted light. Chitin gives a brown reaction with iodine, and a violet, or blue, with iodine and sulphuric acid; methyl-violet stains it violet-red, but methyl-green has no effect upon it. In view of these positive staining reactions, Krawkow supposed that amyloid is chitinous in its nature, a combination of an albuminous body with chitin, and might be known consequently as "chitinoid." Oddi has isolated from the amyloid liver a substance which Schmiedeberg had previously obtained from cartilage and named "chondroitinic-sulphuric acid" (Chondroïtinschwefelsaure). It also occurs in bones and elastic tissue, but is not present in the normal human liver. Oddi does not regard it as the essential constituent of amyloid, chiefly because the colour reactions are forthcoming in the residuum after the substance has been removed, while the substance itself does not give these reactions. Quite likely the amyloid may be a combination of the substance with a proteid. The soda combination of the acid as obtained from the nasal cartilage of pigs had the composition $C_{18}H_{25}Na_2NSO_{17}$.

Amyloid develops, in various organs and tissues in connexion with simple chronic abscess, tubercular abscess and other suppurative states of body, and a number of interesting experiments, designed to test the relationship between the condition of suppuration and the production of amyloid, have been made of late years. The animal most suitable for experimenting upon is the fowl, but other animals have been found to react. Thus Krawkow and Nowak, employing the continuous injection subcutaneously of the usual organisms of suppuration, have induced in the fowl the deposition within the tissues of a homogeneous substance giving the colour reactions of true amyloid. When hardened in spirit, however, the greater part of this experimental amyloid in the fowl vanishes, and the reactions are not forthcoming. They were unable to verify any direct connexion between its production and the organism of tubercle. These observations have been verified in the rabbit, mouse, fowl, guinea-pig, and cat by Davidsohn, occasionally in the dog by Lubarsch; and confirmatory observations have also been made made by Czerny and Maximoff. Lubarsch succeeded in inducing it merely by the subcutaneous injection of turpentine, a result which it has been asserted is due to the turpentine exciting an abscess. Nowak, however, found later that he could generate it where the turpentine failed to induce suppuration, and he believes that it may arise quite apart from the influence of the organisms of suppuration, that it is not a biological product of the micro-organisms of disease, and also that it has nothing to do with emaciation.

Amyloid Bodies.—These are peculiar bodies which are found in the prostate, in the central nervous system, in the lung, and in other localities, and which get their name from being very like starch-corpuscles, and from giving certain colour reactions closely resembling those of vegetable cellulose, or even starch itself. They are minute structures having a round or oval shape, concentrically striated, and frequently showing a small nucleus-like body or cavity in their centre. Iodine gives usually a dark brown reaction, sometimes a deep blue; iodine and sulphuric acid almost always call forth an intense deep blue reaction; and methyl-violet usually a brilliant pink, quite resembling that of true amyloid. They are probably a degeneration-product of cells.

Spurious Amyloid.—If a healthy spinal cord be hung up in spirit for a matter of six months or more, a glassy substance develops within it quite like true amyloid. It further resembles true amyloid in giving all its colour reactions. The reaction with methyl-violet, however, differs from that with true amyloid in being evanescent.

Response of Tissues to Stimulation.

A stimulus may be defined as every change of the external agencies acting upon an organism; and if a stimulus come in contact with a body possessing the property of irritability, *i.e.* the capability of reacting to stimuli, the result is stimulation (Verworn). Stimuli comprise chemical, mechanical, thermal, photic, and electrical changes in the environment of the organism. A stimulus may act on all sides and induce a general effect without direction of movement, but in the production of movement in a definite direction the stimulus must be applied unilaterally. Stimuli applied generally, not unilaterally, in most cases induce increased divisibility of the cells of the part.

Thus the poison of various insects induces in plants the cellular new formation known as a gall-nut; a foreign body implanted in a limb may become encysted in a capsule of fibrous tissue; septic matter introduced into the abdomen will cause proliferation of the lining endo(epi)thelium; and placing an animal (salamander, Galeotti) in an ambient medium at a higher temperature than that to which it is accustomed naturally, increases the rapidity of cell-division of its epithelium with augmentation of the number of karyokinetic figures. Hair and some other like structures grow luxuriantly on a part to which there is an excessive flux of blood. Bone (*e.g.*, drill-bones) may develop in a soft tissue with no natural bone-forming tendencies, as a result of interrupted pressure, or a fatty tumour may arise in the midst of the natural subcutaneous fat in the same circumstances.

Among stimuli acting unilaterally, perhaps none has proved more interesting, in late times, than what is known as *Chemotaxis.* By it is meant the property an organism endowed with the power of movement has to move towards or away from a chemical stimulus applied unilaterally, or, at any rate, where it is applied in a more concentrated state on the one side than on the others, and more particularly where the concentration increases gradually in one direction away from the living organism acted upon. Observed originally by Engelmann in bacteria, by Stahl in myxomycetes, and by Pfeffer in ferns, mosses, &c., it has now become recognized as a widespread phenomenon. The influence of the chemical substance is either that of attraction or repulsion, the one being known as positive, the other as negative chemotaxis.

The female organs of certain cryptogams, for instance, exert a positive chemotactic action upon the spermatozoids, and probably, as Pfeffer suggests, the chemical agent which exerts the influence is malic acid. No other substance, at least, with which he experimented had a like effect, and it is possible that in the archegonium which contains the ovum malic acid is present. Massart and Bordet, Leber, Metchnikoff, and others have studied the phenomenon in leucocytes, with the result that while there is evidence of their being positively chemotactic to the toxines of many pathogenic microbes, it is also apparent that they are negatively influenced by such substances as lactic acid.

From a pathological point of view the subject of chemotaxis must be considered along with that of *phagocytosis.* Certain free mobile cells within the body, such as blood-leucocytes, as well as others which are fixed, as for instance the endothelium of the hepatic capillaries, have the property of seizing upon some kinds of particulate matter brought within their reach. Within a quarter of an hour after a quantity of cinnabar has been injected into the blood of the frog, nearly every particle will be found engulfed by the protoplasm of the leucocytes of the circulating blood. Some bacteria, such as those of anthrax (Fig. 26, Plate VI.), are seized upon in the same manner, indeed, very much as small algæ and other particles are incorporated and devoured by amœba. Melanine particles formed in the spleen in malaria, which pass along with the blood through the liver, are appropriated by the endothelial cells of the hepatic capillaries, and are found embedded within their substance. If the particle enveloped by the protoplasm be of an organic nature, such as a bacterium, it undergoes digestion, and ultimately becomes destroyed, and accordingly the term "phagocyte" is now in common use to indicate cells having the above properties. This phagocytal action of certain cells of the body is held by Metchnikoff and his followers to have an important bearing on the pathology of immunity. Phagocytes act as scavengers in ridding the body of noxious particles, and more especially of harmful bacteria.

A further application of the facts of chemotaxis and phagocytosis has been made by Metchnikoff to the case of *Inflammation.* It is well known that many attempts to define the process of inflammation have been made from time to time, all of them more or less unsatisfactory. Among the latest is that of Metchnikoff: "Inflammation generally," he says, "must be regarded as a phagocytic reaction on the part of the organism against irritants. This reaction is carried out by the mobile phagocytes sometimes alone, sometimes with the aid of the vascular phagocytes, or of the nervous system." Given a noxious agent in a tissue, such, let us say, as a localized deposit of certain bacteria, the phagocytes swarm towards the locality where the bacteria have taken up their residence. They surround individual bacteria, absorb them into their substance, and ultimately destroy them by digestion. The phagocytes are attracted from the blood-vessels and elsewhere towards the noxious focus by the chemotaxis exerted upon them by the toxines secreted by the bacteria contained within it. The chemotaxis in this instance is positive, but the toxines from certain other bacteria may act negatively; and such bacteria are fraught with particular danger from the fact that they can spread through the body unopposed by the phagocytes, which may be looked upon as their natural enemies.

Natural Protection against Parasitism.

The living organism is a rich storehouse of the very materials from which parasites, both animal and vegetable, can best derive their nourishment. Some means is necessary, therefore, to protect the one from the encroachments of the other. A plant or animal in perfect health is more resistant to parasitical invasion than one which is ill-nourished and weakly. Of a number of plants growing side by side, those which become infected with moulds are the most weakly, and an animal in low health is more subject to contagious disease than one which is robust. Each organism possesses within itself the means of protection against its parasitical enemies, and these properties are more in evidence when the organism is in perfect health than when it is debilitated.

One chief means employed by Nature in accomplishing this object is the investment of those parts of the organism liable to be attacked with an armour-like covering of epidermis, periderm, bark, &c. The grape is proof against the inroads of the yeast-plant so long as the husk is intact, but on the husk being injured, the yeast-plant finds its way into the interior and sets up vinous fermentation of its sugar. The root of the French vine is attacked by the Phylloxera, but that of the American vine, whose epidermis is thicker, is protected from it. The larch remains free from parasitism so long as its covering is intact, but as soon as this is punctured by insects, or its continuity interfered with by cracks or fissures, the Peziza penetrates, and before long brings about the destruction of the branch. So long as the epidermis of animals remains sound, disease germs may come in contact with it almost with impunity, but immediately on its being fissured, or a larger wound made through it, the underlying parts, the blood and soft tissues, are attacked by them. A very remarkable instance of an acquired means of protecting a wound against parasitical invasion is to be found in *granulations.* Should these remain unbroken, they constitute a natural barrier to the penetration of most pathogenic and other forms of germ-life into the parts beneath. Bacteria of various kinds which alight upon their surfaces begin to fructify in abundance, but are rapidly destroyed as they burrow deeply. This is accomplished by a twofold agency, for while numbers of them are seized upon by the granulation phagocytes, others are broken up and dissolved by the liquid filling the granulation interspaces (Afanassieff). This latter, or histolytic, property is not confined to the liquid of granulations; normal blood-serum possesses it to a certain extent, and under bacterial influence it may become very much exalted. Jürgelünas makes out that when an animal is rendered immune to a particular micro-organism this histolytic property becomes exalted.

Dropsy.

During conditions of health a certain quantity of lymphy liquid is constantly being effused into the tissues and serous cavities of the body, but in the case of the tissues it never accumulates to excess, and in that of the serous cavities it is never more than sufficient to keep them moist. When any excessive accumulation takes place, the condition is known as "hydrops" or "dropsy." A "transudate" is a liquid having a composition resembling that of blood-serum, while the term "exudate" is applied to an effused liquid whose composition approaches that of the blood-plasma in the relationship of its solid and liquid parts, besides in most cases containing numbers of colourless blood-corpuscles. Exudates are poured out under inflammatory conditions, while none of the truly dropsical effusions are of inflammatory origin; and hence the class of exudates, as above defined, may be rejected from the category of liquids we are at present considering. Where the dropsical condition is more or less general, the term "anasarca" is applied to it; if the tissues are infiltrated locally, the term "œdema" is employed; and various names are applied, with a local significance, to dropsies of individual parts or cavities, such as "hydrothorax," "hydroperitoneum" or "ascites," "hydrocephalus," and so on. In "anasarca" the tissues which suffer most are those which are peculiarly lax, such as the lower eyelids, the scrotum, and the backs of the hands and feet. It is invariably the result of some cause acting generally, such as renal disease, valvular defect of the heart, or an impoverished state of the blood; while a mere œdema is usually dependent upon some local obstruction to the return of blood or lymph, or of both, the presence of parasites within the tissue, such as the filaria sanguinis hominis or trichina spiralis, or the poisonous bites of insects. Dropsy of the serous cavities is very commonly merely part of a general anasarca, although occasionally it may be, as in the case of ascites, the sequel to an obstruction in the venous return. Dropsical liquids are usually pale yellow or greenish, limpid, with a saltish taste and alkaline reaction, and a specific gravity ranging from 1005 to 1024. They all contain albumen and throw down a precipitate with heat and nitric acid. None of them, in man, coagulates spontaneously, although they contain fibrinogen. The addition of some of the liquid squeezed out from a blood-clot, of the squeezed blood-clot itself, or of a little blood-serum, is sufficient to throw down a fibrinous coagulum (Buchanan), evidently by these substances supplying the fibrin-ferment. The proteid constituents are very much like those of blood-serum, although they never come up to them in amount (Runeberg). The quantity of proteid matter in a purely dropsical effusion never amounts to that of an inflammatory exudation (Lassar). Certain peculiar substances, probably degenerative products, some of them reducing copper, are occasionally met with. The liquid of ascites sometimes contains chyle in abundance (hydrops lacteus), the escape having taken place from a ruptured receptaculum chyli.

In a given case of anasarca due to a cause acting generally, it will be found that the liquid of the pleural cavity always contains the highest percentage of proteid, that of the peritoneal cavity comes next, that of the cerebral ventricles follows this, and the liquid of the subcutaneous areolar tissue contains the lowest. The reason of this is apparently that the negative pressure of the pleural, and partly of the peritoneal, cavity tends to aspirate a liquid relatively thicker, so to speak, than that effused where no such extraneous mechanism is at work (James).

The subject of the conditions under which dropsical liquids are poured out opens up a very wide question, and one about which there is the greatest diversity of opinion. It turns in part, but in part only, upon the laws regulating the effusion of lymph, and physiologists are by no means at one in their conclusions on this subject. Thus Ludwig was of opinion that the lymph-flow is dependent upon two factors, first, difference in pressure of the blood in the capillaries and the liquid in the plasma spaces outside; and, secondly, chemical interchanges setting up osmotic currents through the vessel-walls. His results, so far, have been confirmed by Starling, who finds that the amount of lymph-flow from the thoracic duct is dependent upon difference in pressure. It varies with the increase of the intracapillary or decrease of the extracapillary pressure, and is also in part regulated by the greater or lesser permeability of the vessel-walls. Heidenhain, on the other hand, rejected entirely the filtration view of lymph-formation, believing that the passage of lymph across the capillary wall is a true secretion brought about by the secretory function of the endothelial plates. Starling does not accept this view, and cannot regard as an article of faith Heidenhain's dictum that normally filtration plays no part in the formation of lymph. Lazarus-Barlow, again, looks upon the pouring out of lymph as evidence of the demands of the tissue-elements for nutrition. An impulse is communicated to the blood-vessels in accordance with this demand, and a greater or smaller outflow is the result. He traces various local dropsies to the starvation from which the tissues are suffering, the liquid accumulating in excess in accordance with the demand for more nourishment. It may be asked, however, whether a dropsical tissue is being held in a high state of nutrition, and whether, on the contrary, the presence of lymph in excess in its interstices does not tend to impair its vitality rather than to lend it support. According to Rogowicz and Heidenhain, certain substances increase the quantity of lymph given off from a part by acting upon the cells of the capillary wall; they hold, in fact, that these substances are true lymphagogues. Heidenhain recognizes two classes, first, such substances as peptone, leech extract, and cray-fish extract; and, secondly, crystalloids such as sugar, salt, &c. Starling sees no reason to believe that members of either class act otherwise than by increasing the pressure in the capillaries or by injuring the endothelial wall. The members of the first class influence the endothelial plates of the capillaries injuriously, inducing thereby increased permeability; those of the second class (sugar, &c.), on injection into the blood, attract water from the tissues and cause a condition of hydræmic plethora with increased capillary pressure. The increased flow of lymph is due to the increased pressure in the abdominal capillaries.

Increased flow of lymph, however, is one thing, the production of dropsy is another. For, even granted that the amount of lymph poured into a part varies with circumstances, there is not the slightest evidence to show, so long as the paths by which it is naturally removed, namely, the lymph, and blood-vessels, remain open and unimpaired, and so long as the composition of the blood remains normal, that the increased liquid tends to accumulate in the part. In fact, even where these paths are partially obstructed, there is great difficulty in rendering the part œdematous. The obstruction in the veins or lymphatics of a limb requires to be widespread in order to call forth any amount of local dropsy. Obstruction of the veins and lymphatics simultaneously is, however, more potent in occasioning such dropsy than any other measure. Feeble or obstructed action of the heart, combined with malcomposition of the blood, probably explains the tendency to dropsy in conditions of anæmia, the poor quality of the blood tending to bring about malnutrition of the capillary endothelium, and the feeble heart being insufficient to drive the lymph onwards. It is a question whether the malcomposition of the blood, in certain forms of renal diseases, may not be one of the main factors in the production of dropsy accompanying these diseases.

Practical Applications.

Medicine and Surgery have never been slow to appropriate and apply the biological facts of Pathology, and at no period have they followed more closely in its wake than during the last quarter of the 19th century. When, for instance, the cause of septic infection had been revealed, the prophylaxis of the disease became a possibility. Seldom has it happened, since the discovery of the law of gravity, that so profound an impression has been made upon the scientific world at large as by the revelation of the part played by germ-life in nature; seldom has any discovery been fraught with such momentous issues in so many spheres of science and industry.

The names of Pasteur and Lister will descend to posterity as those of two of the greatest figures in the annals of medical science, and indeed of science in general, during the 19th century. The whole system of treatment of tubercular disease has been altered by the discovery of the tubercle microphyte. Previously consumptive individuals were carefully excluded from contact with fresh air, and were advised to live in rooms almost hermetically sealed and kept at a high temperature. The treatment of the disease has now gone off in the opposite direction. Sanatoria have started up all over Europe and elsewhere for its treatment on the open-air principle. Individuals suffering from pulmonary phthisis are encouraged to live night and day in the open, and with the best results. The rapid diagnosis of diphtheria, by recognizing its bacillus, has enabled the practitioner of medicine to commence the treatment early, and it has also enabled the medical officer of health to step in and insist on the isolation of affected persons before the disease has had time to spread. The discovery of the parasite of malaria by Laveran, and of the method by which it gains entrance to the human body, through the bite of a particular variety of mosquito, by Manson and Ross, promises much in the way of eradication of the disease in the future. One of the most remarkable practical outcomes of germ-pathology, however, has been the production of the immunized sera now employed so extensively in the treatment of diphtheria and other contagious diseases. By the continuous injections under the skin, in increasing doses, of the toxines of certain pathogenic micro-organisms, such as that of diphtheria, an animal—usually the horse—may be rendered completely refractory to the disease. Its serum in course of time is found to contain something (antitoxine) which has the power of neutralizing the toxine secreted by the organism when parasitical upon the body. This immunity can be transferred to a fresh host (*e.g.*, man) by injecting such serum subcutaneously. In the general summary of the progress of pathology given in the commencement of this article, it was stated that myxœdema is to be traced to destruction of the thyroid gland. The continuous administration of extract of the gland, or of the gland itself *per os*, has been found to remove the symptoms of the disease. The modern system of hygiene is in great part founded upon recent pathology. The recognition of the dangers accompanying the drinking of polluted water or milk, or of those attached to the breathing of a germ-polluted atmosphere, has been the natural sequence of an improved knowledge of pathology in its bacteriological relationships. Skin-grafting and regeneration of bone are among not the least remarkable applications of pathological principles to the combat with disease in recent times; and in this connexion may also be mentioned the daring acts of surgery for the relief of tumours of the brain, rendered practicable by improved methods of localization, as well as operations upon the serous cavities for diseased conditions within them or in their vicinity.

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(D. J. H.)

II. PARASITIC DISEASES.

It has long been recognized that various specific pathological conditions are due to the presence and action of parasites in the human body, but since the publication of the ninth edition of this work the part played in the causation of the so-called infective diseases by various members of the Schizomycetes—fission fungi—has been more widely and more thoroughly investigated, and the knowledge gained has not only modified our conception of the pathology of these diseases, but has had a most important influence upon our methods of treatment of sufferers, both as individuals and as members of communities. The present article deals chiefly with these infective diseases, and with them only so far as new light has been thrown on their ætiology and pathology; and several diseases mentioned in the following classification are not further referred to in the text, because little or nothing, beyond what has already appeared, can be given. For example, Boil and Carbuncle, and Anthrax or Splenic Fever, had been as fully studied when the articles for the ninth edition were written as they are at the present time; it is therefore unnecessary to write what could only be of the nature of repetition. In certain conditions, such as Rheumatism, Vaccinia, Mumps, Dengue, Epidemic Dropsy, Oriental Sore, Verruga, Framboesia or Yaws, Beriberi,

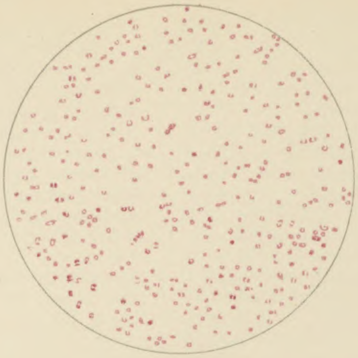


Fig. 6

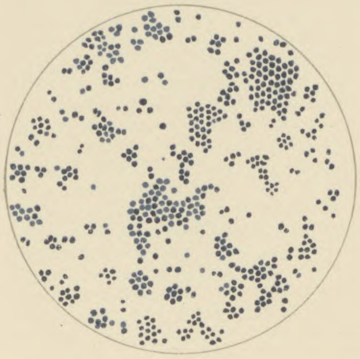


Fig. 1

Fig. 8

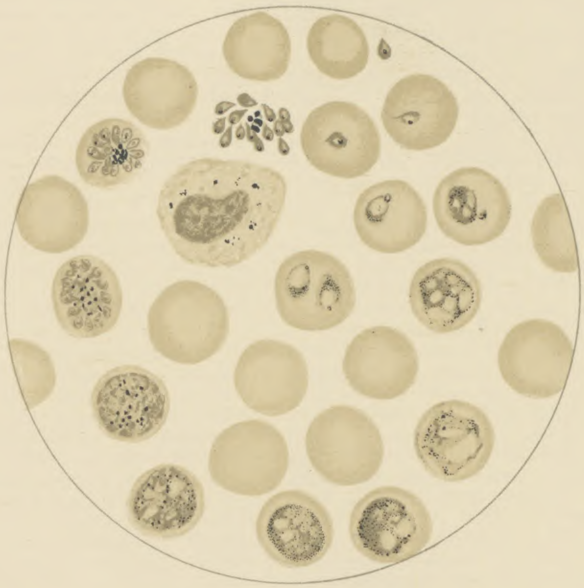


Fig. 18

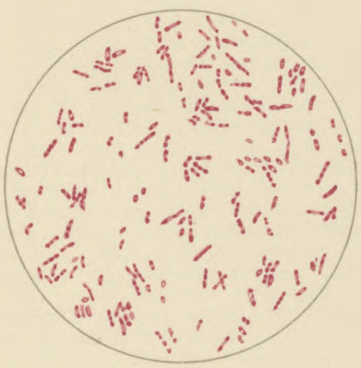


Fig. 13

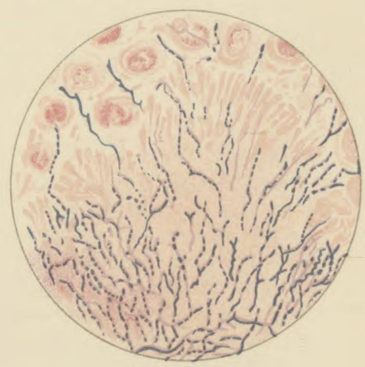
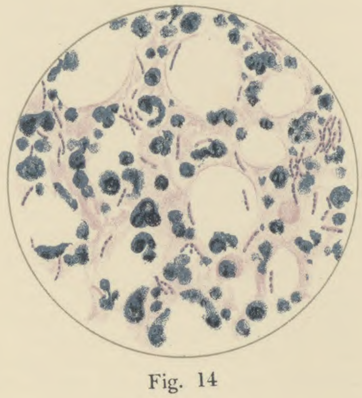


Fig. 17



Drawn by Rd. Muir.

M'Lagan & Cumming, Lith., Edin.

Fig. 14

FIG. 1.—Staphylococcus pyogenes aureus, from a 12-hours' agar culture. × 1000 diam.

,, 6.—Micrococcus melitensis vel Brucei (Micrococcus of Malta Fever), from a 24-hours' agar culture. × 1000 diam.

,, 8.—Fraenkel's diplococcus Pneumoniæ (pneumococcus), from a 12-hours' "blood agar" culture. × 1000 diam.

,, 13.—Preparation of Glanders Bacillus (B. mallei), from a 12-hours' agar culture. × 1000 diam.

,, 14.—Section of gland from a guinea-pig inoculated with the Glanders Bacillus (B. mallei). × 1000 diam.

,, 17.—Branched hyphal threads of the Ray fungus (Actinomyces), clubbed through thickening of the sheath. × 1000 diam.

,, 18.—Malaria. Life-cycle in the blood of the Tertian Malarial Parasite from the small amœbulæ through the spore-bearing stages to the group of amœbulæ. The large nucleated white blood corpuscle contains altered blood pigment. × 1000 diam.

and Syphilis, the disease is probably the result of the action of specific micro-organisms, though as yet it has not been possible to *demonstrate* any ætiological relationship between any micro-organisms found and the special disease. Recent work on Rheumatism and Scarlet Fever may render it necessary to revise this statement, but for the present it is advisable to allow it to stand. In addition to the above, one or two conditions in which the presence of animal parasites in the blood as causative factors of disease has been demonstrated are briefly described, but those which have for long been known to be due to the presence and action of the higher vegetable and animal parasites, and which have been adequately dealt with in the ninth edition, are not here considered. Such diseases as Hæmoglobinuric Fever or Black-Water Fever and Kala-Azar, which are also presumbably parasitic diseases, are not included, as they are probably associated directly with Malaria; this supposition is the more probable in that both of them are recognized as occurring specially in those patients who have been weakened by malaria, intestinal hæmorrhage, and similar conditions.

The following classification is based partly upon the biological relations of the parasites and partly on the pathological phenomena of individual diseases:—

A. Diseases due to Vegetable Parasites:
- I. To Schizomycetes, Bacteria or Fission Fungi:
  - 1. *Caused by the Pyogenetic Micrococci:*
    - Suppuration and Septicæmia.
    - Infective Endocarditis.
    - Erysipelas.
    - Gonorrhœa.
  - 2. *Caused by Specific Bacilli:*
    - ***(a) Acute Infective Diseases:***
      - Cholera.
      - Typhoid Group. Typhoid, Malta Fever, &c.
      - Relapsing Fever.
      - Plague.
      - Pneumonia.
      - Infective Meningitis.
      - Influenza.
      - Yellow Fever and Weil's Disease.
      - Diphtheria.
      - Tetanus.
    - ***(b) More Chronic Infective Diseases (tissue parasites):***
      - Tuberculosis.
      - Leprosy.
      - Glanders.
    - ***(c) Infective Diseases in which organisms have not yet been discovered:***
      - Hydrophobia.
      - Typhus Fever, Scarlet Fever, Measles, Mumps, Whooping-Cough, &c., &c.
- II. To Higher Vegetable Parasites:
  - Actinomycosis.
  - Madura Foot, Aspergillosis, and other Mycoses.

B. Diseases due to Animal Parasites:
- I. To Protozoa:
  - Malaria.
  - Dysentery.
  - Hæmoglobinuric Fever.
  - Kala-Azar.
- II. To other Animal Parasites:
  - Filariasis, &c.

A. Diseases due to Vegetable Parasites.

I. To Schizomycetes, Bacteria or Fission Fungi.

1. *Caused by the Pyogenetic Micrococci.*

Suppuration and Septicæmia.—It is now recognized that although nitrate of silver, turpentine, castor oil, perchloride of mercury, and certain other chemical substances are capable of producing suppuration, the most common causes of this condition are undoubtedly the so-called pus-producing bacteria. Of these perhaps the most important are the staphylococci (Fig. 1, Plate VII.) (cocci arranged like bunches of grapes), streptococci (Fig. 2, Plate VIII.) (cocci arranged in chains), and pneumococci, though certain other organisms not usually associated with pus-formation are undoubtedly capable of setting up this condition, *e.g.*, bacillus pyocyaneus, bacillus coli communis, and the typhoid bacillus. These organisms (the products of which, by chemical irritation, stimulate the leucocytes to emigration) bring about the death and digestion of the tissues and fluids (which no longer "clot") with which they come in contact, pus (matter) being thus formed: this accumulates in the tissues, in the serous cavities, or even on mucous surfaces; septicæmia or blood-poisoning, secondary infection of tissues and organs at a distance from the original site of infection, or pyæmia, with the formation of secondary abscesses, may thus be set up.

In septicæmia the pus-forming organisms grow at the seat of introduction, and produce special poisons or toxins, which, absorbed into the blood, give rise to symptoms of fever. From the point of introduction, however, the organisms may be swept away either by the lymph or by the blood, and carried to positions in which they set up further inflammatory or suppurative changes. In the streptococcal inflammations, spreading by the lymph channels appears to be more common. In the blood the organisms are usually destroyed by the powerful bactericidal action of the plasma; but should they escape, they are carried without multiplication into the systemic capillaries of the general circulation, of the lung, or the liver, where, being stopped, they may give rise to a second focus of infection, especially if at the point of impaction the vitality of the tissues is in any way lowered. Unless the blood is very much impoverished, its bactericidal action is usually sufficiently powerful to bring about the destruction of anything but comparatively large masses of pyogenetic organisms. This bactericidal power, however, may be lost, when the pus-forming organisms may actually multiply, a general hæmic infection resulting. Should micro-organisms be conveyed by the veins to the heart, and there be deposited on an injured valve, an *infective endocarditis* is the result; from such a deposit numerous organisms may be continuously poured into the circulation. Simple thrombi or clots may also become infected with micro-organisms. Fragments of these, washed away, may form septic plugs in the vessels and give rise to abscesses at the point of impaction. A distinction must be drawn between sapræmia and septicæmia. In sapræmia the toxic products of saprophytic organisms are absorbed from a gangrenous or necrotic mass, from an ulcerating surface, or from a large surface on which saprophytic organisms are living and feeding on dead tissues: for example, in the clots that sometimes remain after child-birth on the inner surface of the wall of the womb. So long as no micro-organisms follow the toxins, the condition is purely sapræmic, but should any organisms make their way into and multiply in the blood, the condition becomes one of septicæmia. The term pyæmia is usually associated with the formation of fresh secondary foci of suppuration in distant parts of the body. If the primary abscess occurs in the lungs, the secondary or metastatic abscesses usually occur in the vessels of the general or systemic circulation, and less frequently in other vessels of the lung. When the primary abscess occurs in the systemic area, the secondary abscesses occur first in the lung, and less frequently in the systemic vessels; whilst if the primary abscess be in the portal area (the veins of the digestive tract), the secondary abscesses are usually distributed over the same area, the lungs and systemic vessels being more rarely affected.

Infective Endocarditis.—Acute malignant or ulcerative endocarditis occurs in certain forms of septicæmia or pyæmia. It is brought about by the streptococcus pyogenes, the pneumococcus, or the staphylococcus pyogenes aureus, or, more rarely, by the gonococcus, the typhoid bacillus or the tubercle bacillus, as they gain access to acute or chronic valvular lesions of the heart. The aortic and mitral valves are usually affected, the pulmonary and tricuspid valves much more rarely, though Washbourn states that the infective form occurs on the right side more frequently than does simple endocarditis. A rapid necrosis of the surface of the valve is early followed by a deposition of fibrin and leucocytes on the necrosed tissue; the bacteria, though not present in the circulating blood during life, are found in these vegetations which break down very rapidly; ulcerative lesions are thus formed, and fragments of the septic clot (*i.e.* the fibrinous vegetations with their enclosed bacteria) are carried in the circulating blood to different parts of the body, and, becoming impacted in the smaller vessels, give rise to septic infarcts and abscesses. The ulceration of the valves, or in the first part of the aorta, may be so extensive that aneurysm, or even perforation, may ensue. In certain cases of streptococcic endocarditis the use of anti-streptococcic serum appears to have been attended with good results.

Suppurative Meningitis (see *Infective Meningitis*).

Erysipelas.—In 1883, Fehleisen demonstrated that in all cases of active erysipelatous inflammation a streptococcus or chain of micrococci (similar to those met with in certain forms of suppuration) may be found in the lymph spaces in the skin. The multiplying streptococci found in the lymph spaces form an active poison, which, acting on the blood-vessels, causes them to dilate; it also "attracts" leucocytes, and usually induces proliferation of the endothelial cells lining the lymphatics. These cells—perhaps by using up all available oxygen — interfere with the growth of the streptococcus and act as phagocytes, taking up or devouring the dead or weakened micro-organisms. Both mild and severe phlegmonous cases of erysipelas are the result of the action of this special coccus, alone, or in combination with other organisms. It has been observed that cancerous and other malignant tumours appear to recede under an attack of erysipelas, and certain cases have been recorded in which complete cessation of growth and degeneration of the tumour have followed such an attack. As the streptococcus of erysipelas can be isolated and grown in pure culture in broth, it was thought that a subcutaneous injection of such a cultivation might be of value in the treatment of cancerous tumours. No difficulty was experienced in setting up erysipelas by inoculation, but in some cases the process was so acute that the remedy was more fatal than the disease. The virulence of the streptococcus of erysipelas is greatly exalted when the coccus is grown alongside the bacillus prodigiosus and certain other saprophytic organisms which flourish at the body-temperature. It is an easier matter to control the action of a non-multiplying poison, even though exceedingly virulent, than of one capable, under favourable conditions, of producing an indefinite amount of even a weaker poison. The erysipelatous virus having been raised to as high a degree of activity as possible by cultivating it along with the bacillus prodigiosus—the bacillus of bleeding bread—in broth, it is killed by heat, and the resulting fluid, which contains a quantity of the toxic substances that set up the characteristic erysipelatous changes, is utilized for the production of an inflammatory process—which can now be accurately controlled, and which is said to be very beneficial in the treatment of certain malignant tumours. The accurate determination of the ætiology of erysipelas has led to the adoption of a scientific method of treatment of the disease. The streptococcus erysipelatis is found, not specially in the zone in which inflammation has become evident, but in the tissues outside this zone: in fact, the streptococci appear to be most numerous in the lymphatics of the tissues in which there is least change. Before the appearance of any redness there is a dilatation of the lymph spaces with fluid, and the tissues become slightly œdematous. As soon, however, as the distension of vessels and the emigration of leucocytes, with the accompanying swelling and redness, become marked, the streptococci disappear or are imperfectly stained — they are undergoing degenerative changes—the inflammatory "reaction" apparently being sufficient to bring about this result.

If it were possible to set up the same reaction outside the advancing streptococci, might not a barrier be raised against their advance? This theory was tested on animals, and it was found that the application of iodine, oil of mustard, cantharides, and similar rubefacients, would prevent the advance of certain micro-organisms. This treatment was applied to erysipelas patients with the most satisfactory result, the spread of the disease being prevented whenever the zone of inflammation was extended over a sufficiently wide area. The mere "ringing" of the red patch by nitrate of silver or some other similar irritant, as was at one time recommended, was not sufficient: it is necessary that the reaction should extend for some little distance beyond the zone to which the streptococci have already advanced.

Gonorrhœa.—A micro-organism, the gonococcus, is the cause of gonorrhœa. It is found in the pus of the urethra and in the conjunctiva lying between the epithelial cells, where it sets up considerable irritation and exudation; it occurs in the fluid of joints of patients affected with gonorrhœal arthritis; also in the pleuritic effusion and in the vegetations of gonorrhœal endocarditis. It is a small diplococcus, the elements of which are flattened or slightly concave discs apposed to one another; these, dividing transversely, sometimes form tetrads. They are found in large numbers, usually in the leucocytes, adherent to the epithelial cells or lying free. They stain readily with the basic aniline dyes, but lose this stain when treated by Gram's method. The gonococcus is best grown on human blood-serum mixed with agar (Wertheim), though it grows on ordinary solidified blood-serum or on blood-agar. Like the pneumococcus, it soon dies out, usually before the eighth or ninth day, unless reinoculations are made. It forms a semi-transparent disc-like growth, with somewhat irregular margins, or with small processes running out beyond the main colony. It acts by means of toxins, which have been found to set up irritative changes when injected, without the gonococci, into the anterior chamber of the eye of the rabbit.

2. *Caused by Specific Bacilli.*

(a) Acute Infective Fevers.

Cholera.—In 1884, Koch, in the report of the German Cholera Commission in Egypt and India, brought forward overwhelming evidence in proof of his thesis that a special bacterium is the causal agent of cholera; subsequent observers in all countries in which cholera has been met with have confirmed Koch's observation. The organism described is the "comma" bacillus, one of the spirilla, which usually occurs as a slightly-curved rod 1 to 2μ in length and 0·5 to $0{\cdot}6\mu$ in thickness. These comma-shaped rods occur singly or in pairs; they may be joined together to form circles, half-circles, or "S"-shaped curves (Fig. 3, Plate VIII.).

In cultivations in specially-prepared media they may be so grouped as to form long wavy or spiral threads, each of which may be made up of ten, twenty, or even thirty of the short curved rods; in the stools of cholera patients, especially during the earlier stages of the disease, they are found in considerable numbers; they may also be found in the contents of the lower bowel and in the substance of the mucous membrane of the lower part of the small intestine, especially in the crypts and in and around the epithelium lining the follicles. It is sometimes difficult, in the later stages of the disease, to obtain these organisms in sufficiently large numbers to be able to distinguish them by direct microscopic examination, but by using the Dunbar–Schottelius method they can be detected even when present in small numbers. A quantity of faintly-alkaline meat broth, with 2 per cent. of peptone and 1 per cent. common salt, is inoculated with some of the contents of the intestine, and is placed in an incubator at a temperature of 35° C. for about twelve hours, when, if any cholera bacilli are present, a delicate pellicle, consisting almost entirely of short "comma" bacilli, appears on the surface. If the growth be allowed to go on, the bacilli increase in length, but after a time the pellicle is gradually lost, the cholera organisms being overgrown, as it were, by the other organisms. In order to obtain a pure culture of the cholera bacillus, remove a small fragment of the young film, shake it up thoroughly in a little broth, and then make gelatin-plate cultivations, when most characteristic colonies appear as small greyish or white points. Each of these, when examined under a low-power lens, has a yellow tinge; the margins are wavy or crenated; the surface is granular and has a peculiar ground-glass appearance; around the growing colony liquefaction takes place, and the colony gradually sinks to the bottom of the liquefying area, which now appears as a clear ring. The organism grows very luxuriantly in milk, in which, however, it gives rise to no very noticeable alteration; its presence can only be recognized by a faint aromatic and sweetish smell, which can scarcely be distinguished from the aromatic smell of the milk itself, except by the most practised nose.

The cholera bacillus may remain alive in water for some time, but it appears to be less resistant than many of the putrefactive and saprophytic organisms. It grows better in a saline solution (brackish water) than in perfectly fresh water; it flourishes in serum and other albuminous fluids, especially when peptones are present. Its power of forming poisonous substances appears to vary directly with the amount and nature of the albumen present in the nutrient medium; and though it grows most readily in the presence of peptone, it appears to form the most virulent poison when grown in some form or other of crude albumen to which there is not too free access of oxygen. From the experiments carried out by Koch, Nicati and Rietsch, and Macleod, there appears to be no doubt that the healthy stomach and intestine are not favourable breeding-grounds for the cholera bacillus. In the first place, it requires an alkaline medium for its full and active development, and the acid found in a healthy stomach seems to exert an exceedingly deleterious influence upon it. Secondly, it appears to be incapable of developing except when left at rest, so that the active peristaltic movement of the intestine interferes with its development. Moreover, it forms its poison most easily in the presence of crude albumen. It is interesting to note what an important bearing these facts have on the personal and general spread of cholera. Large quantities of the cholera bacillus may be injected into the stomach of a guinea-pig without any intoxicative or other symptoms of cholera making their appearance. Further, several healthy individuals have swallowed, without any ill effect, pills containing the dejecta from cholera cases. If, however, previous to the injection of the cholera bacillus, the acidity of the stomach be neutralized by an alkaline fluid, especially if at the same time the peristaltic action of the intestine be paralysed by an injection of morphia, a characteristic attack of cholera is developed, the animal is poisoned, and in the large intestine a considerable quantity of fluid fæces containing numerous cholera bacilli may be found. There appear to be slight differences in the cholera organisms found in connexion with different outbreaks, but the main characteristics are preserved throughout, and are sufficiently distinctive to mark out the organisms as belonging to the cholera group. Amongst the known predisposing causes of cholera are the incautious use of purgative medicines, the use of unripe fruit, insufficient food, and intemperance. These may all be looked upon as playing the part of the alkaline solution in altering the composition of the gastric juices, and especially as setting up alkaline fermentation in the stomach and small intestine; beyond this, however, the irritation set up may bring about an accumulation of inflammatory serous fluid, from the albumens of which, as we have seen, the cholera organism has the power of producing very active toxins.

The part played by want of personal cleanliness, overcrowding, and unfavourable hygienic conditions, may be readily understood if it be remembered that the cholera bacillus may grow outside the body. The number of cases in which epidemics of cholera have been traced to the use of drinking-water contaminated with the discharges from cholera patients is now considerable. The more organic matter present, the greater is the virulence of water so contaminated; and the addition of such water to milk has, in one instance at least, led to an outbreak. If cholera dejecta be sprinkled on moist soil or damp linen, and kept at blood-heat, the bacillus multiplies at an enormous rate in the first twenty-four or thirty-six hours; but, as seen in the Dunbar-Schottelius method, at the end of three or four days it is gradually overcome by the other bacteria present, which, growing strongly and asserting themselves, cause it to die out. The importance of this saprophytic growth in the propagation of the disease can scarcely be over-estimated. Water which contains an ordinary amount of organic and inorganic matter in solution does not allow of the multiplication of this organism, which may soon die out; but when organic matter is present in excess, as at the margin of stagnant pools and tanks, development occurs, especially on the floating solid particles. This bacillus grows at a temperature of 30° C. on meat, eggs, vegetables, and moistened bread; also on cheese, coffee, chocolate, and dilute sugar solutions. In some experiments carried out by Cartwright Wood and the writer in connexion with the passage of the cholera organism through filters, it remained alive in the charcoal filtering medium for a period of at least forty-two days, and probably for a couple of months. It must be remembered that cholera bacilli are gradually overcome by other organisms, as only in this way can the immunity enjoyed by certain regions, even after the water and soil have been contaminated, provided that no fresh supply is brought in "to relight the torch," be explained. In most of the regions in which cholera remains endemic the wells are merely dug-out pits beneath the slightly-raised houses, and are open for the reception of sewage and excreta at all times. These dejecta contain organic material which serves as a nutriment on which infective organisms, derived from the soil and ground-water, may flourish. Not only dejecta, but also the rinsings from soiled linen and utensils used by cholera patients, should be removed as soon as possible, "without allowing them to come into contact with the surface of the soil, with wells," or with vegetables and the like. The discovery of Koch's comma bacillus has so altered our conceptions of the ætiology of this disease, that we now study the conditions under which the bacillus can multiply and be disseminated, instead of concerning ourselves with the cholera itself as some definite entity. Telluric agencies merely become secondary factors, the dissemination of the disease by winds from country to country is no longer regarded as being possible, whilst the spread of cholera epidemics along the lines of human intercourse and travel is now recognized. The virulent bacillus requires the human organism to carry it from those localities in which it is endemic to those in which epidemics occur. The epidemiologist has come to look upon the study of the cholera organism and the conditions under which it exists as of more importance than mere local conditions, which are only important in so far as they contribute to the propagation and distribution of the cholera bacillus, and he knows that the only means of preventing its spread is the careful inspection of everything coming from cholera-stricken regions. He also recognizes that the herding together of people of depressed vitality, under unhygienic and often filthy conditions, in quarantine stations or ships, is one of the surest means of promoting an epidemic of the disease; that attention should be confined to the careful isolation of all patients, and to the disinfection of articles of clothing, feeding utensils, and the like; that the comma bacillus can only be driven out of rooms by means of light and fresh air; that thorough personal, culinary, and household cleanliness is necessary; that all water except that known to be pure should be carefully boiled; and that all excess, both in eating and drinking, should be avoided. The object of the physician in such cases must be, first, to isolate as completely as possible all his cholera patients, and then to get rid of all predisposing causes in the patients themselves, causes which have already been indicated in connexion with the ætiology of the disease.

Attention has frequently been drawn to the fact that patients who have lived for some time in a cholera region, or who have already suffered from an attack of cholera, appear to enjoy a partial immunity against the disease. Haffkine, working on the assumption that the symptoms of cholera are produced by a toxin formed by the cholera organism, came to the conclusion that, by introducing first a modified and then a more virulent poison directly into the tissues under the skin, and not into the alimentary canal, it would be possible to obtain a certain insusceptibility to the action of this poison. He found that for this purpose the cholera bacillus, as ordinarily obtained in pure culture from the intestinal canal, is too potent for the preliminary inoculation, but is not sufficiently active for the second, if any marked protection is to be obtained. By allowing the organism to grow in a well-aërated culture the virulence is gradually diminished, and this virulence, once abolished, does not return even when numerous successive cultures are made on agar or other nutrient media. On the other hand, by passing the cholera bacillus successively through the peritoneal cavities of a series of about thirty guinea-pigs, he obtains a virus of great activity; this activity is soon lost on agar cultivations, and it is necessary from time to time again to pass the bacillus through guinea-pigs, three or four passages now being sufficient to reinforce the activity.

From these two cultures the vaccines are prepared as follows:—The surface of a slant agar tube is smeared with the modified cholera organism. After this has been allowed to grow for twenty-four hours, a small quantity of sterile water is poured into the tube, and the surface-growth is carefully scraped off and made into an emulsion in the water; this is then poured off, and the process is repeated until the whole of the growth has been removed. The mixture is made up with water to a bulk of 8 c.c., so that if 1 c.c. is injected the patient receives $\frac{1}{8}$ of a surface-growth; it is found that this quantity, when injected subcutaneously into a guinea-pig, gives a distinct reaction, but does not cause necrosis of the tissues. If the vaccine is to be kept for any length of time, the emulsion is made with 0·5 per cent. carbolic acid solution, prepared with carefully sterilized water, and the mixture is made up to 6 c.c. instead of 8 c.c., since the carbolic acid appears to interfere slightly with the activity of the virus. The stronger virus is prepared in exactly the same way. The preliminary injection, which is made in the left flank, is followed by a rise in temperature and by local reaction. After three or four hours there is noticeable swelling and some pain; and after ten hours a rise in temperature, usually not very marked, occurs. These signs soon disappear, and at the end of three or four days the second injection is made, usually on the opposite side. This is also followed by a rise of temperature, by swelling, pain and local redness: these, however, as before, soon pass off, and leave no ill effects behind. A guinea-pig treated in this fashion is now immune against some eight or ten times the lethal dose of cholera poison, and, from all statistics that can be obtained, a similar protection is conferred upon the human being.

Evidence has been collected that spirilla, almost identical in appearance with the cholera bacillus, may be present in water and in healthy stools, and that it is in many cases almost impossible to diagnose between these and the cholera bacillus; but although these spirilla may interfere with the diagnosis, they do not invalidate Koch's main contention, that a special form of the comma bacillus, which gives a *complete group* of reactions, is the cause of this disease, especially when these reactions are met with in an organism *that comes from the human intestine.*

Typhoid Fever. — Our information concerning the ætiology of typhoid fever was largely increased during the last twenty years of the 19th century. In 1880 Eberth and Klebs independently, and in 1882 Coats, described a bacillus which has since been found to be intimately associated with typhoid fever. This organism (Fig. 4, Plate VIII.) usually appears in the form of a short bacillus from 2 to 3μ in length and 0·3 to $0{\cdot}5\mu$ in breadth; it has slightly rounded ends and is stained at the poles; it may also occur as a somewhat longer rod more equally stained throughout. Surrounding the young organism are numerous long and well-formed flagella, which give it a very characteristic appearance under the microscope. At present there is no evidence that the typhoid bacillus forms spores. These bacilli are found in the adenoid follicles or lymphatic tissues of the intestine, in the mesenteric glands, in the spleen, liver, and kidneys, and may also be detected even in the small lymphoid masses in the lung, and in the post-typhoid abscesses formed in the bones, kidneys, or other parts of the body; indeed, it is probable that they were first seen by von Recklinghausen in 1871 in such abscesses. They undoubtedly occur in the dejecta of patients suffering from typhoid fever, whilst in recent years it has been demonstrated that they may also be found in the urine. It is evident, therefore, that the urine, as well as the fæces, may be the vehicle by means of which the disease has been unwittingly spread in certain otherwise inexplicable outbreaks of typhoid fever, especially as the bacillus may be present in the urine when the acute stage of the disease has gone by, and when it has been assumed that, as the patient is convalescent, he is no longer a focus from which the infection may be spread. There can be little doubt that typhoid bacilli are not, as is very frequently assumed, present merely in the lymphatic glands and in the spleen (Fig. 5, Plate VIII.): they may be found in almost any part of the lymphatic system, in lymph spaces, in the connective tissues, where they appear to give rise to marked proliferation of the endothelial cells, and especially in the various secreting organs. It is probable that the proliferation often noticed in the minute portal spaces in the liver, in cases of typhoid fever, is simply a type of a similar proliferation going on in other parts and tissues of the body. It was for long assumed that the typhoid bacillus could multiply freely in water, but recent experiments appear to indicate that this is not the case, unless a much larger quantity of soluble organic matter is present than is usually met with in water. The fact, however, that the organism may remain alive in water is of great importance; and, as in the case of cholera, it must be recognized that certain of the great epidemics of typhoid or enteric fever have been the result of "water-borne infection." The bacillus, a facultative parasite, grows outside the body, with somewhat characteristic appearances and reactions: it flourishes specially well on a slightly acid medium; in the presence of putrefactive organisms which develop strongly alkaline products it may gradually die out, but it appears to retain its vitality longer in the presence of acid-forming organisms. It may, however, be stated generally, that after a time the typhoid bacillus becomes weakened, and may even die out, in the presence of rapidly-growing putrefactive organisms. In distilled water it may remain alive for a considerable period—five or six weeks, or even longer. It grows on all the ordinary nutrient media.

It does not coagulate milk; hence it may grow luxuriantly in that medium without giving rise to any alteration in that fluid: milk, therefore, is a specially dangerous vehicle for its dissemination. When inoculated on potato, careful examination will reveal the fact that certain almost invisible moist patches are present; these are made up of rapidly-multiplying typhoid bacilli. The typhoid bacillus grows in gelatin, especially on the surface, somewhat like the bacillus coli communis, but with a less luxuriant growth. This organism, when taken from young broth cultures twelve to twenty-four hours old —during the period at which flagella are best seen— and examined microscopically, exhibits very lively movements. When, as pointed out by Gruber and Durham, blood-serum, in certain dilutions, from a case of typhoid fever is added to such a culture, the broth, at first turbid, owing to the suspended and moving micro-organisms, gradually becomes clear, and a deposit is formed which is found to be made up of masses or clumps of typhoid bacilli which have lost their motility. This reaction is so characteristic and definite, that when the mixture is kept under examination under the microscope, it is quite possible to follow the slowing-down and massing together of the organisms. It is found, moreover, that normal diluted blood-serum has no such effect on the bacilli. This property of the blood-serum is acquired at such an early date of the disease—sometimes even at the end of the first week—and occurs with such regularity, that typhoid fever may now actually be diagnosed by the presence or absence of this "agglutinating" property in the blood. If serum taken from a patient supposed to be suffering from typhoid fever, and diluted with saline solution to 1 in 10, to 1 in 50, or in still greater dilution, causes the bacilli to lose their motility and to become aggregated into clumps within an hour, it may be concluded that the patient is suffering from typhoid fever; if this agglutination be not obtained with a dilution of 1 in 10, in from 15 to 30 minutes, experience has shown that the patient is not suffering from this disease. Certain other diseases, such as cholera, give a similar specific serum reaction with their specific organisms. These sera have, in addition, a slight common action—a general agglutinating power— which, however, is not manifested except in concentrated solutions, the higher dilutions failing to give any clumping action at all, except with the specific bacillus associated with the disease from which the patient from whom the serum is taken is suffering.

Mediterranean or Malta Fever.—Until recently, Mediterranean Fever was looked upon as a form of typhoid fever, which in certain respects it resembles; the temperature curve, however, has a more undulatory character, except in the malignant type, where the temperature remains high throughout the course of the attack. According to Hughes, this disease is widely distributed in the countries bordering upon the Mediterranean south of latitude 46° N., and along the Red Sea littoral. Analogous forms of fever giving a "specific" serum reaction with the micrococcus of this disease are also met with in parts of India, China, Africa, and America.

The *Micrococcus melitensis vel Brucei*, which is found most abundantly in the enlarged spleen of the patient suffering from Malta fever, is a very minute organism ($0 \cdot 33\mu$ in diameter), ovoid or nearly round, arranged in pairs or in very short chains (Fig. 6, Plate VII.). If a drop of the blood taken directly from the spleen be smeared over the surface of agar nutrient medium, minute transparent colourless colonies appear; in thirty-six hours these have a slight amber tinge, and in four or five days from their first appearance they become opaque. These colonies, which flourish at the temperature of the human blood, cease to grow at the room-temperature except in summer; and if kept moist, soon die at anything below 60° F., though when dried they retain their vitality for some time. They cause opacity of broth at the end of five or six days, forming a precipitate with a comparatively clear supernatant fluid. They grow best on media slightly less alkaline than human blood.

This organism is distinctly pathogenetic to monkeys, and its virulence may be so increased that other animals may be affected by it. Though unable to live in clean or virgin soil, it may lead a saprophytic existence in soil polluted with fæcal matter. Hughes maintains that the "virus" usually enters the body with inspired air, and leaves it with the fæces and urine; it seldom appears to be carried for any considerable distance. He divides this fever into three types. In the malignant form the onset is sudden, there are headache, racking pain over the whole body, nausea, and sometimes vomiting; the tongue is foul, coated, and swollen, and the breath very offensive; the temperature may continue for some time at 103° to 105° F. The stools in the diarrhœa which is sometimes present may be most offensive. At the end of a few days the lungs become congested and pneumonic, the pulse weak, hyperpyrexia appears, and death ensues. A second type, by far the most common, is the "undulatory" type, in which there is remittent pyrexia, separated by periods in which the patient appears to be improving. These pyrexial curves, from one to seven in number, average about ten days each, the first being the longest, eighteen to twenty-three days. In an intermittent type, in which the temperature-curve closely resembles the hectic pyrexial curve of phthisis or suppuration, the "undulatory" character is also marked. A considerable number of toxic symptoms make their appearance — localized neuritis, synovitis, anæmia, emaciation, bronchial catarrh, weakness of the heart, neuralgia, profuse night sweats, and similar conditions. Patients otherwise healthy usually recover, even after prolonged attacks of the disease, but the mortality amongst patients suffering from organic mischief of any kind may be comparatively high. The diagnosis from malaria, phthisis, rheumatic affections, and pneumonia may in most cases be made fairly easily, but the serum reaction with cultures of the micrococcus melitensis, corresponding to the typhoid reaction with the typhoid bacillus, is sometimes the only trustworthy diagnostic feature between this fever and the above-mentioned diseases. The best preventive measures are: the avoidance of chills, good drainage, and disinfection of stools and urine from the patients affected, so as to stop pollution of the soil.

Relapsing Fever.—The specific cause of relapsing fever (famine fever) appears to be the Spirillum Obermeieri, an organism which occurs in the blood of patients suffering from this disease (during the febrile stages). Between the febrile stages are periods of intermission, during which the spirillum disappears from the blood and apparently retires to the spleen. This disease, in epidemic form, follows in the footsteps of famine and destitution, specially affecting young people between the ages of fifteen and twenty; it seldom attacks children under five years of age, but in patients over thirty it assumes a more virulent form. In monkeys inoculated with blood containing the Spirillum Obermeieri the first symptoms appear between the second and sixth days. In the human subject this incubation period may last as long as three weeks; then comes an attack of fever, which continues for about a week, and is followed by a similar period of apparent convalescence, on which ensues a pyrexial relapse, continuing about half as long as the first. The spirilla, the cause of this disease, are fine spirals with pointed ends, three or four times as long as the diameter of a red blood corpuscle. Although it has as yet been found impossible to cultivate these spirilla outside the body, human beings, and monkeys injected with blood containing them, contract the disease; and in monkeys it has been found that during the period before the relapse the spirilla have made their way into the cells of the spleen. As yet little is known as to the mode of development of these organisms, and of the method of their transmission from one patient to another, but it is thought that, as in the case of malaria and the tsetse-fly disease, they may be carried by bloodsucking insects. Relapsing fever is distinguished from typhoid by its sudden onset, and by the distinct intermissions; and from influenza by the enlargement of the spleen and liver. The most satisfactory method of diagnosis is the examination of the blood for the presence of the spirillum during the febrile period. The *post-mortem* appearances are those of a toxic (bacterial) poisoning. Curious infarction-like masses, in which are numerous spirilla, are found in the spleen; in the liver there is evidence of acute interstitial hepatitis, with cloudy swelling of the liver cells; and similar changes occur in the kidney. Fatty degeneration of the heart and voluntary muscles may also be met with.

Plague.—During recent years opportunities for the study of plague have unfortunately been only too numerous. In patients suffering from this disease, a micro-organism, capable of leading either a saprophytic life or a parasitic existence in the human body, and in some of the lower animals, was described independently by Kitasato and by Yersin, in 1894, in Hong Kong. It is a short, moderately thick bacillus, with rounded ends, which stain deeply, leaving a clear band in the centre (Fig. 7, Plate VIII.). It thus resembles the short diphtheria bacillus and the influenza bacillus. Certain other forms are met with, but the above is the most characteristic. It grows readily on most media at the temperature of the body, but, like the glanders bacillus, soon loses its virulence in cultivations. It may be obtained in pure cultures from the lymph glands, and from the abscesses that are formed in the groin or other positions in which the glands become enlarged and softened. It may also be found in the spleen and in the blood, and, in the case of patients suffering from the pneumonic form of the disease, even in the lungs and in the sputum. It has also been found in the fæces and urine. (It is very important that these excretions from plague patients should always be most carefully disinfected.) This organism, when obtained in pure culture and inoculated into rats, mice, guinea-pigs, or rabbits, produces exactly the same symptoms as does material taken fresh from the softened glands. The symptoms are local swelling, enlargement and softening of the lymphatic glands, and high fever. The fact that rats are susceptible to the disease is one of peculiar significance, as these animals by their habits have special facilities for carrying the plague bacillus from point to point, and thus of spreading the infection very rapidly. It has been noticed that large numbers of rats succumb to plague before the disease assumes the epidemic form; and in Bombay, at an early period of the last outbreak, it was almost impossible to obtain a rat on which to carry out experiments for the purpose of determining whether the organism was really the plague bacillus or not. In India, where the notions of cleanliness are somewhat different from those recognized in Great Britain, most of the conditions favourable to the spread of the plague bacillus are of the most perfect character. This organism may pass into the soil with fæces; it may there remain for some time, and then be taken into the body of one of the lower animals, or of man, and give rise to a fresh outbreak. Kitasato and Yersin were both able to prove that soil and dust from infected houses contain the bacillus, that such bacillus is capable of inducing an attack of plague in the lower animals, and that flies fed on the dejecta or other bacillus-containing material, die, and in turn contain bacilli which are capable of setting up infection. Hankin claims that ants, and Simonds that fleas, may carry the plague to and from rats, and so to the human being. It has already been mentioned that the organism rapidly loses its virulence when cultivated outside the body; on the other hand, on being passed through a series of animals its virulence gradually increases. Thus may be explained the fact that in most outbreaks of plague there is an early period during which the death-rate is very low; after a time the percentage mortality is enormously increased, the virulence of the disease being very great and its course rapid. There seem to be notable differences in the degree of susceptibility of different races and different individuals, and those who have passed safely through an attack appear to have acquired a marked degree of immunity. Two methods of treatment, both of which seem to have been attended with a certain degree of success, are now being tried. Haffkine, applying his inoculation method (first used with cholera) to plague, appears to have produced a certain active immunity, inoculated patients becoming less susceptible to the action of the plague bacillus. This method of treatment, however, is of no use in the case of patients already attacked; for such cases Yersin has used a serum taken from horses into which graduated and systematic injections of the plague bacillus and its products have been made. This "antipest" serum, it is claimed, has induced a favourable turn in the disease in cases which otherwise must inevitably have succumbed.

Pneumonia.—The case in favour of acute lobar pneumonia being an infective disease was a very strong one, even before it was possible to show that a special organism bore any ætiological relation to it. In 1880, Friedländer claimed that he had isolated such an organism, but the pneumobacillus then described appears to be inactive as compared with the pneumococcus isolated by Fraenkel and Talamon. This latter organism, which is usually found in the sputum, is an encapsuled diplococcus (Fig. 8, Plate VII.). Grown on serum or agar over which sterile blood has been smeared, it occurs as minute, glistening, rather prominent points, almost like a fine spray of water or dew. When the organism is cultivated in broth the capsule disappears, and chains of diplococci are seen. It resembles the influenza bacillus in a most remarkable manner. It may be found, in almost every case of pneumonia, in the "rusty" or "prune-juice" sputum. Injected into rabbits, it produces death with very great certainty; and by passing the organism through these animals its virulence may be markedly increased. Like the influenza bacillus and even the diphtheria bacillus, this organism may be present in the mouth and lungs of perfectly healthy individuals, and it is only when the vitality of the system is lowered by cold or other depressing influences that pneumonia is induced; two factors, the presence of the bacillus and the lowered vitality, being both necessary for the production of this disease in the human subject. It is quite possible, however, that, as in the case of cholera, a slight inflammatory exudation may supply a nutrient medium in which the bacillus rapidly acquires greatly increased virulence, and so becomes a much more active agent of infection.

It is claimed by the brothers Klemperer, by Washbourn, and by others, that they have been able to produce an anti-pneumococcic serum, by means of which they are able to treat successfully severe cases of pneumonia. The catarrhal pneumonia so frequently met with during the course of whooping-cough, measles, and other specific infective fevers, is also in all probability due to the action of some organism of which the influenza bacillus and the diplococcus pneumoniæ are types.

Infective meningitis is, in most of the recent works on medicine, divided into four forms: (1) the acute epidemic cerebro-spinal form; (2) a posterior basic form, which, however, is closely allied to the first; (3) suppurative meningitis, usually associated with pneumonia, erysipelas, and pyæmia; and (4) tubercular meningitis, due to the specific tubercle bacillus.

(1) The first form is usually associated with Weichselbaum's *diplococcus intracellularis meningitidis* (two closely-apposed discs), which is found in the purulent exudate, especially in the leucocytes, of the meninges of the brain and cord. It grows, as transparent colonies, on blood-agar at the temperature of the body, but dies out very rapidly unless reinoculated, and has little pathogenetic effect on the lower animals, though under certain conditions it has been found to produce meningitis when injected under the dura mater. (2) *Posterior-basic meningitis*, according to Dr Still, "is frequently seen during the first six months of life, a period at which tuberculous and epidemic cerebro-spinal meningitis are quite uncommon." The organism found in this disease resembles very closely the *diplococcus intracellularis meningitidis*, but differs from it in that it remains alive without recultivation for a considerably longer period. It is less pathogenetic than that organism, of which possibly it is simply a more highly saprophytic form. This is a somewhat important point, as it would account for the great resemblance that exists between the sporadic and the epidemic forms of meningitis. (3) In *suppurative meningitis* these two organisms may still be found in a certain proportion of the cases, but their place may be taken by the pneumococcus or diplococcus pneumoniæ or Fraenkel's pneumococcus—diplococcus lanceolatus—which appears to grow in two forms. In the first it is an encapsulated organism, consisting of small oval cocci arranged in pairs or in short chains; the capsule is unstained. When the pneumococcus grows in chains—the second form—as when cultivated outside the body, on blood-serum or on agar over the surface of which a small quantity of sterile blood has been smeared, it produces very minute translucent colonies. Like Weichselbaum's bacillus, it must be recultivated every three or four days, otherwise it soon dies out. Unlike the other forms previously described, it may, when passed through animals, become extremely virulent, very small quantities being sufficient to kill a rabbit. Although the pneumococcus is found in the majority of these cases, especially in children, suppurative meningitis may also accompany or follow the various diseases that are set up by the streptococcus pyogenes and streptococcus erysipelatis; whilst along with it staphylococci and the bacillus coli communis have sometimes been found. In other cases, again, there is a mixed infection of the pneumococcus and the streptococcus pyogenes, especially in cases of disease of the middle ear. As might be expected in meningitis occurring in connexion with the specific infective diseases, *e.g.*, influenza and typhoid fever, the presence of the specific bacilli of these diseases may usually be demonstrated in the meningeal pus or fluid. (4) The fourth form, *tubercular meningitis* (acute hydrocephalus), is met with most frequently in young children. It is now generally accepted that this condition is the result of the introduction of the tubercle bacillus into the blood-vessels and lymph spaces of the meninges at the base of the brain, and along the fissures of Sylvius.

Influenza.—From 1889 up to the present time, influenza has every year with unfailing regularity broken out in epidemic form in some part of the United Kingdom, and often has swept over the whole country. The fact that the period of incubation is short, and that the infective agent is extremely active at a very early stage of the disease, renders it one of the most rapidly-spreading maladies with which we have to deal. The infective agent, first observed by Pfeiffer and Canon, is a minute bacillus or diplococcus less than 1μ in length and $0{\cdot}5\mu$ in thickness; it is found in little groups or in pairs. Each diplococcus is stained at the poles, a clear band remaining in the middle; in this respect it resembles the plague bacillus. It is found in the blood—though here it seems to be comparatively inactive—and in enormous numbers in the bronchial mucus. It is not easily stained in a solution of carbol-fuchsin, but in some cases such numbers are present that a cover-glass preparation may show practically no other organisms. Agar, smeared with blood and inoculated, gives an almost pure cultivation of very minute transparent colonies, similar to those of the diplococcus pneumoniæ, but as a rule somewhat smaller. This organism, found only in cases of influenza, appears to have the power of forming toxins which continue to act for some time after recovery seems to have taken place; it appears to exert such a general devitalizing effect on the tissues, that micro-organisms which ordinarily are held in check are allowed to become active, with the result that catarrh, pneumonia, and similar conditions are developed, especially when cold and other lowering conditions co-operate with the poison. This toxin produces special results in those organs which, through over-use, impaired nutrition, or disease, are already only just able to carry on their work. Hence in cases of influenza the cause of death is usually associated with the failure of some organ that had already been working up to its full capacity, and in which the margin of reserve power had been reduced to a minimum. It is for this reason that rest, nutrition, warmth, and tonics are such important and successful factors in treatment.

Yellow Fever, endemic in the West Indies and the north-eastern coasts of South America, may become epidemic wherever the temperature and humidity are high, especially along the seashore in the tropical Atlantic coast of North America. It appears to be one of the specific infective fevers in which the liver, kidney, and gastro-intestinal systems, and especially their blood-vessels, are affected. In 1897, Sanarelli reported, in the *Annales de l'Institut Pasteur*, that he had found a bacillus in the blood-vessels of the liver and kidneys, and in the cells of the peritoneal fluid, but never in the alimentary tract, of yellow fever patients. These, he maintained, were perfectly distinct from the putrefactive microbes occurring in the tissues in the later stages, their colonies not growing like those of the bacillus coli communis. They grow readily on all the ordinary artificial nutrient media, as short rods with rounded ends, usually about 2 to 4μ in length and about half as broad as they are long. They are stained by Gram's method and readily by most of the aniline dyes, are ciliated, and do not liquefy gelatin. They flourish specially well alongside moulds, in the dark, in badly-ventilated, warm, moist places, and remain alive for some time in sea-water: these facts, as Sanarelli points out, afford an explanation of the special persistence of yellow fever in old, badly-ventilated ships, and in dark, dirty, and insanitary seacoast towns. Once the organism, whatever it may be, finds its way into the system, it soon makes its presence felt, and toxic symptoms are developed. The temperature rises; the pulse, at first rapid, gradually slows down; and after some time persistent vomiting of bile comes on. At the end of three or four days the temperature and pulse fall, and there is a period during which the patient appears comparatively well; this is followed in a few hours by icterus and scanty secretion of urine. There may be actual anuria, or the small quantity of urine passed may be loaded with casts and albumen; delirium, convulsions, and hæmorrhages from all the mucous surfaces may now set in, or secondary infections of various kinds, boils, abscesses, suppurations, and septicæmia, may result. These often prove fatal when the patient appears to be almost convalescent from the original disease. As regards prognosis, it has been found that the "lower the initial temperature the milder will the case be" (Macpherson). An initial temperature of 106° F. is an exceedingly unfavourable sign. Patients addicted to the use of alcohol are, as a rule, much more severely affected than are others. The treatment is principally directed towards prevention and towards the alleviation of symptoms, though Sanarelli has hopes that an "anti"-serum may be useful. More recently Flexner, working with the American Commission, has isolated another organism, which, he maintains, is the pathogenetic agent in the production of yellow fever; whilst Durham and Myers maintain that a small bacillus previously observed by Sternberg and others is the true cause of this disease.

Weil's disease, a disease which may be considered along with acute yellow atrophy and yellow fever, is one in which there is an acute febrile condition, associated with jaundice, inflammation of the kidney, and enlargement of the spleen. It appears to be a toxic condition of a less acute character, however, than the other two, in which the functions and structure of the liver and kidney are specially interfered with. There is a marked affection of the gastro-intestinal system, and the nervous system is also in some cases profoundly involved. Hæmorrhage into the mucous and serous membranes is a marked feature. The liver cells and kidney epithelium undergo fatty changes, though in the earlier stages there is a cloudy swelling, probably also toxic in its origin. Certain organisms of the Proteus group, which appear to have the power in certain circumstances of forming toxic substances in larger quantities than can be readily destroyed by the liver, and which then make their appearance in the kidney and spleen, are supposed to be the cause of this condition.

Diphtheria.—In regard to no disease has medical opinion undergone greater modification than it has in respect of diphtheria. Accurately applied, bacteriology has here gained one of its greatest triumphs. Not only have the ætiology and diagnosis of this disease been made clear, but knowledge acquired in connexion with the production of the disease has been applied to a most successful method of its treatment. In 1875, Klebs described a small bacillus with rounded ends, and with here and there small clear unstained spaces in its substance. He, however, also described streptococci as present in certain cases of diphtheria, and concluded that there must be two kinds of diphtheria, one associated with each of these organisms. In 1883 he again took up the question; and in the following year Loeffler gave a systematic description of what is now known as the Klebs-Loeffler bacillus, which was afterwards proved by Roux and Yersin and many other observers to be the *causa causans* of diphtheria. This bacillus is a slightly-curved rod with rounded, pointed, or club-shaped end or ends (Fig. 9, Plate VIII.[1]). It is usually from 1·2 to 5μ or more in length and from 0·3 to 0·5μ in breadth; rarely it may be considerably larger in both dimensions. It is non-motile, and may exhibit great variety of form, according to the age of the culture and the nature of the medium upon which it is growing. It is stained by Gram's method if the decolorizing process be not too prolonged, and also by Loeffler's methylene-blue method. Except in the very young forms, it is readily recognizable by a series of transverse alternate stained and unstained bands. The bacillus may be wedge-shaped, spindle-shaped, comma-shaped, or ovoid. In the shorter forms the polar staining is usually well marked; in the longer bacilli, the transverse striation. Very characteristic club-shaped forms or branching filaments are met with in old cultures, or where there is a superabundance of nutritive material. In what may be called the handle of the club the banded appearance is specially well marked. These specific bacilli are found in large numbers on the surface of the diphtheritic membrane (Fig. 10, Plate VIII.[1]), and may easily be detached for bacteriological examination. In certain cases they may be found by direct microscopic examination, especially when they are stained by Gram's method, but it is far more easy to demonstrate their presence by the culture method. On Loeffler's special medium the bacilli flourish so well at body-temperature—about 37° C.—that, like the cholera bacillus, they outgrow the other organisms present, and may be obtained in comparatively pure culture. Distinct colonies may often be found as early as the eighth or twelfth hour of incubation; in from eighteen to twenty-four hours they appear as rounded, elevated, moderately translucent, greyish white colonies, with a yellow tinge, the surface moist, and the margins slightly irregular or scalloped. They are thicker and somewhat more opaque in the centre. When the colonies are few and widely separated, each may grow to a considerable size, 4 to 5 mm.; but when more numerous and closer together, they remain small and almost invariably discrete, with distinct intervals between them. In older growths the central opacity becomes more marked and the crenation more distinct, the moist, shiny appearance being lost. When the surface of the serum is dry, the growth, as a rule, does not attain any very large size.

These "pure" colonies, when sown in slightly alkaline broth, grow with great vigour; and if a small amount of such a forty-eight hours' culture be injected under the skin of a guinea-pig, the animal succumbs, with a marked local reaction and distinct symptoms of toxic poisoning very similar to those met with in cases of diphtheria of the human subject. Roux and Yersin demonstrated that the poison was not contained in the bodies of the bacilli, but that it was formed and thrown out by them from and into the nutrient medium. Moreover, they could produce all the toxic symptoms, the local reactions, and even the paralysis which often follows the disease in the human subject, by injecting the culture from which they had previously removed the whole of the diphtheria bacilli by filtration. This cultivation, then, contains a poisonous material, which, incapable of multiplying in the tissues, may be given in carefully graduated doses. If, therefore, there is anything in the theory that tissues may be gradually "acclimatized" to the poisons of these toxic substances, they saw that it should be possible to prove it in connexion with this disease. Behring, going still farther, found that the tissues so acclimatized have the power of producing a substance capable of neutralizing the toxin, a substance which, at first confined to the cells, when formed in large quantities overflows into the fluids of the blood,

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[1] REFERENCES TO PLATE VIII.

PARASITIC DISEASES.

FIG. 2.—Streptococcus pyogenes, red blood corpuscles and pus cells in the pus from a case of empyæma. ×1000 diams.
,, 3.—Cholera spirillum, from eight days' agar culture, showing many involution forms. Flagella well stained. ×1000.
,, 4.—Bacillus typhi abdominalis (typhoid bacillus), with well-stained flagella. Young agar cultivation. ×1000.
,, 5.—Group of typhoid bacilli, in a section of spleen. ×1000.
,, 7.—Preparation from young cultivation of Bacillus pestis (plague bacillus). Flagella well stained. ×1000.
,, 9.—Bacillus diphtheriæ, from twenty-four hours' culture. ×1000.
,, 10.—Free edge of false membrane from case of diphtheria containing numerous diphtheria bacilli. ×1000.
,, 11.—Bacillus tetani, with well-stained flagella. Twenty-four hours' culture. ×1000.
,, 12.—Scraping from a wound in a case of tetanus, showing several spore-bearing and a few non-spore-bearing tetanus bacilli. ×1000.
,, 15.—Bacillus tuberculosis. Bacilli in a giant-cell in the human liver in a case of acute tuberculosis. ×1000.
,, 16.—Bacillus lepræ. Bacilli in endothelial cells of splenic tissue. ×1000.
,, 19.—Amœbæ in wall of dysenteric abscess of liver, from a specimen kindly lent by Professor Greenfield. ×1000.

with which it is distributed throughout the body. The bulk of this toxin-neutralizing substance remains in the blood-serum after separation of the clot. In proof of this he showed that (1) if this serum be injected into an animal before it is inoculated with even more than a lethal dose of the diphtheria bacillus or its products, the animal remains perfectly well; (2) a certain quantity of this serum, mixed with diphtheria toxin and injected into a guinea-pig, gives rise to no ill effects; and (3) that even when injected some hours after the bacillus or its toxins, the serum is still capable of neutralizing the action of these substances. In these experiments we have the germ of the present antitoxic treatment which has so materially diminished the percentage mortality in diphtheria. This serum may also be used as a prophylactic agent.

The antitoxic serum as now used is prepared by injecting into the subcutaneous tissues of a horse the products of the diphtheria bacillus. The bacillus, grown in broth containing peptone and blood-serum or blood-plasma, is filtered and heated to a temperature of 68° or 70° C. for one hour. It then contains only a small amount of active toxin, but it renders the horse highly insusceptible to the action of strong diphtheria toxins, and even induces the production of a considerable amount of antitoxin. This production of antitoxin, however, may be accelerated by repeated and increasing injections of strong diphtheria toxin, which may be so powerful that $\frac{1}{4}$ to $\frac{1}{5}$ of a drop, or even less, is a fatal dose for a medium-sized guinea-pig. The antitoxic serum so prepared may contain 200, 400, 600, or even more "units" of antitoxin per c.c.—the unit being that quantity of antitoxin that will so far neutralize 100 lethal doses (a lethal dose is the smallest quantity that will kill a 250-gramme guinea-pig on the fifth day) of toxin for a 250-gramme guinea-pig, that the animal continues alive on the fifth day from the injection. This, however, is a purely arbitrary standard of neutralizing power, as it is found that, owing to the complicated structure of the toxin, the neutralizing and the lethal powers do not always go hand in hand; but as the toxin used in testing the antitoxin is always compared with the original standard, accurate results are easily obtained.

Diphtheria, though still prevalent in cities, has now lost many of its terrors. In large hospitals the death-rate has fallen from nearly 40 per cent. to under 14 per cent.; and if antitoxin could be given as soon as the disease manifests itself, the mortality might be brought down to a very insignificant figure. It has been maintained that as soon as antitoxin came into use the number of cases of paralysis increased rather than diminished. This may be readily understood when it is borne in mind that many patients recover under the use of antitoxin who would undoubtedly have succumbed in the pre-antitoxin days; and it cannot be too strongly insisted, that although the antitoxin introduced neutralizes the free toxin and prevents its further action on the tissues, it cannot entirely neutralize that which is already acting on the cells, nor can it make good damage already done before it is injected. Even allowing that antitoxin is not accountable for the whole of the improvement in the percentage mortality statistics since 1896 or so, it has undoubtedly accounted for a very large proportion of recoveries. Antitoxin often cuts short functional albuminuria, but it cannot repair damage already done to the renal epithelium before the antitoxin was given. The clinical evidence of the value of antitoxin in the relief that it affords to the patient is even greater than that derived from the consideration of statistics.

The diphtheria bacillus or its poison acts locally as a caustic and irritant, and generally or constitutionally as a protoplasmic poison, the most evident lesions produced by it being degeneration of nerves and muscles, and in acute cases changes in the walls of the blood-vessels. Other organisms, streptococci or staphylococci, when present, may undoubtedly increase the mortality by producing secondary complications, which end in suppuration. Diphtheria bacilli may also be found in pus, as in the discharges from cases of otorrhœa.

Tetanus (*Lockjaw*).—Although tetanus was one of the last of the diseases to which a definite micro-organismal origin could be assigned, it has long been looked upon as a disease typical of the "septic" group. Nicolaier described in 1885 an organism multiplying outside the body and capable of setting up tetanus, but this was only obtained in pure culture by Kitasato, a Japanese, and by the Italians in 1889. It has a very characteristic series of appearances at different stages of its development. It grows first of all as long, very slender threads, which rapidly break up into shorter sections from 4 to 5μ in length (Fig. 12, Plate VIII.). In these shorter rods spores may appear on the second or up to the seventh day, according to the temperature at which the growth goes on. The rods then assume a very characteristic pin or drum-stick form; they are non-motile, are somewhat rounded at the ends, and at one end the spore, which is of considerably greater diameter than the rod, causes a very considerable expansion. Before sporulation the organisms are distinctly motile, occurring in rods of different lengths, in most cases surrounded by bundles of beautiful flagella, which at a later stage are thrown off, the presence of flagella corresponding very closely with the "motile" period (Fig. 11, Plate VIII.). The bacillus grows best at the temperature of the body; it becomes inactive at 14° C. at the one extreme, and at from 42° to 43° C. at the other; in the latter case involution forms, clubs and branching and degenerated forms, often make their appearance. It is killed by exposure for an hour to a temperature of from 60° to 65° C.; but the spores are very resistent to the action of heat, as they withstand the temperature of boiling water for several minutes. The organism has been found in garden earth, in the excrement of animals—especially horses—and in dust taken from the streets or from living-rooms, especially when it has been allowed to remain at rest for a considerable period. It has also been demonstrated in, and separated from, the pus of wounds (Fig. 12, Plate VIII.) in patients suffering from lockjaw, though it is then invariably found associated with the micro-organisms that give rise to suppuration.

It is important to remember that this bacillus is a strict anaërobe, and can only grow when free oxygen has been removed from the cultivation medium. It may be cultivated in gelatin to which has been added from 2 to 3 per cent. of grape-sugar, when, along the line of the stab culture, it forms a delicate growth, almost like a fir-tree, the tip of which never comes quite to the surface of the gelatin. The most luxuriant growth—evidenced by the longest branches—occurs in the depth of the gelatin away from free oxygen. After a time the gelatin becomes sticky, and then undergoes slow liquefaction, the growth sinking and leaving the upper layers comparatively clear. This organism is not an obligate, but a facultative, parasite; it may grow outside the body and remain alive for long periods.

Lockjaw is most common amongst agricultural labourers, gardeners, soldiers on campaign, in those who go about with bare feet, or who, like young children, are liable to get their knees or hands accidentally wounded by contact with the ground. Anything which devitalizes the tissues—such as cold, bruising, malnutrition, the action of other organisms and their products—may all be predisposing factors, in so far as they place the tissue at a disadvantage and allow of the full development of the specific bacillus of tetanus. In order to produce the disease, it is not sufficient merely to inoculate tetanus bacilli, especially where resistent animals are concerned: they must be injected along with some of their toxins or with other organisms, the presence of which seems to increase the power of, or assist, the tetanus organism, by diverting the activity of the cells and so allowing the bacillus to develop. The poison formed by this organism resembles the enzymes and diphtheria poison, in that it is destroyed at a temperature of 65° C. in about five minutes, and even at the temperature of the body soon loses its strength, although, when kept on ice and protected from the action of light, it retains its special properties for months. Though slowly formed, it is tremendously potent, $\frac{1}{2500000}$ part of a drop (the five-millionth part of a c.c.) of the broth in which an active culture has been allowed to grow for three weeks or a month, being sufficient to kill a mouse in twenty-four hours, $\frac{1}{250}$ of a drop killing a rabbit, $\frac{1}{25}$ a dog, or $\frac{1}{10}$ of a drop a fowl or a pigeon; it is from 100 to 400 times as active as strychnine, and 400 times as poisonous as atropine. It has been observed that, quite apart from size, animals exhibit a varying degree of susceptibility. Frogs kept at their ordinary temperature are exceedingly insusceptible, but when they are kept warm it is possible to tetanize them, though only after a somewhat prolonged incubation period, such as is met with in very chronic cases of tetanus in the human subject. In experimentally-produced tetanus the spasms usually commence and are most pronounced in the muscles near the site of inoculation. It was at one time supposed that this was because the poison acted directly upon the nerve terminations, or possibly upon the muscles; but as it is now known that it acts directly on the cells of the central nervous system, it may, as in the case of rabies, find its way along the lymphatic channels of the nerves to those points of the central nervous system with which these nerves are directly connected, spasms occurring in the course of the muscular distribution of the nerves that receive their impulses from the cells of that area. As the amount of toxin introduced may be contained in a very small quantity of fluid and still be very dilute, the local reaction of the connective-tissue cells may be exceedingly slight; consequently a very small wound may allow of the introduction of a strong poisonous dose. Many of the cases of so-called idiopathic tetanus are only idiopathic because the wound is trifling in character, and, unless suppuration has taken place, has healed rapidly after the poison has been introduced. In tetanus, as in diphtheria, the organisms producing the poison, if found in the body at all, are developed only at the seat of inoculation; they do not make their way into the surrounding tissues. In this we have an explanation of the fact that all the earlier experiments with the blood from tetanus patients gave absolutely negative results. It is sometimes stated that the production of tetanus toxin in a wound soon ceases, owing to the arrest of the development of the bacillus, even in cases that ultimately succumb to the disease. Roux and Vaillard, however, maintain that no case of tetanus can be treated with any prospect of success, unless the focus into which the bacilli have been introduced is freely removed. The antitetanic serum was the first antitoxic serum produced. It is found, however, that though the antitetanic serum is capable of acting as a prophylactic, and of preventing the appearance of tetanic symptoms in animals that are afterwards, or simultaneously, injected with tetanus toxin, it does not give very satisfactory results when it is injected after tetanic symptoms have made their appearance. It would appear that in such cases the tetanus poison has become too firmly bound up with the protoplasm of the nerve cells, and has already done a considerable amount of damage.

(b) More Chronic Infective Diseases (tissue parasites).

Tuberculosis.—In no quarter of the field of preventive medicine have more important results accrued from the discovery of a specific infective organism than in the case of Koch's demonstration and separation in pure culture of the tubercle bacillus and the association of this bacillus with the transmission of tuberculosis. In connexion with diagnosis—both directly from observation of the organism in the sputum and urine of tuberculous patients, and indirectly through the tuberculin test, especially on animals—this discovery has been of very great importance; and through a study of the life-history of the bacillus and its relation to animal tissues much has been learned as to the prevention of tuberculosis, and something even as to methods of treatment. One of the great difficulties met with in the earlier periods of study of this organism was its slow, though persistent, growth. At first cultivations in fluid media were not kept sufficiently long under observation to allow of its growth; it was exceedingly difficult to obtain pure cultures, and then to keep them, and in impure cultures the tubercle bacilli were rapidly overgrown. Taken directly from the body, they do not grow on most of the ordinary media, and it was only when Koch used solidified blood-serum that he obtained pure cultures. Though they may now be demonstrated by what appear to be very simple methods, before these methods were devised it was practically impossible to obtain any satisfactory results.

The principle involved in the staining of the tubercle bacillus is that when once it has taken up fuchsin, or gentian violet, it retains the stain much more firmly than do most organisms and tissues, so that if a specimen be thoroughly stained with fuchsin and then decolorized in a mineral acid—25 per cent. of sulphuric acid, say—although the colour is washed out of the tissues and most other organisms, the tubercle bacilli retain it; and even after the section has been stained with methylene-blue, to bring the other tissues and organisms into view, these bacilli still remain bright red, and stand out prominently on a blue background. If a small fragment of tuberculous tissue be pounded in a sterile mortar and smeared over the surface of inspissated blood-serum solidified at a comparatively low temperature, and if evaporation be prevented, dry scaly growths make their appearance at the end of some fourteen days. If these be reinoculated through several generations, they ultimately assume a more saprophytic character, and will grow in broth containing 5 per cent. of glycerin, or on a peptone beef-agar to which a similar quantity of glycerin has been added. On these media the tubercle bacillus grows more luxuriantly, though after a time its virulence appears to be diminished. On blood-serum its virulence is preserved for long periods if successive cultivations are made. It occurs in the tissues or in cultivations as a delicate rod or thread 1·5 to 3·5μ in length and about 0·2 to 0·5μ in thickness (Fig. 15, Plate VIII.). It is usually slightly curved, and two rods may be arranged end to end at an open angle. There is some doubt as to whether tubercle bacilli contain spores, but little masses of deeply-stained protoplasm can be seen, alternating with clear spaces within the sheath; these clear spaces have been held to be spores. This organism is found in the lungs and sputum in various forms of consumption, in tubercular ulcers of the intestine, in the lymph spaces around the vessels in tubercular meningitis, in tubercular nodules in all parts of the body, and in tubercular disease of the skin—lupus. It is found also in the tubercular lesions of animals; in the throat-glands, tonsils, spleen, and bones of the pig; in the spleen of the horse; and in the lungs and pleura of the cow. Tuberculosis may be produced artificially by injecting the tubercle bacillus into animals, some being much more susceptible than others. Milk drawn from an udder in which there are breaking-down tubercular foci, may contain an enormous number of active tubercle bacilli; and pigs fed upon this milk develop a typical tuberculosis, which can be traced from point to point, commencing in the glands of the throat, with the utmost precision. It

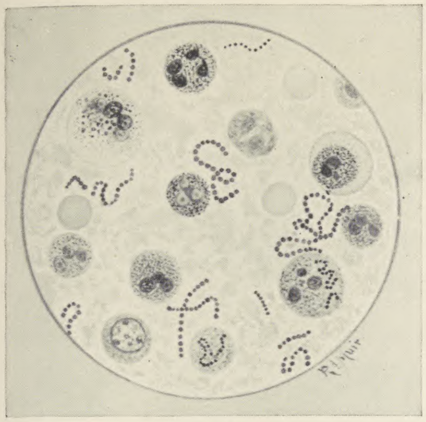
Fig. 2.

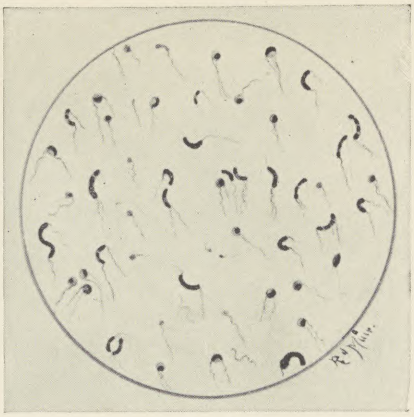
Fig. 3.


Fig. 4.

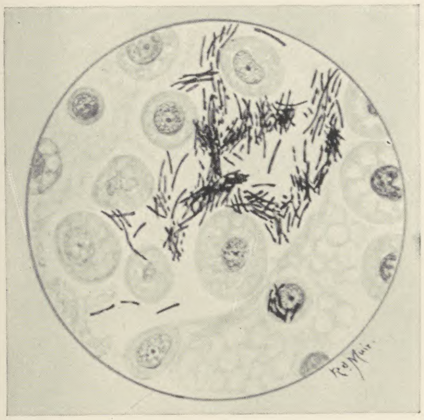
Fig. 5.


Fig. 7.


Fig 9.

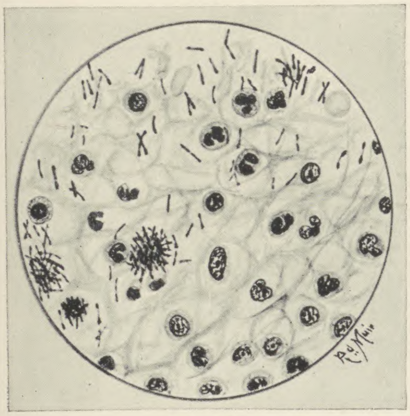
Fig. 10.


Fig. 11.

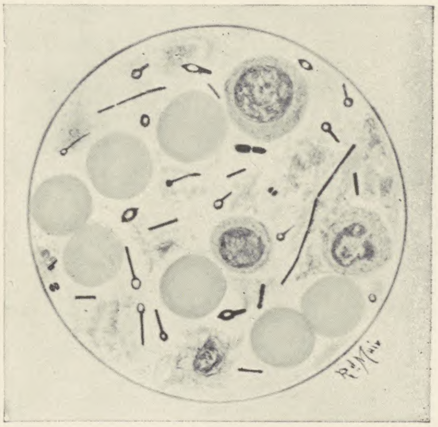
Fig. 12.


Fig. 15.

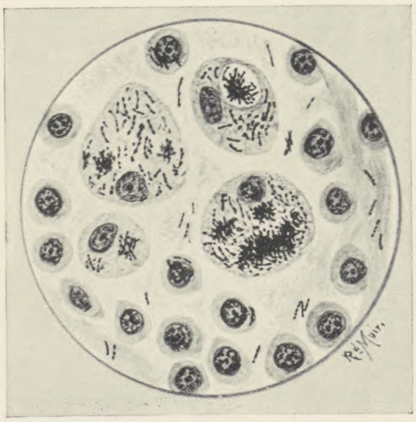
Fig. 16.

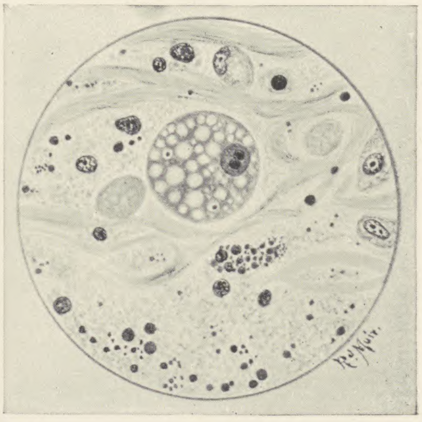
Fig. 19.

must be assumed that what takes place in the pig may also take place in the human subject; and a sufficient number of cases are now on record to show that the swallowing of tuberculous material is a cause of tuberculosis, especially amongst children and adolescents. Inhaled tubercle bacilli from the recently-dried sputum of phthisical patients, like milk derived from tuberculous udders, may set up tuberculosis of the lungs or of the alimentary tract, especially when the epithelial layer is unhealthy or imperfect. The two main causes of the prevalence of tuberculosis in the human subject are: (1) tubercle bacilli may become so modified that they can flourish saprophytically; as yet it has not been possible to trace the exact conditions under which they live, but we are gradually coming to recognize that although when they come from the body they are almost obligate parasites, they may gradually acquire saprophytic characters. (2) Many of the domestic animals are readily infected with tuberculosis, and in turn may become additional centres from which infection may radiate.

Although Koch's tuberculin, from which at one time so much was expected therapeutically, has not entirely fulfilled its promise, it is of great use in early diagnosis, and therefore should prove invaluable in the eradication of tuberculosis.

Tuberculin, from which the tuberculin test derives its name, consists of the products of the tubercle bacillus when grown for a month or six weeks in peptone meat-broth to which a small proportion, say 5 or 6 per cent., of glycerin has been added. The tubercle bacilli are then killed at boiling-temperature, and are partially removed by sedimentation, and completely by filtration through a Berkfeld or Pasteur-Chamberland filter. If a large dose of this filtered fluid be injected under the skin of a healthy man or brute, it is possible to produce some local swelling and to induce a rise of temperature; but in a similar patient suffering from tuberculosis a very much smaller dose (one which does not affect the healthy individual in the slightest degree) is sufficient to bring about the characteristic swelling and rise of temperature. To obtain trustworthy results the dosage must always be carefully attended to. The reaction is only obtained under certain well-defined conditions. Driven animals seldom, if ever, react properly. Cattle to be tested should be allowed to remain at rest for some time; they should be well fed, and be carefully protected from cold or draughts. After an injection of tuberculin into the subcutaneous tissues (usually in front of the shoulder or on the chest-wall) they should be kept under the same conditions and should be watered very carefully; the temperature should be taken at the sixth hour, and every three hours afterwards up to the twenty-first or even twenty-fourth hour. If during this time the temperature rises to 104° F., there can be little doubt that the animal is tuberculous; but if it remains under 103°, the animal must be considered free from disease: if the temperature remains between these points, the case is a doubtful one, and, according to Principal M'Fadyean, should be retested at the end of a month. It is interesting to note that the test is not trustworthy in the case of animals in which tuberculosis is far advanced, especially when the temperature is already high—103° F. In such cases, however, it is an easy matter to diagnose the disease by the ordinary clinical methods. At first objections were raised to this test on two grounds: (1) that mistakes in diagnosis are sometimes made; (2) that tuberculin may affect the milk of healthy animals into which it is injected. As the methods of using the tuberculin have been perfected, and as the conditions under which the reaction is obtained have become better known, mistakes have rapidly become fewer; further, it has been amply proved that tuberculin has not the slightest deteriorating effect on the quality of the milk.

Leprosy.—Armauer Hansen in 1871, and Neisser in 1881, described a "leprosy bacillus" corresponding in size and in certain points of staining reaction to the tubercle bacillus, and it is now generally accepted that this bacillus is the direct and specific causal agent of leprosy. The discovery of this organism paved the way for the proof that the tubercular and anæsthetic forms of leprosy are essentially the same disease, or rather are the manifestations of the action of a common organism attacking different series of tissues.

To demonstrate the presence of the leprosy bacillus, tie an indiarubber ring firmly around the base of one of the leprosy tubercles. As soon as the blood is driven out, leaving the nodule pale, make a puncture with the point of a sharp knife. From this puncture a clear fluid exudes; this, dried on a cover-glass, stained with carbol-fuchsin, and rapidly decolorized with a weak mineral acid, shows bacilli stained red and very like tubercle bacilli; they differ from that organism, however, in that they are somewhat shorter, and that if the acid be too strong, or be allowed to act on them for too long a time, the colour is discharged from them much more readily. These organisms, which are from 4 to 6μ in length and 0·3μ in breadth, are as a rule more rigid and more pointed than are the tubercle bacilli (Fig. 16, Plate VIII.). It is doubtful whether they form spores. They are found in large numbers lying embedded in a kind of gelatinous substance in the lymphatics of the skin, in certain cells of which they appear to be taken up.

It is curious that these bacilli affect specially the skin and nerves, and rarely the lungs and serous membranes, thus being in sharp contrast to the tubercle bacillus, which affects the latter very frequently and the former rarely. They are seldom found in the blood, though they have been described as occurring there in the later stages of the disease. It is stated that leprosy has been inoculated directly into the human subject, the patient dying some five or six years after the inoculation had been made; but up to the present no pure culture of the leprosy bacillus has been obtained; it has therefore been impossible to produce the disease by the inoculation of the bacillus only. What evidence we have at our disposal, however, is all in favour of the transmissibility of the disease from patient to patient and through the agency of the leprosy bacillus. None of the numerous non-bacillary theories of leprosy account at all satisfactorily for this transmissibility of the disease, for its progressive nature, and for the peculiar series of histological changes that are met with in various parts and organs of the leprous body. Leprosy occurs in all climates. It is found where no fish diet can be obtained, and where pork and rice are never used, though to these substances has been assigned the power of giving rise to the disease. Locality appears to influence it but little, and with improved sanitation and increased cleanliness it is being gradually eradicated. The only factor that is common in all forms of leprosy, and is met with in every case, is the specific bacillus; and in spite of the fact that it has yet been found impossible to trace the method of transmission, we must, from what is known of the presence and action of bacilli in other diseases, especially in tuberculosis, assign to the leprosy bacillus the rôle of leprosy-producer, until much stronger evidence than has yet been obtained can be brought forward in favour of any of the other numerous causes that have been assigned. Two cases are recorded in which people have contracted leprosy from pricking their fingers with needles whilst sewing a leper's clothes; and a man who had never been out of Dublin is said to have contracted the disease by sleeping with his brother, a soldier who had returned from India suffering from leprosy.

Glanders.—Farcy in the human subject resembles the same disease experimentally produced in animals with material from a glandered animal, and as there is no pathological distinction between the two, from the ætiological standpoint, they may be considered together. If the pus from a glanders abscess be mixed with a little sterile saline solution and spread over the cut surface of a boiled potato kept at the body-temperature, bright yellow or honey-coloured, thick, moist-looking colonies grow very rapidly and luxuriantly. These colonies gradually become darker in colour, until they assume a *café-au-lait*, or even a chocolate, tint. On examining one of them microscopically, it is found to be made up of bacilli 2 to 5 μ long and $\frac{1}{5}$ to $\frac{1}{8}$ of their own length broad (Figs. 13 and 14, Plate VII.). The bacillus is usually straight or slightly curved and rounded at one end; it appears to be non-motile. As first pointed out by Loeffler and Schütz, when a portion of a culture is inoculated subcutaneously, typical farcy, with the acute septicæmia or blood-poisoning so characteristic of certain cases of glanders and farcy, is the result. The human subject is usually inoculated through wounds or scratches, or through the application of the nasal discharge of a glandered animal to the mucous membrane of the nose or mouth. Man is not specially susceptible to the glanders virus; cattle never take it in the usual way, and even when inoculated exhibit nothing more than localized ulceration. The goat appears to occupy an intermediate position between cattle and the horse in this respect; in sheep, which are fairly susceptible, the disease runs its course slowly, and appears to resemble chronic farcy in man. In rabbits and the dog the disease runs a very slow and modified course. Although field-mice are extraordinarily susceptible, white mice and house mice, unless previously fed on sugar or with phloridzin, are unaffected. The pigeon is the only bird in which glanders has been produced. Lions and tigers are said to contract the disease, and to take it in a very severe and rapidly fatal form. The glanders organism rapidly loses its virulence and even its vitality. Dry, it dies in about ten days; placed in distilled water, in about five days; but kept moist, or when grown on culture media, it retains its vitality for about a month, although its activity soon becomes considerably lessened. These bacilli are readily killed at a temperature of 55° C.; they can pass through the kidneys even when there is no lesion to be made out either with the naked eye or under the microscope (Sherrington and Bonome).

The glanders bacillus grows best in the presence of oxygen, but it may grow anaërobically; it then appears to have the power of forming toxin, either more in quantity or of greater activity than when it has access to a free supply of oxygen. This poison (mallein) is used for the purpose of diagnosing the presence of glanders. A cultivation is made in peptonized bouillon to which a small portion of glycerine has been added. This is allowed to grow at the temperature of the body for a month or six weeks; the bacilli are killed by heat, and 0·5 per cent. carbolic acid is added. The cultivation is then filtered through a porcelain filter in order to remove the bodies of the bacilli, and the resulting fluid, clear and amber-coloured, should have the power, when injected in quantities of 1 c.c., of giving the glanders reaction in an animal suffering from that disease; in a healthy animal 6 c.c. should give no reaction. The suspected animal should be kept at rest and in a warm stable for twenty-four to forty-eight hours before the test is applied. The temperature should be normal, as no proper reaction is obtained in an animal in which the temperature is high. This reaction, which is a very definite one, consists in a rise of temperature of from 2° to 4° F., and the appearance of a swelling, of from 3 to 4 inches in diameter and from 1 to $1\frac{1}{2}$ inches in height, before the sixteenth or eighteenth hour; this swelling should continue to increase for some hours. It has been suggested that the injection of $\frac{1}{20}$ to $\frac{1}{15}$ c.c. of mallein, at intervals of two or three days, may be used with advantage in the treatment of glanders. Glandered horses seem to improve under this treatment, and certainly do not react even to much larger doses of mallein. The mallein test has revealed the fact that glanders is a far more common and more widespread disease than was at one time supposed.

(c) Infective Diseases in which Organisms have not yet been discovered.

Hydrophobia is usually contracted by man through inoculation of an abraded surface with the saliva of an animal affected with rabies—through the bite of a dog, the animal in which the so-called rabies of the streets occurs. The other animals that may be affected "naturally" are wolves, cats, foxes, horses, cows, and deer; but all warm-blooded animals may be inoculated with the disease. The principal changes are in the nervous system, and include distension of perivascular lymphatic sheaths; dilatation of blood-vessels and hæmorrhages, especially in the floor of the fourth ventricle of the brain, and in the various mucous and serous membranes; hyaline changes in and around the walls of blood-vessels; proliferation of the endothelium; swelling and vacuolation of nerve cells; pericellular infiltration with leucocytes, and also infiltration of the salivary glands with leucocytes (Coats). An increased number of leucocytes and microcytes in the blood has also been made out. As yet the definite form of the virus is unknown, but, whatever it may be, it has a power of multiplying in the tissues and of producing a toxic substance which, as in the case of tetanus toxin, appears to act specially on the central nervous system. At present two organisms are being studied in connexion with this disease—one a yeast described by Dr G. Memmo, the other an organism something like Fraenkel's diplococcus, by Bruschettini—but neither of them has as yet been satisfactorily worked out. The nature of the disease produced by the inoculation of saliva from a rabid animal appears to depend upon (1) the quantity of the rabic virus introduced; (2) the point of its introduction; (3) the activity of the virus. Thus by diluting the poison with distilled water or saline solution and injecting small quantities, the period of incubation may be prolonged. Slight wounds of the skin, of the limbs, and of the back are followed by a long incubation period; but when the inoculation takes place in the tips of the fingers or in the skin of the face, where nerves are numerous, and especially where the wound is lacerated or deep, the incubation period is much shorter and the attack usually more severe. This, as in tetanus, is accounted for by the fact that the lymphatics of the nerves are much more directly continuous with the central nervous system than are any other set of lymphatics. The poison appears to act directly upon the cells of the central nervous system.

Arising out of recent researches on hydrophobia, two methods of treatment—one of which, at any rate, has been attended by conspicuous success—have been put into practice. The first of these, Pasteur's, is based upon the fact that rabic virus may be intensified or attenuated at will. Pasteur found that although the virus taken from the cerebrospinal fluid of the dog always produces death in the same period when inoculated into the same animal, virus taken from other animals has not the same activity. If passed through a succession of monkeys it may become so attenuated that it is no longer lethal. If either the "monkey virus," which is not fatal to the rabbit, or the "dog virus," which kills in twelve to fourteen days, be passed through a series of rabbits, the virulence may be so exalted that it may kill in about six days, though its activity cannot be increased beyond this point by any means at present at our disposal. This intensified virus was therefore named by Pasteur the *virus fixe*, and it forms a standard from which to work. He found, too, that under certain conditions of temperature the virus may be readily attenuated, one hour at 50° C. or half an hour at 60° completely destroying it. A 5 per cent. solution of carbolic acid acting for half an hour, or a 1 per 1000 solution of bichloride of mercury or acetic acid or permanganate of potash, brings about the same result as do also exposure to air and sunlight. The poison contained in the spinal cords of rabbits exposed to dry air and not allowed to undergo putrefactive changes, gradually loses its activity, and at the end of fourteen to fifteen days is incapable of setting up rabid symptoms. A series of cords from rabbits inoculated with the *virus fixe* are cut into short segments, which, held in series by the dura mater, are suspended in sterile glass flasks plugged with cotton-wool and containing a quantity of potassium hydrate—a powerful absorbent of water. At the end of twenty-four hours the activity of the virus is found to have fallen but slightly; at the end of forty-eight hours there is a still further falling off, until on the fourteenth or fifteenth day the virus is no longer lethal. With material so obtained Pasteur treated patients who had been bitten by mad dogs. On the first day of treatment small quantities of an emulsion of the cord exposed for thirteen or fourteen days in saline solution are injected subcutaneously, and the treatment is continued for from fifteen to twenty-one days, according to the severity of the bite, a stronger emulsion—*i.e.* an emulsion made of a cord that has been desiccated for a shorter period—being used for each succeeding injection, until at last the patient is injected with an emulsion which has been exposed to the air for only three days. In the human subject the period of incubation of the disease is comparatively prolonged, owing to the insusceptibility of the tissues to the action of this poison; there is therefore some chance of obtaining a complete protection or acclimatization of the tissues before the incubation period is completed. The virus introduced at the bite has then no more chance of affecting the nerve centres than has the strong virus injected in the late stages of the protective inoculation: the nerve centres, having become gradually acclimatized to the poisons of the rabic virus, are able to carry on their proper functions in its presence, until in time, as in the case of microbial poisons, the virus is gradually neutralized and eliminated from the body. Various modifications and improvements of this method have from time to time been devised, but all are based on, and are merely extensions of, Pasteur's original work and method. As soon as it was found that antitoxins were formed in the tissues in the case of an attack of tetanus, attention was drawn to the necessity of determining whether something similar might not be done in the production of an antirabic serum for the treatment of rabies. Babes and Lepp, and then Tizzoni and his colleagues Schwarz and Centanni, starting from *virus fixe*, obtained a series of weaker inoculating materials by submitting it for different periods to the action of gastric juice. Beginning with a weak virus so prepared, and from time to time injecting successively stronger emulsions (seventeen injections in twenty days) into a sheep, they succeeded in obtaining a serum of such antirabic power that if injected in the proportion of 1 to 25,000 of body-weight, an animal is protected against a lethal dose of *virus fixe*. The activity of this serum is still further reinforced if a fresh series of injections is made at intervals varying from two to five months, according to the condition of the animal, each series occupying twelve days. This antirabic substance stored in the blood has not only the power of anticipating (neutralizing?) the action of the poison, but also of acting as a direct curative agent; as a prophylactic agent, readily kept in stock and easily and rapidly exhibited, it possesses very great advantages. It must be borne in mind that the longer the period after the inoculation, the greater must be the amount of serum used to obtain a successful result.

There can be little doubt that hydrophobia is a specific disease due to a multiplication of virus in the nervous system, in the elements of which it is ultimately fixed; that it passes from the wound to the central nervous system by the lymphatics; and that, as in tetanus, the muscular spasms are the result of the action of some special poison on the central nervous system.

Small-pox.—There have been few recent additions to our knowledge of the ætiology of small-pox, though Dr Monckton Copeman now holds that the small-pox organism, like that of vaccine, is probably a very minute bacillus, which, from its behaviour in the presence of glycerin, is possessed of the power of forming spores. If vaccine lymph, taken from the calf, be protected from all extraneous spore-bearing organisms and treated with 50 per cent. solution of glycerin, it in time becomes absolutely sterile as regards ordinary non-spore-bearing organisms. Even the staphylococci and streptococci, usually found in calf lymph, cannot withstand the prolonged action of this substance, but spore-bearing organisms still remain alive and active. Moreover, the lymph still retains its power of producing vaccine vesicles, so that the vaccine organism, in its powers of resistance, resembles the spore-bearing, and not the non-spore-bearing, organisms with which we are acquainted. This vaccine organism is very minute; it is stated that it can be cultivated only on special media, though it multiplies freely in the superficial cutaneous tissues of the calf, the monkey, and the human subject. Perhaps the most important outcome of Dr Copeman's work on this subject is that he has obtained a vaccine lymph from which are eliminated all streptococci and staphylococci, and, if the lymph be taken with reasonable care, any other organisms which could possibly give rise to untoward results.

Typhus Fever.—Up to the present time, although it is fully recognized that typhus must be one of the specific infective fevers brought about by the action of a special micro-organism, no definite information as to the bacterial ætiology of this condition has been obtained. It is always looked upon as a "filth" disease; and from the frequency of minute hæmorrhages, and from the resemblance to the hæmorrhagic septicæmias in other respects, it appears probable that the bacillus of typhus is the organism described by Mott in 1883 as an actively motile dumb-bell coccus, and ten years later by Dubieff and Bruhl as the diplococcus typhosus exanthematicus; the polar staining and general resemblance to the diplococcus of fowl cholera, the plague bacillus, the diplococcus of "Wildseuche," certain forms of swine fever and hog cholera, and others of the hæmorrhagic septicæmias, are sufficient to suggest the generic affinity of this organism to this septicæmic group. We have as yet, however, no absolute proof of the ætiological relation of the bacillus to this disease, such as has been obtained in connexion with other diseases, and it is impossible to add anything beyond this to the article contributed by Dr Affleck to the ninth edition.

Scarlet Fever.—In scarlet fever recent observations have been comparatively few and unimportant. Crooke, and later Klein, and others have, however, shown that in the glands and throats of scarlet fever patients a streptococcus, to which is assigned the chief ætiological rôle in connexion with this disease, is present. On the other hand, it is maintained by many observers that these streptococci are nothing more than the streptococci found in puerperal fever, erysipelas, and similar infective conditions, and certainly the organisms described closely resemble streptococcus pyogenes.

Measles.—In measles, as in scarlet fever, micrococci have had ascribed to them the power of setting up the specific disease. Canon and Pielicke have, however, described minute bacilli somewhat resembling those described as occurring in vaccine lymph. These are found in the blood in the early stages of the disease, and also in the profuse catarrhal secretions so characteristic of this condition. There are no records of the successful inoculation of this minute bacillus, and until such evidence is forthcoming this organism must be looked upon as being an accessory, possibly, but not the prime cause, of measles.

Mumps.—It is generally accepted that mumps is probably caused by a specific micro-organism, the infective material making its way in the first instance through the ducts to the parotid and other salivary glands. It appears to bring about a peculiar œdematous inflammation of the interstitial tissue of the glands, but slight parenchymatous changes may also be observed. The virus is present in the tissues for some days before there is any manifestation of parotid swelling, but during this period it is extremely active, and the disease may be readily transmitted from patient to patient. The infectivity continues for some time, probably for nearly a week after naked-eye manifestations of the diseased condition have disappeared. The specific organism has not yet been isolated.

Whooping-Cough.—Within the last few years there has been little addition to our knowledge either of the ætiology, course, or treatment of whooping-cough, although a diplococcus, a streptococcus, and various higher fungi have in turn been put down as the cause of this disease. It must, from its resemblance to the other specific infective fevers, be considered as an infective disease of microbic origin, which goes through a regular period of incubation and invasion, and in which true nervous lesions, especially of the pneumogastric and superior laryngeal nerves, are somewhat common.

Affanassieff, and later Koplick, have described a minute bacillus, with rounded ends and bi-polar staining, which occurs in the mucus discharged at the end of a paroxysm of whooping-cough. Koplick examined sixteen cases, and found this organism in thirteen of them. There can be little doubt that the infective material is contained in the expectoration. It may remain active for a considerable period, but is then usually attached to solid particles. It is not readily carried by the breath, and multiplies specially in the mucous membranes, setting up inflammation, probably through its toxic products, which appear to be absorbed, and, as in the case of the tetanus poison, to travel specially along the lymphatics of the local nerves. Affections of the lung—bronchitis and broncho-pneumonia—may be directly associated with the disease, but it is much more likely that these affections are the result of secondary infection of tissues already in a weakened condition.

II. To Higher Vegetable Parasites.

Actinomycosis.—A disease very prevalent in certain low-lying districts, especially amongst cattle, giving rise to the condition known as "sarcoma," "wooden tongue," "wens," "bony growths on the jaw," &c. It is characterized by the presence of a fungus, which, at first growing in the form of long slender threads that may be broken up into short rods and cocci, ultimately, as the result of a degenerative process, assumes the form of a "ray-fungus," in which a series of club-like rays are arranged around a common centre. It is probably a streptothrix—streptothrix Försteri (Fig. 17, Plate VII.). Numerous cases have been observed in the human subject. Suppuration and the formation of fistulous openings, surrounded by exuberant granulations, "proud flesh," usually supervene, and in the pus discharged are found yellowish green or reddish brown points, each made up of a central irregular mycelium composed of short rods and spores, along with the clubs already described. The mycelial threads may reach a considerable length (20 to 100μ); some of them become thicker, and are thus differentiated from the rest; the peripheral club is the result of swelling of the sheath; the filaments nearer the centre contain the spores, which measure from 1 to 2μ in diameter. This fungus appears to lead a saprophytic existence, but it has the power of living in the tissues of the animal body, to which it makes its way through or around carious or loose teeth, or through abrasions of the tongue or tonsils. After the above positions, the abdomen, especially near the vermiform appendix, is a special seat of election, or in some cases the thorax, the lesions being traceable downwards from the neck. Any of the abdominal or thoracic organs may thus be affected. The process spreads somewhat slowly, but once started may extend in any direction, its track being marked by the formation of a large quantity of fibrous tissue, often around a long fistula. In the more recent growths, and in solid organs, cavities of some size, containing a soft semi-purulent cheesy-looking material, may be found, this mass in some cases being surrounded by dense fibrous tissue. When once a sinus is formed the diagnosis is easy, but before this the disease, where tumours of considerable size are rapidly formed, may readily be mistaken for sarcoma, or, when the lungs are affected, for tuberculosis, especially as bronchitis and pleuritic effusion are frequently associated with both actinomycosis and tuberculosis.

Mycetoma, the Madura foot of India, is a disease very similar to actinomycosis, and, like that disease, is produced by a somewhat characteristic streptothrix. It usually attacks the feet and legs, however, and appears to be the result of infection through injured tissues. Under certain conditions and in long-standing cases the fungus appears to become pigmented (black) and degenerated.

Other forms of fungus disease or *Mycoses* are described. Aspergillosis, or pigeon-breeders' disease, is the result of the infection with the Aspergillus fumigatus. Certain tumours appear to be the result of the action of a yeast, Blastomycosis or Saccharomycosis. The spores of the Penicillium glaucum, and of some of the Mucors, are also said to have the power of setting up irritation, which may end in the formation of a so-called granuloma or granulation tissue tumour. These, however, are comparatively rare.

B. Diseases due to Animal Parasites.

I. To Protozoa.

Malaria.—Following Laveran's discovery, in 1880, of a parasite in the blood of patients suffering from malaria, our knowledge of the disease has increased by leaps and bounds, and one of the most important questions concerning tropical diseases has now been cleared up. Numerous observations have been carried out to determine the different parasites found in different forms of malaria—the tertian, quartan, and æstivo-autumnal fever—in each of which, in the red blood corpuscles, a series of developmental stages of a parasite from a small pale translucent amœbiform body may be followed. This small body first becomes lobulated, nucleated, and pigmented; it then, after assuming a more or less marked rosette-shape with a deeply pigmented centre, breaks up into a series of small rounded hyaline masses of protoplasm, each of which has a central bright point. The number of these, contained in a kind of capsule, varies from 12 to 20 in the tertian and æstivo-autumnal forms, and from 8 to 10 in the quartan form. There are certain differences in the arrangement of the pigment, which is present in larger quantities and over a wider area in the somewhat larger parasites that are found in the tertian and quartan fevers. In the parasite of the æstivo-autumnal fever the pigment is usually found in minute dots, dividing near the pole at the point of division of the organism, along with it in the earlier stages (Fig. 18, Plate VII.). Here, too, the rosette form is not so distinct as in the parasite of tertian fever, and in that not so distinct as in the quartan parasites. These dividing forms make their appearance immediately before the onset of a malarial paroxysm, and their presence is diagnostic. The process of division takes place especially in the blood-forming organs, and is therefore found more frequently in the spleen and in bone-marrow than in any other situations. The parasites, at certain stages of their development, may escape from the red blood corpuscles, in which case (especially when exposed to the air for a few minutes) they send out long processes of protoplasm and become very active, moving about in the plasma and between the corpuscles, sometimes losing their processes, which, however, continue in active movement. In the æstivo-autumnal fever curious crescent-shaped or ovoid bodies were amongst the first of the parasitic organisms described as occurring in the blood, in the red corpuscles of which they develop. Manson maintains that from these arise the flagellate forms, all of which, he thinks, are developed in order that the life of the malarial parasite may be continued outside the human body. It is probable that most of the pigment found in the organs taken from malarial patients is derived from red blood corpuscles broken down by the malarial parasites; many of these, in turn, are devoured by leucocytes, which in malarial blood are usually greatly increased in number, and frequently contain much pigment, which they have obtained either directly from the fluid plasma or from the pigmented parasitic organism. The work recently carried out by Bruce on the tsetse-fly parasite, by Smith on Texas fever, and by Thayer and Hewitson on the blood parasites of birds, has opened up the way for the further study of the malarial parasites outside the human body. There can be no doubt as to the close relation of the multiplication and sporulation of the malarial parasite with the ague paroxysm: the anæmia results from the breaking down of blood corpuscles. Toxic substances are present in the blood during the setting free of the spores; of this we have proof in the increased toxicity of the urine during the paroxysmal phases of the disease; necrotic areas, similar to those found in acute toxic fevers produced by other micro-organisms, are also met with. It is well to bear in mind that the accumulation of débris of parasites and corpuscles in the capillaries may be an additional factor in this necrosis, especially when to this is added the impairment of nutrition necessarily involved by the impoverished condition of the malarial blood. It is interesting to note that, although, as pointed out by Nuttall, the Italian and Tyrolese peasantry have long been firmly of the opinion that malaria is transmitted through the mosquito, and although Nott of New Orleans as early as 1848 "refers to malaria as if the mosquito theory had already been advanced," little attention has been given to this question by most observers. Still earlier, Rasori (in 1846) had stated that "for many years I have held the opinion that intermittent fevers are produced by parasites, which renew the paroxysm by the act of their reproduction, which recurs more or less rapidly according to the variety of the species"; and this appears to be the first well-authenticated reference to this subject. Nuttall, who gives an excellent summary of the literature on the mosquito theory of malaria, assigns to King the honour of again drawing attention to this question. Laveran in 1891, Koch in 1892, Manson in 1894, Bignami and Mendini in 1896, and Grassi in 1898, all turned their attention to the mosquito theory. Manson, basing his theory upon what he had observed as regards the transmission of Filaria by the mosquito, suggested a series of experiments to Major Ronald Ross. These were carried out in 1895, when it was found that in mosquitoes that had taken up blood containing amœboid parasites, crescents, which were first described as cells, appeared in the stomach-wall after four or five days; these contained a number of stationary vacuoles and pigment granules, ten to twenty in number, bunched together or distributed in lines. Grassi, Bignami, and Bastianelli have confirmed and added to Ross's observations; they find that *anopheles claviger*, taking the blood from a patient suffering from malaria, soon develops hæmosporidia in the intestine. These parasites are then found between the muscular fibres of the stomach; they increase in size, become pigmented, and more and more vacuolated, until they project into the body-cavity. On the sixth day these large spheres contain an enormous number of minute bodies, refractive droplets like fat, and a diminishing amount of pigment. On the seventh day numerous filaments, arranged in rows around several foci, are seen. They are very delicate, are stained with difficulty, and appear to be perfectly independent of each other, though grouped within a capsule. After the capsule has ruptured, these thread-like "sporozooites," escaping into the body-cavity, gradually make their way to, and accumulate in, the cells or tubules of the salivary glands, whence their passage through the proboscis into the human blood is easily understood.

Development of the malarial parasite.

Two phases or cycles of existence have then been demonstrated—one within the human body, the second in the mosquito. That within the human body appears to be capable of going on almost indefinitely as long as the patient lives, but that in the mosquito appears to be, as it were, an intermediate stage. The minute specks of protoplasm, the amœbulæ, which have already been described as occurring in the red blood corpuscles of the higher animals, increase in size, take up blood pigment, probably from the red corpuscles, and then become developed into sporocytes or gametocytes. The sporocyte is the form which, remaining in the body, ultimately breaks up, as already seen, into a series of minute spores or amœbulæ, which in turn go through the same cycle again, increasing in size and forming spores, and so on indefinitely. Gametocytes (the true sexual form) are in certain species, to outward appearance, very similar to the sporocyte, but in others they assume the crescentic shape, and can thus be recognized. The male cell resembles the female cell very closely, except that the protoplasm is hyaline and homogeneous-looking, whilst that of the female cell is granular. It has already been noted that when the blood is withdrawn from the body certain of the malarial parasites become flagellated. These flagella may be looked upon as sperm elements, which, forming in the male gametocyte, are extruded from that cell, and, once set free, seek out the granular female gametocytes. A single flagellum becomes attached to a small projection that appears on the female cell; it then makes its way into the protoplasm of the female cell, in which rapid streaming movements are then developed. In certain species the female cell is somewhat elongated, and may be peculiarly constricted. It becomes motile, and appears to have the power of piercing the tissues. In this way the first stages of development in the mosquito are passed. The gametocytes, taken along with the blood into the stomach of this insect, pass through the various phases above mentioned, though the zygote form has not yet been traced in the human malarial parasite. In the blood of a patient bitten by an infected mosquito, the ordinary malarial parasite may be demonstrated without any difficulty at the end of a week or ten days, and the cycle recommences. This theory, in which the mosquito acts as an intermediary host for one stage of the parasite and transmits the parasite to man, affords an explanation of many apparently anomalous conditions associated with the transmission of malaria, whilst it harmonizes with many facts which, though frequently observed, were very difficult of explanation. Malaria was supposed to be associated with watery exhalations and with the fall of dew, but a wall or a row of trees was seemingly quite sufficient to prevent the passage of infection. It was met with on wet soils, on broken ground, in marshes, swamps, and jungles; on the other hand, it was supposed to be due to the poisonous exhalations from rocks. All this is now explained by the fact that these are the positions in which mosquitoes occur: wherever there are stagnant pools, even of a temporary nature, mosquitoes may breed. It has been observed that although the malarial "miasma" never produces any ill effects in patients living at more than a few feet from the surface of the ground, malaria may be found at a height of from 7000 to 9000 feet above the sea-level; and the fact that a belt of trees or a wall will stop the passage of the poison is readily explicable on the mosquito theory. These insects are incapable, owing to their limited power of flight, of rising more than a few feet from the ground, and cannot make their way through a belt of trees of even moderate thickness. The fact that broken ground, such as is found in connexion with railway cuttings and canals, may be a focus from which malaria may spread, is further support of this theory, from the fact that in such broken ground pools are of common occurrence, and afford the conditions for the development of the mosquito, whilst the infected tools used in one area may easily convey the germs to another. The conditions of climate under which malaria is most rife are those which are most suitable for the development of the mosquito. The protection afforded by fires, the recognized value of mosquito curtains, the simultaneous disappearance of anopheles and malaria on the complete draining of a neighbourhood, the coincidence of malaria and mosquitoes, and the protection afforded by large expanses of water near walls and trees, are all important in this connexion.

Mosquitoes, malarial parasites, and malaria have the same geographical distribution.

The mosquitoes specially associated with the transmission of malaria in the human subject belong apparently to the genus Anopheles, *Anopheles claviger* (*maculipennis*) and *Anopheles bifurcatus*, both species found in Great Britain, and *Anopheles pictus*, another species found in Europe, but so far not in Great Britain. The important member of the genus Culex is the grey mosquito or *Culex fatigans*, the intermediate host of the proteosoma of birds, on which many of the intermediate phases of the life-history of these malarial parasites has been studied. Ross describes a dappled-wing mosquito as the one with which he performed his experiments on birds in India. *Anopheles claviger* is a British species, an interesting fact in association with the former prevalence of malaria in Great Britain. The remedy for malaria appears to be thorough drainage of pools and puddles, or, where this cannot be easily effected, the throwing of a certain amount "of kerosene on the surface of these pools" (Nuttall).

Species of mosquito concerned.

Amœbic Dysentery.—In addition to the dysentery set up by bacteria, a form has been described which is said to be due to an animal parasite—amœbic dysentery or amœbic enteritis—and it has been proposed to separate the various types of dysentery according to their ætiology, in which case the amœbic group is probably more specific than any other. The amœba supposed to give rise to this condition was first described by Lösch in 1875. Since then it has been described either as a harmless parasite or as a cause of dysentery in Europe, Africa, the United States, and in Brazil, and more recently in India. This organism, which is usually placed amongst the rhizopods, consists of a small globule of protoplasm, varying in size from 6 to 35μ, though, as Lafleur points out, these limits are seldom reached, the organism being usually from one and a half to three times the diameter of a leucocyte—from 12 to 26μ (Fig. 19, Plate VIII.). Its margins are well defined, and the body appears to consist of a granular inner portion and a homogeneous outer portion, the latter being somewhat lighter in colour than the inner; in the resting stage this division cannot be made out. The organism appears to pass through at least two phases, one corresponding to a cystic, the other to an amœboid, stage. In the latter stage, if the organism be examined on a warm stage, it is seen to send out processes, and, as in other amœbæ, vacuoles may be seen as clear spaces lying in the granular and darker-coloured inner protoplasm. In some cases these vacuoles are so numerous that they occupy the whole of the spaces usually occupied by the granular protoplasm, and are merely surrounded by a zone of variable thickness, which "has the appearance of finely granular glass of a distinctly pale green tint" (Lafleur). In the cystic stage it is often easy to make out the presence of a nucleus which appears amongst the vacuoles, usually towards one side of the amœba. This nucleus is of considerable size, *i.e.* nearly as large as a red blood corpuscle, and is readily distinguishable from the surrounding protoplasm. When stained by the Benda method (safranin and light green) a nucleolus may be seen in the nucleus. The nucleus is perhaps best seen when stained by this method, but it is always difficult to obtain well-stained specimens of this organism. Red blood corpuscles are often englobed by this amœba, as are also micrococci and bacilli. The movements of the amœbæ are most active at a temperature of about 90° to 98° F. From the fact that pigment is contained in these organisms, it is supposed that they take in the red blood corpuscles as nutritive material, and that other substances may be taken in to serve a similar purpose. Nothing is known of the method of multiplication of the amœba, but it is supposed that it may be both by fission and by spore formation. These organisms are present in the early stage of the acute disease, and disappear at the later stages. A similar organism, however, may be found even in the normal intestine. Perhaps of some importance is the fact that the abscesses found in the liver and lung, which occur so frequently in cases of dysentery, usually contain, especially in the portions immediately adjoining the suppurating mass, a considerable number of these amœbæ. In the very small abscesses the amœbæ are numerous and active, and occupy the capillaries in the tissues. It is quite possible that this plugging of the capillaries with amœbæ is the cause both of the hæmorrhages and of the small areas of necrosed tissue, the supply of nutriment being cut off from the liver cells and from the lung tissues, and that suppuration only occurs as a secondary process, though Councilman and Lafleur maintain that the amœba itself is the primary cause of suppuration. It is possible, of course, that the suppuration is due to the action of pus-forming organisms conveyed along with, or following, the amœba, as we know that the growth of suppurating organisms can go on in dead tissues when these organisms have no chance of surviving in the healthy tissues and fluids of the body. Lafleur holds that the amœba forms a toxic substance which exerts a direct devitalizing effect on the liver cells, and that the amœba itself causes suppuration. The abscesses in the lung, which invariably extend directly from the liver and occur at the base of the right lung, also contain these amœbæ. It is for these reasons that this organism is looked upon as the cause of dysentery and of certain forms of dysenteric abscess.

Tsetse-Fly Disease.—The interesting observations carried out by Surgeon-Major Bruce have invested the tsetse-fly with an entirely new significance and importance. In 1895, Bruce first observed that in the tsetse disease—*nagana*—there may be found a flagellated hæmatozoon closely resembling the Trypanosoma Evansii found in Surra. This, like the Surra organism, is very similar in appearance to, but considerably smaller than, the hæmatozoon often found in the blood of the healthy rat. It has, however, as a rule a single flagellum only. A small quantity of blood, taken from an affected buffalo, wildebeest, koodoo, bushbuck, or hyæna—in all of which animals it was found by Bruce—when inoculated into a horse, mule, donkey, cow, dog, cat, rabbit, guinea-pig, or rat, produces a similar disease, the organisms sometimes being found in enormous numbers in the blood of the inoculated animal, especially in the dog and in the rat. He then found that the tsetse-fly can only produce the disease in a healthy animal when it has first charged itself with blood from a diseased animal, and he produced evidence that *Glossina morsitans* is not capable of producing the disease, except by carrying the parasites from one animal to another in the blood that it takes through its proboscis into its stomach. The parasites taken in along with such blood may remain in the stomach and alive for a period of 118 hours, but shortly after that the stomach is found to be empty, and the parasites contained in the excrement no longer retain their vitality. The mode of multiplication of these organisms has been studied by Rose-Bradford and Plimmer, who maintain that the multiplication takes place principally in the spleen and lymphatic glands. The tsetse-fly parasite, however, is still imperfectly understood, though much attention is now being paid to its life-history and development.

Surra.—In Surra, Evans described a hæmatozoon—Trypanosoma Evansii—which in many points resembles the Trypanosoma of tsetse disease. This disease, which specially affects horses, mules, and camels in India, and, according to Steel, the dog and the monkey, was at one time supposed to correspond to relapsing fever, but careful comparison of the spirillum or spirochæte with the organism found in the tsetse disease and the hæmatozoon of the rat, has led to the conclusion that the two parasites are perfectly distinct, and these latter are now recognized as an animal parasite—Trichomonas. When this parasite is found in the blood of an animal, especially in advanced forms of the disease, there is marked fever, often jaundice and minute hæmorrhages—especially in the mucous membranes, and sometimes the serous membranes—marked general malaise, muscular weakness, and great wasting. The disease does not appear to be infectious or contagious in the ordinary sense of the term; but when blood from an infected animal is introduced into the stomach or subcutaneous tissues of an animal, the latter is rapidly attacked, the Trypanosoma making its way into the blood and multiplying with extraordinary rapidity. The exact site and method of multiplication have not yet been fully worked out. There is sufficient resemblance between this organism and the tsetse-fly parasite to render a comparison between the two unavoidable, but the general opinion of those who have worked at these parasites is that not only are the species distinct, but that they give rise to somewhat different lesions and symptoms in the animals in which they multiply.

II. To other Animal Parasites.

Filariasis.—Since Bancroft and Manson first described *Filaria nocturna* and its relation to the common form of filariasis, the most important contribution to our knowledge has been made, at the suggestion of the younger Bancroft, by Dr G. C. Low, who has demonstrated that the embryos of the filaria may be found in the proboscis of the mosquito (*Culex ciliaris*), whence they probably find their way into the circulating blood of the human subject. It appears that the filaria embryo, after being taken with the blood of the patient into the stomach of the mosquito, loses its sheath; after which, leaving the stomach, it passes into the thoracic muscles of its intermediate host, and becomes more fully developed, increasing considerably in size and attaining a mouth, an alimentary canal, and the characteristic trilobed caudal appendage. It now leaves the thoracic muscles, and, passing towards the head, makes its way "into the loose cellular tissue which abounds in the prothorax in the neighbourhood of the salivary glands." Most of them then "pass along the neck, enter the lower part of the head," whence they may pass into the proboscis. Although it has never been demonstrated that the filaria is directly inoculated into the human subject from the proboscis of the mosquito, it seems impossible to doubt that when the mosquito "strikes," the filaria makes its way into the circulation directly from the proboscis. It is important to note that the mosquito, when fed on banana pulp, does not get rid of the filaria from its proboscis. This, however, is not to be wondered at, as the filaria is apparently unable to live on the juices of the banana, whilst the consistence of the banana is very different from that of the human skin. The importance of this observation, as affording an additional reason for taking measures to get rid of the mosquito in districts in which filariasis is rife, can scarcely be over-estimated.

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NOTE.—Reference may further be made, under each heading, to the various articles and bibliographies in Allbutt's *System of Medicine*, and other works quoted under "general" literature.

(G. S. W.)

III. NEUROPATHOLOGY.

The morbid processes affecting the nervous system are numerous and varied, but usually they are clinically divided into two great groups of (1) organic disease, (2) functional disturbance. Such a classification depends upon whether or not symptoms observed during life can be associated with recognizable changes of the nervous system, gross or microscopical, after death. Sometimes this is the morbid process itself, sometimes only the ultimate result of the process. It must be remarked, however, that many diseases which we now look upon as functional may be found due to recognizable changes when suitable methods of investigation shall have been discovered. The paroxysmal neuroses and psychoses may be considered *a priori* to be due to temporary morbid functional conditions. Our knowledge of the first group is naturally much more advanced than of the latter, for, given certain symptoms during life, we are able, as a rule, to predict not only the nature of the morbid process, but its particular locality.

The histological elements which make up the nervous system may also be divided into two groups: (1) the nervous units or neurones, (2) the supporting, protecting, and nutrient tissues. Organic diseases may start primarily in the nervous units or neurones and cause their degeneration; such are true diseases of the nervous system. But the nervous units may be affected secondarily by diseases starting in the supporting, protecting, and nutrient tissues of the nervous system; such are essentially diseases *within* the nervous system, and include diseases of the blood-vessels, lymphatics, membranes, and the special nervous connective tissue, neuroglia (a residue of the embryonal structure from which the nervous system was developed). Tumours and new growths must also be included.

The modern conception of the "neurone" as an independent complex cell with branching processes, in physiological rather than anatomical association with other neurones, has modified our ideas of the morbid processes affecting the nervous system, especially as regards degenerations of systems, communities, or collections of neurones subserving special functions. It was formerly believed, and generally taught, that the primary systemic degenerations were due to a sclerosis; thus locomotor ataxy was believed to be caused by an overgrowth of the supporting glia tissue of the posterior columns of the spinal cord, which caused a secondary atrophy of the nervous tissue. We now know that this overgrowth of glia tissue is secondary to the atrophy of the nervous elements, and the only true primary overgrowth of glia tissue is really of the nature of the new growth (gliosis). But even in this case it is doubtful if the mere proliferation of the glia tissue elements could destroy the nervous elements, if it were not for the fact that it leads to changes in the vessel walls and to hæmorrhages.

The symptoms manifested during life depend upon the nature of the morbid process and the portion of the nervous system affected. A correct understanding of neuropathology involves the study of (1) the causes which give rise to morbid conditions, which are often complex and due to various combinations of factors arising from without and within the body, and (2) the changes in the structure and functions of the nervous system brought about by intrinsic and extrinsic causes. It will be assumed that the reader has already acquired a knowledge of the anatomy and physiology of the nervous system.

The *causes of pathological processes* occurring in the nervous units (neurones) may be divided into *internal* and *external*, and it may be remarked that in all cases except direct injury the two groups are generally more or less combined.

A. *Internal Causes.*—Of all the causes of nervous disease, *hereditary predisposition* stands pre-eminently first; it may be convergent, paternal, maternal; from grandparents or even more remote ancestors. Especially does this statement apply to functional neuroses, *e.g.*, epilepsy, migraine, hysteria, and neurasthenia; and to psychoses, *e.g.*, delusional insanity, mania, and melancholia. In 70 per cent. of 150 cases of idiocy or imbecility in the London county asylums, Dr Tredgold found a family history of insanity in some form or another. Strictly speaking, it is the tendency to nervous disease rather than the disease itself that is inherited, and this is frequently spoken of as a neuropathic or psychopathic taint. There are, besides, a number of inherited diseases, which, although somewhat rare, are of interest inasmuch as they affect members of a family, the same disease frequently commencing in each individual at about the same age. These are termed *family diseases*, and include hereditary ataxia (Friedreich's disease), myotonia (Thomsen's disease), hereditary (Huntingdon's) chorea, amaurotic idiocy, and various forms of idiopathic muscular atrophy. Alcoholism, tuberculosis, and syphilis in the parents, especially if one or both come from a neuropathic or psychopathic stock, frequently engender idiocy, imbecility, epilepsy, and general paralysis in the offspring, by the production of defects in the vitality of the germinal plasm, causing arrest, imperfect development, or premature decay of groups, communities, or systems of neurones, especially those which are latest developed—the symptoms manifested depending upon the portions of the nervous system affected. To explain the hereditary neuropathic tendency morphologically, we may suppose that there is an inherited defect in the germinal plasm which is concerned in the formation of the neurones. We may regard the neurone as a complex cell, and the nervous system as a community of neurones arranged in systems and groups having special functions. Like all cells, the neurone nourishes itself and is not nourished; certainly it depends for its development, life, and functional activity upon a suitable environment, but it must also possess an inherent vital energy by which it can assimilate and store up nutrient material which may be regarded as *potential* (latent nerve energy), to be converted into nerve force as required. A constant constructive and destructive bio-chemical process occurs in the neurones of a healthy nervous system, latent nervous energy is high, and the sense of fatigue is the natural indication for sleep and repose, whereby it is constantly recuperated. In the neuropathic or psychopathic individual it may be conceived that in some portion of the nervous system, especially the brain, there may exist communities, systems, or groups of neurones with inherited low potential, readily becoming exhausted, and, under the influence of altered blood states or stress, especially liable to functional depression, from which arise function-paralysis and melancholia. Again, the bio-chemical substance which represents potential in the nervous system may be in a chemically unstable condition, so as readily to fulminate when excited by abnormal conditions (*e.g.*, toxic conditions of the blood), thus acting as a centre of discharge of nervous energy, which may be manifested by mental or bodily symptoms. We know that in strychnia and tetanus poisoning the most localized peripheral excitation will cause general muscular spasm; in both toxic conditions the spread is probably due to a bio-chemical change in the protoplasm of the spinal neurones, whereby the excitability is greatly increased and a slight stimulus is sufficient to fulminate the whole system of motor neurones. In epilepsy and other paroxysmal neuroses and psychoses it is possible that some altered condition of the blood, when associated with an inherited bio-chemical instability of certain groups, systems, or communities of neurones, may act as a *fulminating agent*. In neuralgia and local hyperæsthesia the slightest general or distant local irritation suffices to produce pain; thus coughing, the vibration of a passing train, or the slamming of a door, may produce pain by the stimulation of the hyper-excitable neurones. Moreover, it must be borne in mind that the symptoms of nervous disease are due as much to normal physiological functional activity improperly applied, as to actual loss of function occasioned by disease. Thus squint, caused by paralysis of one of the muscles of the eyeball, causes less trouble to the patient than the double vision occasioned by the physiological activity of the two retinæ, upon the corresponding points of which the images are prevented by the paralysis from falling.

B. The *external causes* producing morbid changes in the nervous elements are:—

I. Abnormal conditions of the blood and lymph, by which the neurones are poisoned and their metabolism morbidly affected.

II. Excess or deficiency of normal stimulation, or existence of abnormal stimulation.

III. Injury or diseases of supporting, enclosing, or vascular tissues.

I. *Abnormal Conditions of the Blood and Lymph.*—The immediate environment of all the cellular elements of the body is lymph, and in the central nervous system there is a special form of lymph, the cerebro-spinal fluid. The neurones, like other cellular elements, are bathed in the lymph, and extract from it the materials necessary for their growth and vital activities, casting out the waste products incidental to the bio-chemical changes which are continually taking place. The lymph, therefore, serves as a medium of exchange between the blood and the tissues, consequently the essential causes of change in environment of the nervous elements (neurones) are: (1) Deficiency or absence of blood-supply to the nervous system in general (as after severe hæmorrhage), or to some particular portion, owing to local vascular disturbance or occlusion. (2) Alterations in the normal condition of the blood, due to (*a*) deficiency or absence of certain essential constituents, (*b*) excess of certain normal constituents, (*c*) the presence of certain abnormal constituents produced within the body, or entering it from without.

(1) *Quantity of Blood Supply.*—Syncope or fainting occurs when the blood supply suddenly fails to reach the higher centres of the brain; this usually arises from sudden reflex arrest of the heart's action. If a portion of the central nervous system is cut off from its arterial blood-supply by embolic plugging or by clotting of the blood in a vessel with diseased walls, the portion of the brain substance thus deprived of blood undergoes softening, the nervous elements are destroyed, and the systems of nerve fibres, which have had their trophic and genetic centres in the area destroyed, undergo *secondary degeneration.* Clotting of the blood in the veins may also give rise to destructive softening of the brain, and similar secondary degeneration.

(2) *Quality of Blood Supply.*—(*a*) *Insufficiency of oxygen*, due to poverty of the colouring matter or of the number of the red corpuscles, which constitutes the various forms of anæmia, leads to functional depression, lassitude, and mental fatigue. Impoverishment of the blood in women by frequent pregnancies and excessive lactation causes neuralgia, nervous exhaustion, and, in the neuropath, hysteria, neurasthenia, melancholia, and mania. The mental depression, and the tendency that the various neuroses and psychoses have to occur and recur at the time of the menstrual and climacteric periods in women, suggests the possibility of an alteration in the composition of the blood, either in the nature of an auto-intoxication or "sub-minimal deficiency," as the probable

contributory factor of the mental disturbance. It may be remarked that eclampsia, puerperal and lactational mania, are relatively common forms of insanity in women; although sometimes of septic origin, they more frequently are occasioned by some morbid metabolism as yet little understood. The most striking examples we have, however, of the effect of absence or "sub-minimal" deficiency of a normal constituent of the blood upon the development and functions of the nervous system, are afforded by cretinous idiots, who are born without thyroid glands, and whose brains never develop in consequence; and by those people who suffer from the disease known as *myxœdema*, occasioned by the absence of iodothyrin, a product of the internal secretion of the thyroid gland. The proof of this is shown by the disappearance of the nervous phenomena, slowness of thought, slowness of speech, &c., after a preparation of the gland has been continuously administered by the mouth. Even cretinous idiots, when subjected in early life to thyroid treatment, improve considerably. The removal of the testicles in the male may produce a profound effect upon the nervous temperament; for probably there is an internal secretion of this gland in the male, as of the ovary in the female, which has some subtle influence upon the functional activity of the nervous system. The seminal fluid contains a large amount of complex phosphorus-containing substances, which, lost to the body by sexual excess or onanism, have to be replaced by the blood; the nervous system, which also needs these complex organic phosphorus compounds, is thereby robbed, and neurasthenia ensues. Brown-Séquard's testicular injection treatment for many nervous complaints, based upon this idea, has not, however, met with much success.

(*b*) *Excess of certain Normal Constituents in the Blood.*—Excess of carbonic acid causes drowsiness, and probably in asphyxia is one of the causes of the convulsions. All the series of the nitrogenous waste products—the most highly oxidized, most soluble, and least harmful of which is urea—are normal constituents of the blood; but should the oxidation process be incomplete, owing to functional or organic disease of the liver, or should these substances accumulate in the blood, owing to inadequate function of the kidneys, a toxic condition, called uræmia, may supervene, the nervous manifestations of which are headache, drowsiness, unconsciousness or coma, epileptiform convulsions, and sometimes symptoms of polyneuritis. Again, in Graves's disease, nervous phenomena, in the form of exophthalmos, fine tremors, palpitation, and mental excitement, have by some authorities been explained by the excess of thyroid internal secretion, due to the enlargement and increased functional activity of the gland.

(*c*) The presence of *abnormal constituents in the blood* is a most important cause of disease of the nervous elements. We may consider the subject under the following headings: Poisons produced within the body (α) by perverted function of organs or tissues, auto-intoxication; (β) by the action of micro-organisms upon the living fluids and tissues of the body; (γ) poisons introduced into the body from without, in the food and drink, or by inhalation.

(α) *Poisons resulting from perverted Function of the Organs.*—In the process of digestion a number of poisonous substances, *e.g.*, albumoses, &c., are produced, which, although absorbed in the alimentary canal, are prevented by the living epithelium, and possibly by the liver, from entering the systemic circulation. Fatigue products, *e.g.*, sarcolactic acid in prolonged muscular spasms, may lead to auto-intoxication. Excess of uric acid in the blood is associated with high arterial pressure, deposits of lithates in the urine, headache and nervous irritability; it is an indication of imperfect metabolism and auto-intoxication, as shown by the fact that marked improvement occurs by suitable diet and treatment. Phosphoruria, oxaluria, and glycosuria, tokens of deranged metabolism, may be associated with various nervous phenomena. Bile in the blood, cholæmia, resulting from obstructive jaundice, may be attended by stupor and psychical depression; and the term melancholia, signifying "black bile," indicates the importance which has long been attached to the liver as an organ the derangement of which causes nervous depression. The rapidly fatal results attending acute yellow atrophy of the liver, namely, the profound changes in the urine, the jaundice, and the nervous phenomena of delirium, motor irritation, delusions, stupor, and coma, demonstrate the important part this organ plays in preserving the normal quality of the blood. The delirium and coma which sometimes supervene in diabetes, heralded by acetonæmia, is another instance of auto-intoxication. The coma is very possibly due to the saturation of the sodium salts of the blood by aceto-acetic and oxybutyric acids, products of imperfect proteid metabolism. The effect of this would be an interference with the elimination of carbonic acid in the processes of tissue and pulmonary respiration. Again, in pernicious and certain grave anæmias, the degenerative changes in the spinal cord found in some cases is due, not so much to the defect in the red corpuscles, as to some neuro-toxin, which probably arises from imperfect metabolism or absorption from the alimentary canal. In this question of auto-intoxication, it must be remarked that all the tissues of the body are mutually interdependent. If one suffers, all suffer, and a disease of one organ or tissue is thereby apt to establish a vicious circle which is constantly enlarging; therefore nervous symptoms manifesting themselves in the course of a disease add much to the gravity of the complaint.

(β) *Poisons produced by Infective Micro-organisms.*—Some of these poisons have a general devitalizing influence, by an alteration of the blood and the production of fever. In the course of the acute infectious diseases, typhoid, typhus, small-pox, scarlet fever, measles, influenza, also tuberculosis and septicæmia, delirium is a frequent complication; it may be the result of high fever or prolonged fever, or directly due to the poison, or the two combined. In severe cases stupor and coma may occur, and it has been shown that in this extreme stage the nerve cells undergo an acute morbid bio-chemical change. These particular poisons have no selective toxic action upon a particular part of the nervous system, and symptoms not only during, but after, the acute illness are liable to supervene, especially in a neuropathic individual. Thus many cases of neurasthenia, insanity, neurosis, also neuritis, date their origin from an acute specific fever. In cerebro-spinal meningitis, tubercular meningitis, acute delirious mania, and leprous neuritis, the inflammation of the membranes of the brain and spinal cord, is due to the growth of the specific organism in the lymph and interstitial tissue elements.

Poisons may have a *selective influence* upon some part of the nervous system. The syphilitic poison is the most important factor in the production of two progressive degenerations of the nervous system—one affecting especially the afferent conducting tracts of the spinal cord, namely, locomotor ataxy, and the other affecting especially the frontal and central convolutions of the cerebral hemispheres, namely, general paralysis of the insane. A striking instance of the selective action of the syphilitic poison is shown in the fact that only in persons affected with acquired or inherited syphilis is a symptom known as Argyll-Robertson pupil found; this is the absence of the pupil reflex contraction to light, while that for accommodation persists. Seeing that this is the most common objective phenomenon in the two diseases mentioned, it strengthens the presumption, based on experience, that the syphilitic poison is the cause of these diseases in the majority of instances. Again, syphilis, when it attacks the supporting, enclosing, and nutrient vascular tissues, shows a predilection to affect structures about the base of the brain, and paralyses of the third nerve are almost pathognomonic of this disease. In rabies, although the whole nervous system is charged with the poison, the medulla oblongata (as shown by the symptoms) is especially affected. Again, in tetanus the bacilli are only found in the wound; they must therefore be comparatively few in number, but they elaborate a virulent poison, which affects particular groups of neurones. The fact that lockjaw nearly always occurs first, shows that the poison selects the motor nucleus of the fifth nerve; but it is remarkable that experiment has shown that the tetanus toxin, if mixed with an emulsion of nervous matter before injection into an animal, loses its toxicity. This fact indicates its affinity for nervous matter, and also a power of absorption of the poison by some chemical substance in the nervous matter. Another example is offered by diphtheria. A neuro-toxin is produced by the local action of the bacilli, for they do not become freely generalized in the blood and tissues. Whether the poison is a direct production of the bacilli themselves, or is an auto-toxin created in the body itself, by an influence exerted on the living fluids and tissues by a ferment-like product of the bacilli, is not determined. But whatever may be the source of the toxin, its effects upon the neurones are constant, as shown by the sufferings of the patients—paralysis of the soft palate, with nasal speech and regurgitation of fluids through the nose when swallowing is attempted; inability to read, owing to the paralysis of the muscle of accommodation; weakness and incoordination of the limbs, which may amount to paralysis; absence of the knee-jerks; and often skin anæsthesia.

(γ) *Poisons introduced into the Body.*—The most widespread and potent cause of nervous and mental disease is the abuse of alcoholic stimulants. At least 20 per cent. of the inmates of the asylums of London are suffering from the effects of the abuse of alcohol. Most of these patients, however, inherit the neuropathic tendency, and it is a rare thing, among such, to find cirrhosis of the liver with ascites, a condition which indicates long persistent spirit-drinking. The writer, from a very large experience as pathologist to the asylums of London, only remembers one such case, and that was in a notorious woman who was convicted nearly four hundred times for drunkenness before she could be certified as of unsound mind, a fact which indicates that she inherited a very stable nervous constitution. To people with unstable nervous systems a relatively small quantity of alcohol may act as a poison. Alcohol may produce acute delirium, with fine tremors, and, generally, visual hallucinations of a horrible nature, indicating acute toxic influence upon the brain. This acute form of alcohol poisoning is much commoner in men than in women, and it is remarkable how a severe injury or illness, such as pneumonia, will bring out *delirium tremens* in a drunkard. Alcohol acts especially upon the higher centres of the brain, and a drunken man may exhibit "the abstract and brief chronicle of insanity, going through its successive phases in a short period of time" (Maudsley). The effect on the nervous system of chronic tippling is dementia, a very characteristic manifestation of the mental degradation being absence of knowledge of time and place, personal illusions, and loss of memory of recent events, indicating a failure of receptivity and of the formation of memory-pictures in the higher centres. A certain amount of improvement may occur when total abstinence is enforced, which shows the poison has damaged but not destroyed the nervous elements. Besides mental symptoms of alcoholic poisoning, there is frequently paralysis, affecting especially the lower limbs (structures suffer most where vitality is least), although the upper limbs, and even the respiratory muscles, may be affected in severe cases. The patient becomes helpless and bedridden, and death frequently occurs from heart failure. Characteristic features of this affection are great tenderness on pressure of the muscles, especially of the calves, absence of reflexes, a variable degree of skin anæsthesia, wasting of muscles and alteration of the normal electrical reactions, and frequently pyrexia. There is no loss of control over the bladder and bowels, unless there is very marked dementia. This "complex of symptoms" points to a *peripheral polyneuritis*, although frequently changes occur also in the ganglion cells, from which the axis cylinders of the nerves have their origin (*vide* Plate X., Nos. 6, 7, 8, and 9). Many other poisons, notably lead and arsenic, the specific fevers before mentioned, syphilis, and alterations of the blood due to imperfect metabolism, such as occur in diabetes and gout, may produce, or become important factors in producing, peripheral neuritis. The outbreak of arsenical neuritis from beer containing this poison in Manchester in 1900 is of interest, from the fact that the symptoms closely resemble acute alcoholic neuritis. A distinctive feature, however, was the pigmentation of the skin and the severity of the nervous symptoms. A disease which is common in the East, termed *Beriberi*, is a form of neuritis, the cause of which is not exactly known, although it is possibly infective, and due to elaboration by micro-organisms of some chemical poison which escapes into the blood. Still, the fact that it has almost disappeared from the Japanese navy with improved diet and better hygiene would suggest that it is due to auto-intoxication from defective metabolism. Anæsthetic leprosy is an interstitial inflammation of the nerves due to the *Lepra bacillus*. Among the nervous diseases due to occupation may be cited lead-poisoning. This is peculiar in selecting the nerve which supplies the extensor muscles of the wrist and fingers, so that dropped wrist is almost characteristic of this form of toxic neuritis. Lead also produces a chronic inflammation of the cerebral cortex, *Encephalitis saturnina*, causing a complex of symptoms, namely, dementia, loss of memory, weakened intellect, paresis and epileptiform seizures, hallucinations of sight and hearing, and mental exaltation or depression. Mirror-makers suffer with characteristic fine tremors, from the slow absorption of mercury into the system. Workmen at indiarubber factories may suffer from severe mental symptoms, owing to the inhalation of the fumes of bisulphide of carbon.

There are a certain number of poisons, besides alcohol, which act upon the nervous system when continually entering the body as the result of a *habit*, namely, absinthe, ether, cocaine, opium, morphia, haschish, and tobacco. Each of these poisons produces a train of symptoms denoting a selective influence upon certain parts of the nervous system. In illustration thereof may be mentioned impairment of central vision in tobacco amblyopia.

Unsound Food.—In northern Italy and Egypt numbers of people suffer with *Pellagra*, an affection of the skin associated with degenerative changes in the brain and spinal cord. The symptoms of the disease are generally a fatuous melancholy with suicidal impulses, sometimes mania associated with paresis. It is supposed that this disease is due to the bad maize upon which the people at times have to subsist. Another disease, *ergotism*, in an epidemic form, has affected poor people in Russia and North Germany when obliged to subsist upon bread made of rye which has been attacked by the ergot fungus. The poison thus introduced into the system produces progressive degenerative changes in the brain and spinal cord, which are manifested by psychical disturbances, such as slowness of thought, weakness of memory, dulness of perception, sometimes delirium and incoherence; other symptoms are blunted sensibility, dilated pupils, muscular spasms, perhaps even epileptiform seizures and ataxy, and, lastly, stupor deepening into coma. Sausage disease, due to eating decayed meat and fish infected with *Bacillus botulinus*, is associated with symptoms which frequently terminate fatally, and it has been shown that the symptoms are due to a poison which has a very destructive effect upon the nerve cells (Plate X., No. 10).

II. *Normal and Abnormal Stimulation.*—The nervous system, in order to develop and manifest functional activity, requires suitable stimulation from without. Structure and function are mutually reciprocal and interdependent; for a structure which is not used will gradually lose its function, while its nutrition will also suffer, and in time atrophy may occur. Consciously and unconsciously, a continuous stream of impulses is pouring into the nervous system from without by the sensory channels, which are the avenues of experience and intelligence, and our somatic and psychical life depends upon the existence of such stimuli. The nervous system in the form of systems, groups and communities of neurones, each with special functions, yet all woven together in one harmonious whole, develops in a particular way in consequence of the awakening influence of these stimuli from without. Consequently nervous structures which are not used are liable to undergo regressive metamorphosis and atrophy; thus amputation of a limb in early life causes atrophy of the nervous structures which presided over the sensation and movement of the part. This is seen both in the grey and white matter of the spinal cord. A healthy physical, intellectual, and moral environment of the individual is an essential factor in the prevention and cure of psychoses and neuroses, because it tends to develop and strengthen body and mind, deliberation, judgment, and the higher controlling functions of the brain. A function not used will gradually disappear, and become more and more difficult to evoke. This fact is of importance in functional neuroses and psychoses, *e.g.*, hysterical paralysis, melancholia, and delusional insanity, because the longer mental or bodily function is left in abeyance, the more likely is the defect to become permanently installed. The converse is also true: the longer a perverted function exists, the more unlikely it is to disappear. Thus auditory hallucinations, a very important and frequent symptom in the insane, commence with indistinct noises; these are followed by "voices," which eventually become so distinct and real that the greater part of the patient's psychical existence is concentrated upon, and determined by, this abnormal stimulus from within, indicating progressive strengthening and fixation of the perverted functions of the mind, and progressive weakening and dissolution of the normal functions.

Mental pain in the form of grief, worry, anxiety, fright, shock, violent emotions (pleasurable or painful), disappointed love, sexual excesses or perversions, and excessive brain work, frequently precede and determine, in persons with the insane or neuropathic taint, various forms (*a*) of psychoses, *e.g.*, mania, melancholia, delusional insanity; (*b*) of neuroses, *e.g.*, chorea, hysteria, epilepsy, hystero-epilepsy; (*c*) of organic brain disease, *e.g.*, apoplexy, thrombosis, general paralysis.

Visceral reflex irritation affords many examples of neuroses and psychoses, the symptoms of which are set up by irritation of the viscera, *e.g.*, intestinal worms. Teething and indigestible food are often the exciting cause in infants and young children of convulsions, spasms of the glottis, and tetany. Various functional and organic diseases of the female reproductive organs act as exciting causes in the production of hysteria, hystero-epilepsy, melancholia, and mania; moreover, paroxysmal attacks in these diseases are more liable to occur at the menstrual period or menopause. The irritation of a carious tooth may produce spasmodic tic and trigeminal neuralgia. Wax in the ear may occasion vertigo and tinnitus; and errors of refraction in the eyes may be the cause of attacks of migraine, and even tend to excite epileptic fits in a person suffering from epilepsy. Numerous other examples of peripheral disturbance could be mentioned as exciting causes of nervous affection in neurotic individuals. Irritation of the terminals of the vagus in almost any part of its widespread visceral distribution may lead to vomiting. The characteristic pain of angina pectoris, which radiates down the inner side of the left arm, is explained by the fact that the cardiac branches of the sympathetic arise from the same segments of the spinal cord as the sensory branches of the ulnar nerve; consequently the pain is referred to the corresponding skin area supplied by this nerve. This is one example of a great number of *referred pains*.

III. *Injury or disease of enclosing or supporting structures* may lead to paralytic or irritative lesions of the nervous system, or the two may be combined. Blows or wounds of the head and spine may damage or destroy the nervous structures by shock or direct injury. Concussion of the brain or spinal cord may occur, as a result of injury, without any recognizable serious damage of the enclosing structures or even the central nervous system. Shock, due to concussion, can only be explained by a molecular or bio-chemical change in the nervous structures.

Direct injury or a fall fracturing the skull, driving the fragments into the brain, will cause direct destruction of the nervous tissue; but wounds and diseases of the enclosing and supporting structures, if producing simple non-infective inflammation, give rise only to such symptoms as accord with the nerve structure irritated or destroyed. Should, however, the wound or diseased structure become infected with micro-organisms, the disease spreads and becomes generalized, likewise the symptoms. Of all the causes of infective inflammation, middle-ear disease, on account of its frequency and insidious onset, is the most important. It is very liable, when neglected, to be followed by a septic meningitis, encephalitis, and brain abscess, the most frequent seat of which is in the adjacent temporal lobe, but it may be in other parts of the brain, *e.g.*, the cerebellum and frontal lobe (Fig. 2, Plate IX.). The peripheral nerves may be destroyed or irritated by direct injury, disease, or new growth in adjacent tissues, or they may be involved in the callus thrown out round the seat of a fracture.

Diseases of the blood-vessels are among the most frequent causes of organic brain disease. Arteries or veins—more frequently the former—may become blocked or ruptured from various causes, the result being destruction of some portion or portions of the nervous tissue, with corresponding loss and disturbance of function. The cerebral arteries may be occluded by embolism; a portion of a clot or vegetation from a diseased valve of the left side of the heart may be detached, and escape into the circulation; and this is carried into one of the arteries of the brain, usually the middle cerebral, more often of the left side than the right. The area of brain tissue supplied by that artery is deprived of blood, and undergoes softening in consequence, resulting in paralysis of the opposite half of the body (hemiplegia), associated with aphasia when the paralysis affects the right side in a right-handed person. Softening may also arise from coagulation of the blood (thrombosis) in an artery the walls of which are diseased. This is a very common cause of paralysis and dementia in people who have passed middle life. General disease of the arteries of the body, associated especially with chronic Bright's disease and high arterial pressure, is frequently attended with the formation of minute miliary aneurysms upon the cerebral arteries, which may rupture and cause apoplexy. Hæmorrhage into the brain from this cause is especially liable to occur in certain situations; one vessel in particular, supplying the basal ganglia, most frequently gives way, the effused blood tearing through the motor efferent fibres, which, proceeding from the cerebral cortex in the shape of a funnel, become aggregated together to form the neck between the two masses of grey matter—the optic thalamus and the corpus striatum (Fig. 4, Plate IX.). The result is hemiplegia of the opposite side of the body. Disease of the arteries of the central nervous system, occurring in a person under forty, is generally due to syphilis, the poison of which produces an inflammation of the coats of the vessel, especially the inner. Occlusion and softening may arise; and seeing that any or all the arteries of the brain may be affected successively, simultaneously, or at random, the symptoms may be manifold. They may be general or local, and not uncommonly are associated with inflammation of the membranes. The disease, under treatment, may abate, and the paralytic or mental phenomena partially or completely disappear, indicating the restoration, or partial restoration, of the circulation in the diseased arteries; sometimes with the lapse of treatment and sometimes without, new symptoms, such as paralysis of a fresh group of muscles or of the opposite side of the body, may manifest themselves, showing that the disease has attacked a fresh set of arteries. *Disseminated sclerosis* (*insular*) is another random morbid process, affecting especially the white matter, with certain characteristic symptoms of a progressive character, the pathology of which is not understood fully. Islands of nervous tissue undergo a morbid change, commencing in the myelin sheath and ending in an increase of the supporting neuroglia tissue at the expense of the true nervous tissue.

Tumours and new growths in the central and peripheral nervous systems may be primary or secondary: the former arise in the supporting, enclosing, or nutrient tissue elements; the latter are metastatic deposits from tumours originating elsewhere. Tumours may be single or multiple, the special symptoms occasioned depending upon the seat of the tumour and whether it destroys or only irritates the adjacent nervous tissue. Tumours situated within the cranial cavity cause general symptoms, namely, optic neuritis, severe headache and vomiting; these symptoms, which are caused by increased intracranial pressure, are more severe in rapidly-growing vascular tumours, even though small, than in large slow-growing tumours. If the growth is situated in a portion of the cortex having some special localizing function, *e.g.*, the motor area (*vide* Fig. 1), it may give rise to epileptiform convulsions, starting in a limb or definite group of muscles; but the irritation usually spreads to the whole motor area of the same side, and even extends to the opposite hemisphere, by an overflow of the discharge through the corpus callosum. In such case there is loss of consciousness. If, however, the tumour destroys the cerebral cortex of a particular region, it may give rise to a paralytic lesion, *e.g.*, paralysis of the arm (*vide* Fig. 3, Plate IX.).

Organic diseases of the blood-vessels, or of supporting and enclosing tissues, produce secondary degenerations of the nervous system. The symptoms, like the lesion, are obvious, coarse, and obtrusive; frequently arising suddenly, they may in a short time terminate fatally, or tend towards

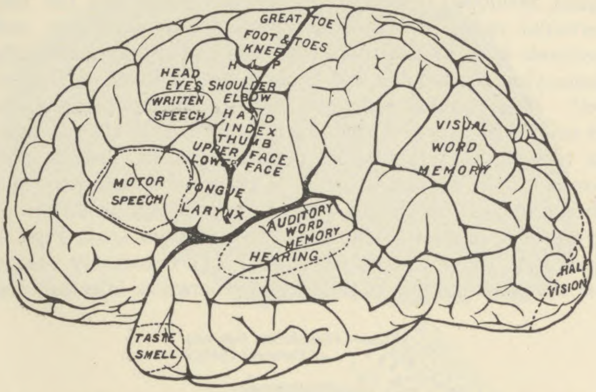


FIG. 1.—Diagram of left cerebral hemisphere, showing localization of function. The motor region is situated in front of the central sulcus, and is arranged in a series from "toe to larynx" downwards, corresponding in an inverse manner to the spinal series. Irritation of any part of this area will cause localized convulsive spasms, which may spread in a definite march to the whole motor area, as in Jacksonian epilepsy. Destructive lesions will cause paralysis. The centre for "taste and smell" is represented at the tip of the uncinate convolution. The centre for "half-vision" is only in small part represented, for the larger part is on the mesial surface. "Hearing" is represented occupying the posterior half of the first temporal convolution. Included in this area, but in the *left* hemisphere only, is the centre for "auditory word memory"; destruction of this causes inability to understand the meaning of words uttered, although the patient is able to read aloud. Behind this, in the angular gyrus, is the centre for "visual word memory"; destruction of this causes loss of power of understanding of written or printed words—therefore inability to read. In front of the motor area is Broca's convolution, the centre of "motor speech"; destruction of this produces motor aphasia, or inability to articulate words. Above this is a centre which is connected with written speech. These four centres concerned with verbal and written language are connected by commissural fibres, and destruction of these connexions leads to various defects in verbal and written language. It will be understood from this diagram that diseases of the left hemisphere in right-handed persons are associated with results of more significance than similar affections of the right hemisphere.

partial or complete recovery. Various forms of motor and sensory loss and disturbance of function may arise, indicating destruction or disturbance of particular regions of the central nervous system; and degenerations in certain tracts and systems of fibres arise, corresponding in histological character with those observed when a nerve fibre

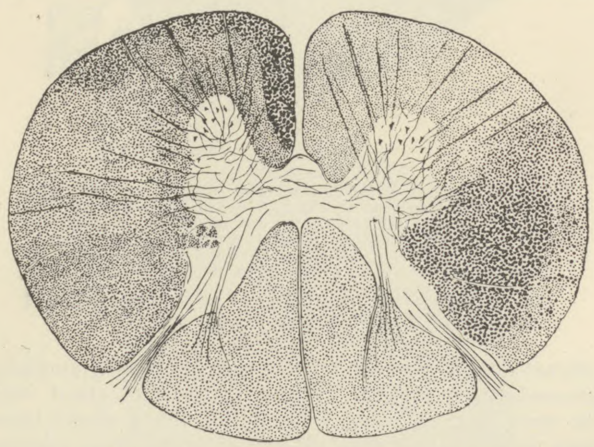


FIG. 2.—Diagram of section of the spinal cord in the upper cervical region, showing recent degeneration of the crossed pyramidal tract of the right side and direct pyramidal tract of the left side. The black dots indicate the degenerated fibres stained by the Marchi method. This degeneration is secondary to hæmorrhage into the internal capsule of the left hemisphere, and it will be observed by the number of degenerated fibres that the greater bulk have crossed over to the right side of the spinal cord, thus agreeing with the fact that the paralysis is of the right half of the body.

is separated from its cell of origin by section (secondary degeneration of Waller and Türck) (*vide* Fig. 2, with explanation). This form of degeneration must be distinguished from primary degeneration, which is due to an inherent nutritional defect of the nerve cell and all its processes (the neurone), in which a regressive metamorphosis occurs; it starts in the structures of the neurones latest developed (namely, the myelin sheath and the fine terminal twigs of the axis cylinder and dendrons), and proceeds back to the main branches and trunk, eventually destroying the trophic and genetic centre itself, the nerve cell. These *primary* degeneration processes are insidious in origin, progressive in character, and nearly always fatal in termination; they affect definite systems, groups, and communities of neurones in a progressive manner, and therefore are associated with a progressive evolution of symptoms, related to the structures affected (*vide* Figs. 3 and 4). To cite some examples: (1) Locomotor ataxy, on the one hand, is a primary degeneration affecting the

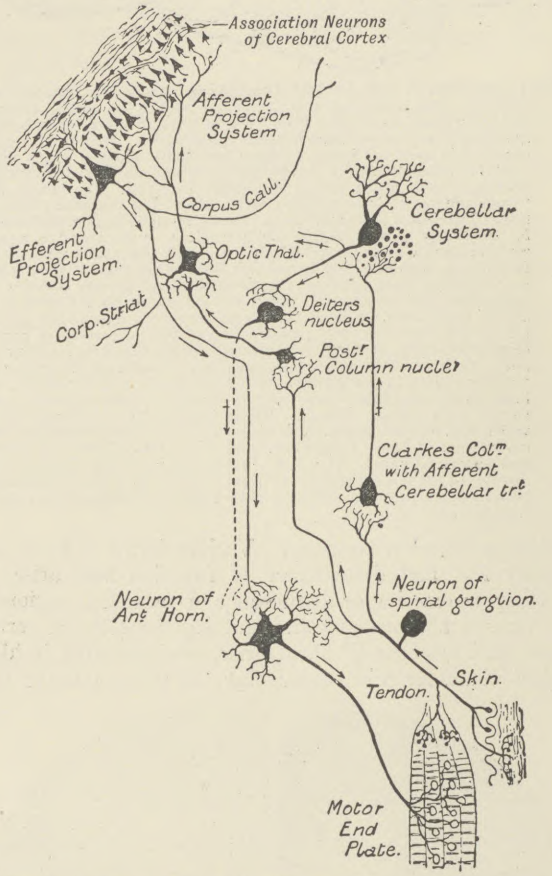


FIG. 3.—A diagram to indicate afferent, efferent, and association systems of neurones. It will be observed that there are three nervous circles indicated by the arrows—spinal, cerebellar, and cerebral. In every perfect co-ordinate movement impulses properly adjusted are flowing along these three systems of neurones. In systemic degenerations one or more of these systems may be affected, and the symptoms will depend partly upon the function which is lost or disturbed, and partly upon the disturbance of equilibrium of the three co-ordinated systems.

afferent system of neurones; it is characterized by muscular inco-ordination without wasting, inability to stand with the eyes shut, lightning pains in the limbs, absent knee-jerks, Argyll-Robertson pupils, and other symptoms pointing to a morbid process affecting especially the afferent sensory system of neurones. (2) Progressive muscular atrophy, on the other hand, is a disease of the *efferent* motor system of neurones of the brain and spinal cord, characterized by progressive wasting of groups of muscles innervated by groups of neurones which are undergoing degeneration. A fatal termination to this disease frequently arises from affection of the medulla oblongata, causing what is known as bulbar paralysis. Infantile paralysis is an acute inflammation of the anterior horns of the spinal cord, causing destruction of the spinal motor neurones of the anterior horn. It differs from the above chronic disease in its sudden onset and non-progressive character; it resembles

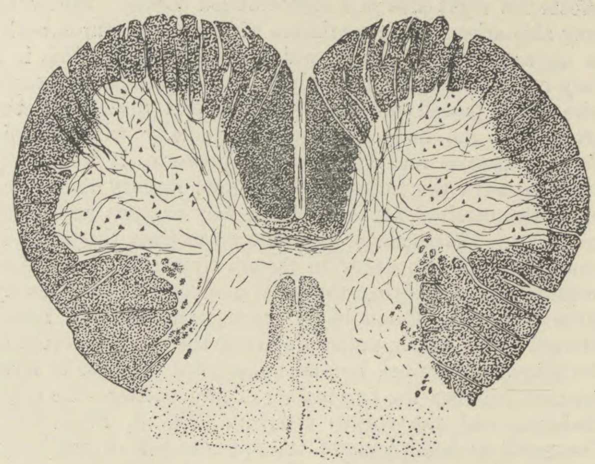
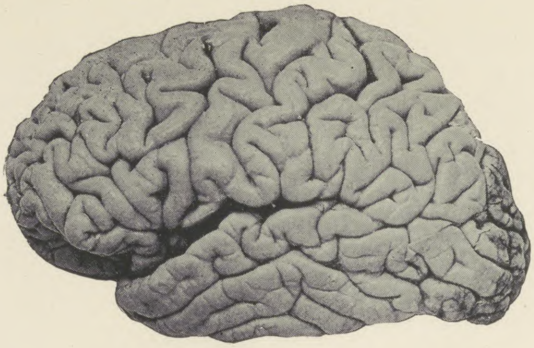


FIG. 4.—Diagram of spinal cord, fifth lumbar segment, from a case of advanced *tabes dorsalis*. The posterior column is shrunken, and but faintly stained, except in the anterior part; the shrinkage and the loss of stainability are due to the absence of fibres of the posterior roots, which normally form the greater part of this region of the cord. The fibres which are seen in the anterior part of the posterior column are derived from cells within the spinal cord, and belong to spinal association neurones.

it in producing paralysis of muscles without sensory disturbance. (3) General paralysis of the insane is a degeneration which begins in the association system of neurones of the cerebral cortex, but which may be, and frequently is, associated with degeneration of the afferent or efferent systems (Fig. 3).

It is not attempted in this article to explain neuroses and psychoses by morphological changes in the brain (Fig. 1, Plate IX.). We know little or nothing accurately about the morbid histology of insanity, except as regards the morphological changes met with in cases of amentia and dementia. The conditions of amentia, namely, idiocy and imbecility, are associated with arrest of development of the brain, as a whole or in part, the naked-eye evidence of which may be afforded by small size and simplicity of convolutions of the brain as a whole or in part (Figs. 7, 8, and 9, Plate IX.); and the microscopical evidence by arrest of development, or imperfect development, of structures connected with the higher functions of the mind, namely, the association neurones in the superficial layers of the cerebral cortex (Fig. 5). Conditions of dementia, primary or secondary, are associated with progressive decay and atrophy of the superficial layers of the grey matter of the cortex, and naked-eye evidence thereof is afforded by partial or general wasting of the cerebral hemispheres, accompanied with thickening of the pia-arachnoid membrane, atrophy of the convolutions, and with deepening and widening of the intervening sulci (Figs. 5 and 6, Plate IX.). This wasting is especially due to atrophy of the cells and fibres of the superficial grey matter of the cortex, sections of which, examined microscopically, after suitable methods of staining have been employed, show great poverty, or complete loss, of three sets of delicate myelinated fibres, namely, tangential, super-radial, and the inter-radial corresponding to the line of Baillarger. This degeneration of the superficial association fibres of the cerebral cortex affects especially the frontal and central convolutions, and is the earliest and most constant microscopical change in progressive dementia; it is accompanied usually by vascular changes, atrophy of the nerve cells, and proliferation of the neuroglia (Fig. 5). Possibly new methods may enable us to show changes of structure in diseases such as epilepsy and delusional insanity, in which hitherto

PLATE IX.



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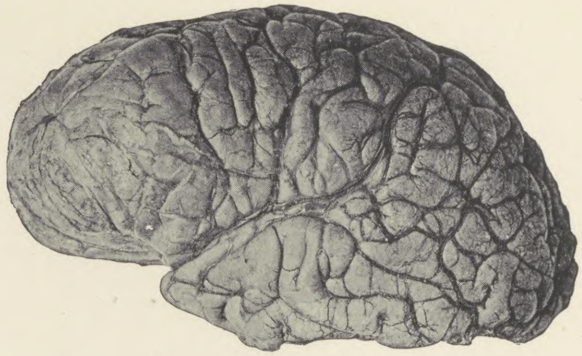

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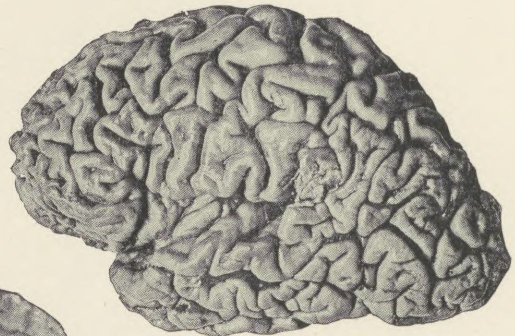

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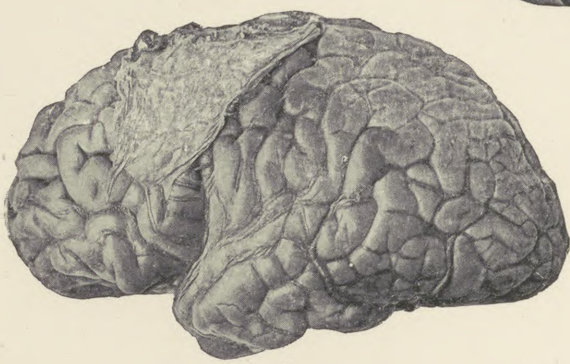

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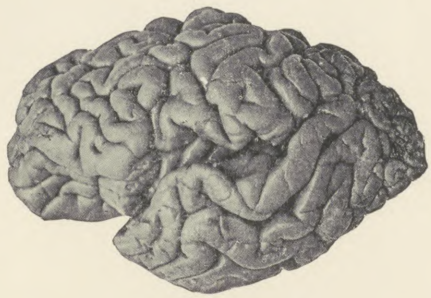

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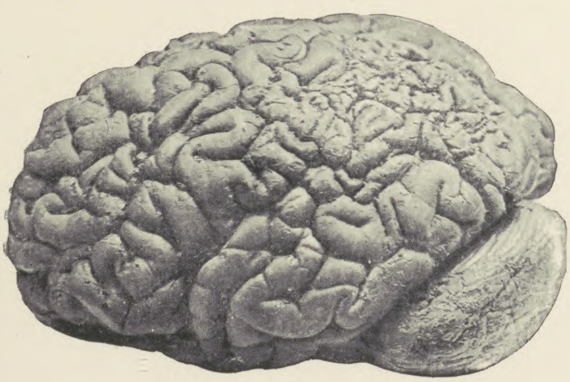

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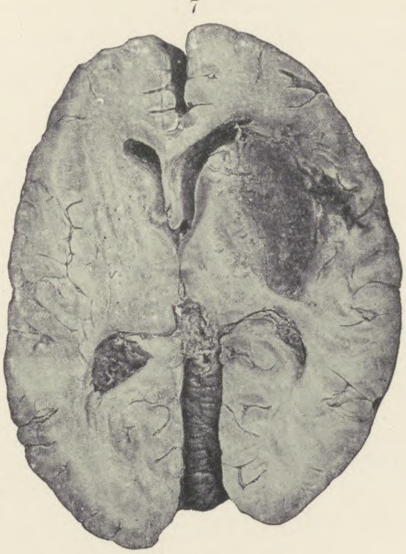

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(For explanation, see page 546.)

PLATE X.

Varions Motor Cells, drawn from microphotographs of preparations stained by Nissl method to show microchemical changes produced by various diseases. 1. Normal motor cell from cerebral cortex, showing a mosaic pattern of the cytoplasm due to a substance stainable by basic aniline dyes; this stainable substance exists also on the dendrons. By comparing the appearances of this cell with the other figures a just idea can be obtained of the morbid changes which result in various pathological conditions. 2. Cell from a case of hyper-pyrexia—disappearance of the mosaic pattern, substance uniformly stained; absence of the chromatic elements on the dendrons, due to a precipitation of cell-globulin by the heat. 3. Cell in an advanced stage of coagulation necrosis, complete absence of mosaic pattern; diffuse fine dust-like stain; breaking off of the processes; all caused by softening of the brain from vascular obstruction. 4. Another specimen from the same brain in a still more advanced stage of destruction, and showing a phagocyte attached to the cell and devouring the decayed structure. 5. A cell with enormously swollen nucleus, the result of hydration due to absorption of fluid after ligature of cerebral vessels. Such a cell will probably recover. 6, 7, 8, and 9. Spinal motor cells in various stages of destruction, from a case of acute alcoholic poly-neuritis, illustrating, 6, chromatolysis; 7, ditto with eccentric nucleus; 8, extrusion of nucleus; 9, vacuolation. 10. Cell illustrating swelling of nucleus and chromatolysis in acute toxæmia produced by poison of bacillus botulinus.

no naked-eye or microscopical structural defects accounting for the symptoms have been certainly demonstrated.

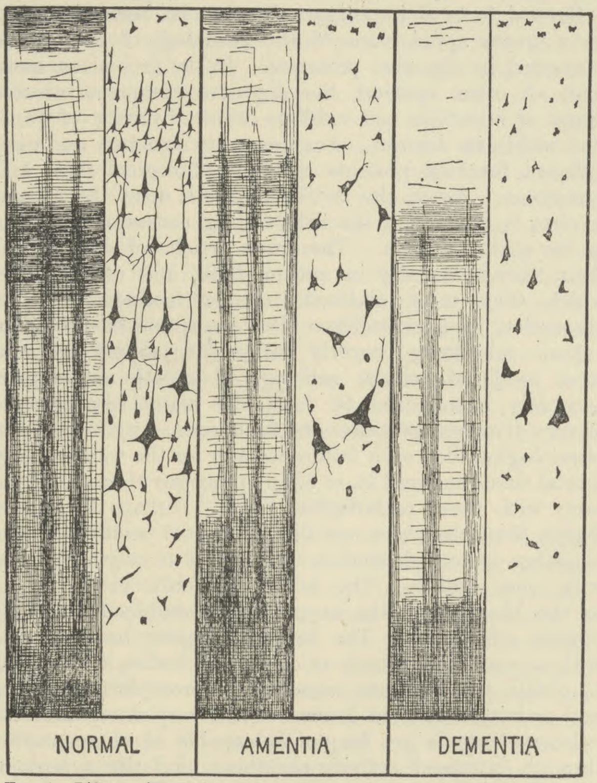

FIG 5.—Diagram illustrating the relative number and wealth of cells and fibres in the cerebral cortex in the normal brain, in amentia and dementia. The horizontal systems of fibres are association systems, and it will be observed that these are especially diminished in amentia, and still more in dementia, whereas the radial fibres are less affected. In the normal, there are five layers of cells arranged in columns (Meynert's); in the pathological conditions it will be observed that the pyramidal-shaped cells no longer have their apical processes pointing vertically upwards. The processes are broken off, the cells are distorted in shape and diminished in numbers, and the degree of dementia in a wasted brain is proportional to the atrophy and destruction of the small and medium-sized pyramids of the whole cerebral cortex, and the disappearance of the superficial layers of fibres. This is especially manifested in paralytic dementia and the dementia of chronic insanity.

In conditions of acute mania there is usually considerable vascular engorgement.

Microscopical changes in degeneration of the neurone.—About 1850, Waller demonstrated that a nerve fibre underwent degeneration to its termination when separated from its cell of origin; hence the term "Wallerian degeneration." Embryological researches by Professor His showed that the axis-cylinder process (the essential conducting portion of the nerve fibre) is an outgrowth of the nerve cell. The cell, therefore, is the trophic and genetic centre of the nerve fibre. Acute alterations and death of the nerve cells may occur from toxic conditions of the blood; from high fever (107–110° F.); arrest of the blood supply, as in thrombosis and embolism; or actual destruction by injury, hæmorrhage, or inflammation. These morbid processes produce, as a rule, bio-chemical as well as morphological changes in the nerve cell and its processes. Space will not allow of a full description, but some of these changes are indicated in Plate X. When a nerve cell dies, the nerve fibre undergoes secondary degeneration and death; that is to say, the whole neurone dies, and regeneration, at any rate in the higher vertebrates, does not take place. Restoration, or partial restoration, of function is due to other structures taking on the function, and the more specialized that function is, the less likely is restoration to take place. If, however, a peripheral nerve is divided, its component fibres are merely severed from their cells of origin. All that portion of the nerve which is in connexion with the nerve cells of origin practically undergoes no change. The peripheral portion undergoes degeneration, but from the central end of the nerve new axis cylinders again grow out and a new nerve is formed. With this regeneration comes restoration of function, which may be hastened by suturing the ends of the cut nerve. A similar regeneration, however, does not occur after section of fibres of the white matter of the central nervous system, and this may be due to the fact that the nerve fibres of the white matter of the cerebro-spinal axis possess no nucleated sheath of Schwann, which, by the light of recent investigations, is shown to play an important part in regeneration; in the writer's opinion, the neurilemmal sheath of the old fibre forms a new protoplasmic basis, into which the axis-cylinder from above grows, the passage of stimulus determining its function. The accompanying Fig. 6, Nos. 1–8, with explanatory text, shows the changes which occur in degeneration and regeneration of a peripheral nerve after section, with loss of function; and subsequent union, with restoration of function. The writer, in conjunction with Professor Halliburton, has shown that the characteristic microscopical changes in the myelin sheath which occur in the process of degeneration are due to a splitting up of the complex phosphoretted substance "protagon" into glycero-phosphoric acid, choline, and oleic acid by a process of hydration. The Marchi reaction, which has been found so useful for demonstrating degeneration of the central and peripheral nervous systems, is dependent upon the

FIG. 6.—Diagram to illustrate various stages in degeneration and regeneration of medullated nerve fibres. 1. Normal medullated nerve with node of Ranvier. 2. Degenerated nerve, ten days after section, showing degenerated myelin stained black; disappearance of axis-cylinder. 3. Central end of cut nerve, showing at the top an axis-cylinder budding out, proliferated neurilemmal cells, and still some degenerated myelin in sheath. 4. Peripheral cut end of same, showing proliferated neurilemmal cells, still some degenerated myelin. 5. Complete absorption of degenerated myelin, protoplasmic basis of new fibre formed out of neurilemmal cells. 6. A new fibre, with axis-cylinder. 7. Central end of cut nerve at junction, showing an axis-cylinder sprouting and forming a number of axis-cylinder processes, which grow into the peripheral end to form new channels of conduction. 8. is a new regenerated fibre resembling a sympathetic fibre in having as yet no myelin sheath; as the nerve becomes excitable and stimulus passes, a myelin sheath is formed.

fact that the myelin sheath, after hardening in a solution of bichromate of potash, does not turn black when acted upon by osmic acid, whereas the simpler non-phosphoretted fatty product of degeneration is stained black. When the Marchi reaction of degeneration is fully developed, it has been ascertained that the nerve yields no phosphorus. The degeneration resulting from section of a nerve is termed *secondary*, to distinguish it from another, *primary*, due to slow and progressive decay of the whole neurone, beginning usually at the terminal twigs and proceeding back towards the cell body with its contained nucleus. These primary degenerations involve systems of neurones, correlated by function rather than by anatomical situation. Examples are afforded by locomotor ataxy and progressive muscular atrophy, the former being a degeneration of the afferent sensory system of neurones, the latter of the motor efferent system. The cause of primary degenerations is probably a defect inherited or acquired in the "vita propria" of the neurones affected. They slowly atrophy and disappear, and their place is filled up by an overgrowth of the supporting neuroglia tissue (Figs. 4 and 7). This overgrowth of dense tissue is termed sclerosis, and was erroneously considered to be the cause, instead of the effect, of the atrophy of the nervous tissue.

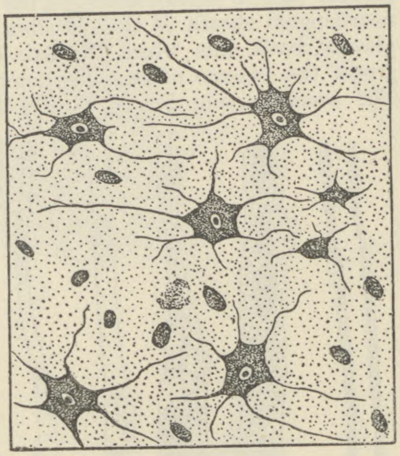

FIG. 7.—Diagram drawn from micro-photograph to show different forms of neuroglia cells in a patch of sclerosis secondary to degeneration and disappearance of the neurones. Observe the large branched cells of Deiters.

For further information the reader may consult the Croonian Lectures on the Degeneration of the Neurone, by the writer of this article, published in the *Lancet*, 1900; also Gower's *Handbook of the Nervous System*, Von Monakow's *Gehirn Pathologie*, and Ford-Robertson's *Pathology of Mental Diseases*. (F. W. MO.)

EXPLANATIONS OF PLATE IX.

PHOTOGRAPHS OF THE BRAIN (ABOUT ⅓ THEIR NATURAL SIZE) ILLUSTRATING VARIOUS PATHOLOGICAL CONDITIONS.

1. Left hemisphere, case of delusional insanity; this in all respects might pass for a normal brain.
2. Left hemisphere, case of abscess of the frontal lobe: the convolutions and sulci are obliterated and the membranes thickened, so that the fore part of the brain presents the appearance of a membranous bag; this contained a large amount of pus.
3. Right hemisphere seen from above instead of laterally: a hole corresponding to the middle of the central convolutions is seen, out of which a tumour is displaced towards the middle line. This tumour was situated over the region of the arm area, and gave rise at first to fits commencing in the left arm and hand, and eventually to paralysis.
4. Brain from a case of apoplexy: the tops of the hemispheres have been sliced off to show the hæmorrhage (dark patch) in the right centrum ovale, which has ruptured the fibres proceeding from the motor area of the brain, situated between the basal ganglia.
5. Case of paralytic dementia with thickened membranes, which have been stripped off the frontal lobe and thrown back.
6. Left hemisphere: a case of advanced dementia, showing atrophy of the convolutions, with deep and wide sulci intervening.
7. Left hemisphere of low-grade imbecile, with simple convolutional pattern, and small in size.
8. Brain of extreme case of microcephalic idiocy. The convolutional pattern is simpler than that of an embryo of eight months.
9. Left hemisphere and cerebellum of a case of porencephaly. A local atrophy of the convolutions, owing to a vascular lesion before birth, is seen in the parietal lobe.

IV. DIGESTIVE SYSTEM.

Several facts of importance have to be borne in mind for a proper appreciation of the pathology of the organs concerned in digestive processes. In the first place, more than all other systems, the digestive comprises greater range of structure and exhibits wider diversity of function within its domain. Each separate structure and each different function presents special pathological signs and symptoms. Again, the duties imposed upon the system have to be performed notwithstanding constant variations in the work set them. The crude articles of diet offered them vary immensely in nature, bulk, and utility, from which they must elaborate simple food-elements for absorption, incorporate them after absorption into complex organic substances properly designed to supply the constant needs of cellular activity, of growth and repair, and fitly harmonized to fulfil the many requirements of very divergent processes and functions. Any form of unphysiological diet, each failure to cater for the wants of any special tissue engaged in, or of any processes of, metabolism, carry with them pathological signs. Perhaps in greater degree than elsewhere are the individual sections of the digestive system dependent upon, and closely correlated with, one another. The lungs can only yield oxygen to the blood when the oxygen is uncombined; no compounds are of use. The digestive organs have to deal with an enormous variety of compound bodies, from which to obtain the elements necessary for protoplasmic upkeep and activity. Morbid lesions of the respiratory and circulatory systems are frequently capable of compensation through increased activity elsewhere, and the symptoms they give rise to follow chiefly along one line; diseases of the digestive organs are more liable to occasion disorders elsewhere than to excite compensatory actions. The digestive system includes every organ, function, and process concerned with the utilization of food-stuffs, from the moment of their entrance into the mouth, their preparation in the canal, assimilation with the tissues, their employment therein, up to their excretion or expulsion in the form of waste. Each portion resembles a link of a continuous chain; each link depends upon the integrity of the others, the weakening or breaking of one straining or making impotent the chain as a whole.

Descriptions of the different organs of the digestive system are given elsewhere. (See ANATOMY.) The mucous membrane lining the alimentary tract is the part most subject to pathological alterations, and in this connexion it should be remembered that this membrane differs both in structure and functions throughout the tract. Chiefly protective from the mouth to the cardia, it is secretory and absorbent in the stomach and bowel; while the glandular cells forming part of it secrete both acid and alkaline fluids, several ferments, or mucus. Over the dorsum of the tongue its modified cells subserve the sense of taste. Without, connected with it by the submucous connective tissue, is placed the muscular coat, and externally over the greater portion of its length the peritoneal serous membrane. All parts are supplied with blood-vessels, lymph-ducts, and nerves, the last belonging either to local or to central circuits. Associated with the tract are the salivary glands, the liver, and the pancreas; while, in addition, lymphoid tissue is met with diffusely scattered throughout the lining membranes in the tonsils, appendix, solitary glands and Peyer's patches, and the mesenteric glands. The functions of the various parts of the system in whose lesions we are here interested are many in number. It would take up too much space to enumerate all their proved and suggested functions. Broadly, they may be given as: (1) Ingestion and swallowing of food, transmission of it through the tract, and expulsion of the waste material; (2) secretion of acids and alkalies for the performance of digestive processes, aided by (3) elaboration and addition of complex bodies, termed enzymes or ferments; (4) secretion of mucus; (5) protection of the body against organismal infection, and against toxic products; (6) absorption of food elements and reconstitution of them into complex substances fitted for metabolic application; and (7) excretion of the waste products of protoplasmic action. These functions may be altered by disease, singly or in conjunction; it is rare, however, to find but one affected, while an apparently identical disturbance of function may often arise from totally different organic lesions. Another point of importance is seen in the close interdependence which exists between the secretions of acid and those of alkaline reaction. The difference in reaction seems to act *mutatis mutandis* as a stimulant in each instance.

General Diseases.

Vascular lesions.

In all sections of the alimentary canal actively engaged in the digestion of food, a well-marked local engorgement of the blood-vessels supplying the walls occurs. The hyperæmia abates soon after completion of the special duties of the individual sections. This normal condition may be abnormally exaggerated by over-stimulation from irritant poisons introduced into the canal; from too rich, too copious, or indigestible articles of diet; or from too prolonged an experience of some unvaried kind of food-stuff, especially if large quantities of it are necessary for metabolic needs; entering into the first stage of inflammation, acute hyperæmia. More important, because productive of less tractable lesions, is passive congestion of the digestive organs. Whenever the flow of blood into the right side of the heart is hindered, whether it arise from disease of the heart itself, or of the lungs, or proceed from obstruction in some part of the portal system, the damming-back of the venous circulation speedily produces a more or less pronounced stasis of the blood in the walls of the alimentary canal and in the associated abdominal glands. The lack of a sufficiently vigorous flow of blood is followed by deficient secretion of digestive agents from the glandular elements involved, by decreased motility of the muscular coats of the stomach and bowel, and lessened adaptability throughout for dealing with even slight irregular demands on their powers. The mucous membrane of the stomach and bowel, less able to withstand the effects of irritation, even of a minor character, readily passes into a condition of chronic catarrh, while it frequently is the seat of small abrasions, hæmorrhagic erosions, which may cause vomiting of blood and the appearance of blood in the stools. Obstruction to the flow of blood from the liver leads to dilatation of its blood-vessels, consequent pressure upon the hepatic cells adjoining them, and their gradual loss of function, or even atrophy and degeneration. In addition to the results of such passive congestion exhibited by the stomach and bowel as noted above, passive congestion of the liver is often accompanied by varicose enlargement of the abdominal veins, in particular of those which surround the lower end of the œsophagus, the lowest part of the rectum and anus. In the latter position these dilated veins constitute what are known as hæmorrhoids or piles, internal or external as their site lies within or outside the anal aperture.

The mucous and serous membranes of the canal and the glandular elements of the associated organs are the parts most subject to inflammatory affections. Among the several sections of the digestive tract itself, the œsophagus and jejunum are singularly exempt from inflammatory processes; the fauces, stomach, cæcum and appendix, ileum, mouth and duodenum (including the opening of the common bile duct), are more commonly involved.

Inflammatory lesions.

Carious teeth, accumulations of sordes, and attacks of acute fevers frequently are the causal agents in stomatitis or inflammation of the mouth; while a more local form of the ailment over the dorsum of the tongue is commonly a sympathetic condition accompanying gastric or hepatic derangements. An ordinary "sore throat" usually signifies acute catarrh of the fauces, and is in all likelihood of purely organismal origin, "catching cold" being only a secondary and minor cause. In "relaxed throats" there is a chronic catarrhal state of the lining membrane, with some passive congestion. The tonsils are peculiarly liable to catarrhal attacks, as might *a priori* be expected by reason of their Cerberus-like function with regard to bacterial intruders. Still, acute attacks of tonsillitis appear on good evidence to be more common among individuals predisposed constitutionally to rheumatic manifestations. Cases of acute tonsillitis may or may not go on to suppuration or quinsy; in all there is great congestion of the glands, increased mucus secretion, and often secondary involvement of the lymphatic glands of the neck. Repeated acute attacks often lead to chronic inflammation, in which the glands are enlarged, and often hypertrophied in the true sense of the term. In children, however, hypertrophy of the tonsils seems to occur *sui generis.* The œsophagus is the seat of catarrh but seldom; too hot food and strong solutions of corrosive or irritant substances, if swallowed, may cause the symptoms common to inflamed tissues. The physical changes presented by the coats of the stomach and the intestine, the subjects of catarrhal attacks, closely resemble one another, but differ symptomatically. Acute catarrh of the stomach is associated with intense hyperæmia of its lining coats, with visible engorgement and swelling of the mucous membrane, and an excessive secretion of mucus. The formation of active gastric juice is arrested, digestion ceases, peristaltic movements are sluggish or absent, unless so over-stimulated that they act in a direction the reverse of the normal, and induce expulsion of the gastric contents by vomiting. The gastric contents, in whatever degree of dilution or concentration they may have been ingested, when ejected are of porridge-thick consistency, and often but slightly digested. Such conditions may succeed a severe alcoholic bout, be caused by irritant substances taken in by the mouth, or arise from fermentative processes in the stomach contents themselves. Should the irritating material succeed in passing from the stomach into the bowel, similar physical signs are present; but as the quickest path offered for the expulsion of the offending substances from the body is downwards, peristalsis is increased, the flow of fluid from the intestinal glands is larger in bulk, though of less potency as regards its normal actions, than in health, and diarrhœa, with removal of the irritant, follows. As a general rule, the more marked the involvement of the large bowel, the severer and more fluid is the resultant diarrhœa.

Catarrhal affections of the cæcum and its attached appendix vermiformis are very common, and give rise to several special symptoms and signs. Acute inflammatory appendicitis appears to be increasing in frequency, and is caused without doubt, in the great majority of instances, by fæcal accumulation, with the entrance of a small fæcal mass into the lumen of the organ, or by the occurrence of bacterial fermentation of a malign type, along with, it may be, and because of, fæcal stasis. Occasionally the entrance of some foreign body, a cherry-stone, a fish-bone, or a pin, sets up an attack; but exciting agents of this type are less commonly met with than popular ideas would suggest. Very similar symptomatically is the condition termed perityphlitis, doubtless in former days frequently due to the appendix, an acute or chronic inflammation of the walls of the cæcum often leading to abscess formation outside the gut, with or without direct communication with the canal. The colon and sigmoid flexure are more subject to chronic inflammatory attacks than to acute, save in cases of acute gastro-enteritis and diarrhœa, or of special infections. Prolonged constipation, with fæcal accumulation in the large bowel, may lead to a secondary diarrhœa, from the severe irritation of the mucous membrane of the gut occasioned by the scybalous masses. Acute simple hepatitis is a rare disease; acute pancreatitis is usually of septic origin.

Chronic catarrhal affections of the stomach are very common, and often follow upon repeated acute attacks. In them the connective tissue increases at the expense of the glandular elements; the mucous membrane becomes thickened and less active in function. Should the muscular coat be involved, the elasticity and contractility of the organ suffer; peristaltic movement is weakened; expulsion of the contents through the pylorus hindered; and, aggravated by these effects, the condition becomes worse, atonic dyspepsia in its most pronounced form results, with or without dilatation. Chronic vascular congestion may occasion in process of time similar signs and symptoms.

Duodenal catarrh is constantly associated with jaundice, indeed is most probably the commonest cause of catarrhal jaundice; often it is accompanied by catarrh of the common bile duct. Chronic inflammation of the small intestine gives rise to less prominent symptoms than in the stomach. It generally arises from more than one cause; or rather secondary causes rapidly become as important as the primary in its incidence. Chronic congestion and prolonged irritation lead to deficient secretion and sluggish peristalsis; these effects encourage intestinal putrefaction and auto-intoxication; and these latter, in turn, increase the local unrest. Chronic catarrh of the colon is frequently characterized by secretion of an excessive amount of mucus from the goblet cells and its appearance in the stools—mucous colitis; or, again, by the passage of membranous shreds and casts of the bowel—membranous colitis—the casts really consisting of a mucus skin from the surface of the gut, including some of the epithelial cells. The rectum may suffer in the same way—proctitis. Membranous colitis is stated to be closely associated with disordered nervous control. Simple chronic peritonitis is not of frequent occurrence, nor are the views held as to its causation very clear. In common with the acute form, it may be localized or general. A hyperplastic variety is met with in which the peritoneal membrane is greatly thickened. Undoubtedly some cases arise from pelvic disease in women. Distinct localized forms occur over the liver and spleen—perihepatitis and perisplenitis—in which an external chronic fibroid change coincides with similar conditions within the organs.

Infective lesions.

The intestinal mucous membrane, the peritoneum, and the mesenteric glands are the chief sites of tubercular infection in the digestive organs. Rarely met with in the gullet and stomach, and comparatively seldom in the mouth and lips, tubercular inflammation of the small intestine and peritoneum is common. Tubercular enteritis is a frequent accompaniment of phthisis pulmonum, but may occur apart from tubercle of other organs. Children are especially subject to the primary form. Tubercular peritonitis often is present also. The inflammatory process readily tends towards ulcer formation, with hæmorrhage and sometimes perforation. If in the large bowel, the symptoms are usually less acute than those characterizing tubercular inflammation of the small intestine. The appendix has been found to be the seat of tubercular processes; in the rectum they form the general cause of the fistulæ and abscesses so commonly met with here. Tubercular peritonitis may be primary or secondary, acute or chronic; occasionally very acute cases are seen running a rapid course; the majority are chronic in type. The tubercles spread over the surface of the serous membrane, and if small and not very numerous, may give rise in chronic cases to few symptoms; if larger, and especially when they involve and obstruct the lymph- and blood-vessels, ascites follows. It is hardly possible that tubercular invasion of the mesenteric glands can ever occur unaccompanied by peritoneal infection; but when the infection of the glands constitutes the most prominent sign, the term *tabes mesenterica* is sometimes employed. Here the glands, enlarged, form a doughy mass in the abdomen, leading to marked protrusion of the abdominal walls, with wasting elsewhere, and diarrhœa.

The liver is seldom attacked by tubercle, unless in cases of general miliary tuberculosis. Now and then it contains large caseous tubercular masses in its substance.

An important fact with regard to the tubercular processes in the digestive organs lies in the ready response to treatment shown by many cases of peritoneal or mesenteric invasion, particularly in the young.

The later sequelæ of syphilis display a predilection for the rectum and the liver, usually leading to the development of a stricture in the former, to a diffuse hepatitis or the formation of gummata in the second. The upper incisor teeth in cases of congenital syphilis are often stunted and peg-shaped. As the result both of syphilis and of tubercle, the tissues of the liver and bowel may present a peculiar alteration; they become amyloid, or lardaceous, a condition in which they appear "waxy," are coloured dark mahogany brown with dilute iodine solutions, and show degenerative changes in the connective tissue.

Malarial cirrhosis of the liver is described, but the connexion between it and abuse of alcohol requires further study.

The bacillus of Eberth, which appears to be the invariable associate and probable causal agent of typhoid fever, has its chief seat of activity in the small intestine, more especially in the lower half of the ileum. Attacking the lymphoid follicles in the mucous membrane, it causes first inflammatory enlargement, then necrosis and ulceration. The adjacent portions of the mucous membrane show acute catarrhal changes. Diarrhœa, of a special "pea-soup" type, may or may not be present; while hæmorrhage from the bowel, if ulcers have formed, is common. As the ulcers frequently extend down to the peritoneal coat of the bowel, perforation of this membrane and extravasation into the peritoneal cavity is easily induced by irritants introduced into or elaborated in the bowel, acting physically or by the excitation of hyper-peristalsis.

True Asiatic cholera has been shown to be due to the presence of a spirillum in the contents of the bowel, and to its growth therein; more rarely, and only in chronic types, to its development in the tissues of the intestinal wall. The spirillum of cholera produces an intense irritation of the bowel, seldom of the stomach, without giving rise locally to any marked physical change; it causes violent diarrhœa and copious discharges of "rice-water" stools, consisting largely of serum swarming with the organism.

The lesions in dysentery are almost entirely confined to the large bowel; at first inflammatory, later ulcerative. The stools are chiefly composed of gelatinous mucus and blood. Two forms are distinguished—the non-amœbic, ascribed to famine and close confinement, and the amœbic, from the *amœba coli* (Lösch) constantly found with it; the disease is common to the warmer climates.

Acute parotitis, or mumps, is an infectious disease of the parotid glands, chiefly interesting because of the association between it and the testes in males, inflammation of these glands occasionally following or replacing the affection of the parotids. The causal agent is probably organismal, but has as yet escaped detection.

New growths.

The relative frequency with which malignant growths occur in the different organs of the digestive system may be gathered from the following tabular analysis of 1768 cases recorded in the books of the Edinburgh Royal Infirmary as having been treated in the medical and surgical wards between the years 1892 to 1899 inclusive. Of these, 1263, or 71·44 per cent., were males; 505, or 28·56 per cent., females:—

Males.		Females.		Both Sexes.	
Organ or Tissue in Order of Frequency.	Percentage.	Organ or Tissue in Order of Frequency.	Percentage.	Organ or Tissue in Order of Frequency.	Percentage.
1 Stomach	22·56	1 Stomach	22·37	1 Stomach	22·49
2 Lip	12·94	2 Rectum	17·24	2 Rectum	13·12
3 Reetum	11·57	3 Liver	15·50	3 Liver	10·02
4 Tongue	11·36	4 Peritoneum	7·86	4 Lip	9·89
5 Œsophagus	10·90	5 Œsophagus	5·33	5 Œsophagus	9·29
6 Liver	7·80	6 Sigmoid	4·53	6 Tongue	8·96
7 Jaw	6·38	7 Pancreas	3·52	7 Jaw	5·65
8 Mouth	2·88	8 Tongue	3·12	8 Peritoneum	2·94
9 Tonsils	2·09	9 Omentum	2·98	9 Sigmoid	2·56
10 Sigmoid flexure	1·77	10 Lip	2·57	10 Mouth	2·40
11 Parotid }	1·10	11 Jaw	1·97	11 Pancreas	1·80
12 Pancreas }		12 Colon }	1·84	12 Tonsils	1·35
13 Cæcum }	0·94	13 Abdomen }		13 Omentum	1·25
14 Peritoneum }		14 Intestine	1·56	14 Parotid }	1·12
15 Colon	0·89	15 Cæcum	1·37	15 Colon }	
16 Pharynx }	0·79	16 Mouth }	1·18	16 Cæcum	1·08
17 Intestine (site unknown) }		17 Parotid }		17 Intestine }	1·00
18 Abdomen	0·71	18 Splenic flexure	0·98	18 Abdomen }	
19 Mesentery }	0·55	19 Jejunum and ileum	0·78	19 Pharynx	0·62
20 Omentum }		20 Tonsils	0·68	20 Mesentery	0·52
21 Hepatic flexure	0·39	21 Pharynx }	0·40	21 Jejunum and ileum }	0·44
22 Submaxillary gland }	0·31	22 Hepatic flexure }		22 Hepatic flexure }	
23 Jejunum and ileum }		23 Mesentery }		23 Splenic flexure }	
24 Duodenum	0·23	24 Submaxillary }	0·20	24 Submaxillary	0·28
25 Splenic flexure	0·15	25 Duodenum }		25 Duodenum	0·22

Note.—The figures where several organs are bracketed apply to each organ separately.

If the figures given above be classified upon broader lines, the results are as follows, and speak for themselves:—

Males.	Percentage.	Females.	Percentage.	Total.	Percentage.
1 Mouth and pharynx	37·85	1 Intestines	28·9	1 Œsophagus and stomach	31·78
2 Œsophagus and stomach	33·46	2 Œsophagus and stomach	27·7	2 Mouth and pharynx	30·27
3 Intestines	17·04	3 Liver	15·5	3 Intestines	20·42
4 Liver	7·8	4 Peritoneum	13·1	4 Liver	10·02
5 Peritoneum	2·75	5 Mouth and pharynx	11·3	5 Peritoneum	5·71
6 Pancreas	1·1	6 Pancreas	3·5	6 Pancreas	1·80

The digestive organs are peculiarly subject to malignant disease, a result of the incessant changes from passive to active conditions, and *vice versâ*, called for by repeated introduction of food; while the comparative frequency with which different parts are attacked depends, in part, upon the degree of irritation or changes of function imposed upon them. Scirrhous, encephaloid, and colloid forms of carcinoma occur. In the stomach and œsophagus the scirrhous form is most common, the soft encephaloid form coming next. The most common situation for cancerous growth in the stomach is the pyloric region. Walsh out of 1300 cases found 60·8 per cent. near the pylorus, 11·4 per cent. over the lesser curvature, and 4·7 per cent. more or less over the whole organ. The small intestine is rarely attacked by cancer; the large intestine frequently. The rectum, sigmoid flexure, cæcum, and colon are affected, and in this order, the cylindrical-celled form being the most common. Carcinoma of the peritoneum is generally colloid in character, and is often secondary to growths in other organs. Cancer of the liver follows cancer of the stomach and rectum in frequency of occurrence, and is relatively more common in females than males. Secondary invasion of the liver is a frequent sequel to gastric cancer. The pancreas occasionally is the seat of cancerous growth.

Sarcomata are not so often met with in the digestive organs. When present, they generally involve the peritoneum or the mesenteric glands. The liver is sometimes attacked, the stomach rarely.

Benign tumours are not of common occurrence in the digestive organs. Simple growths of the salivary glands, cysts of the pancreas, and polypoid tumours of the rectum are the most frequent.

Animal parasites.

The intestinal canal is the habitat of the majority of animal parasites found in man. Frequently their presence leads to no morbid symptoms, local or general; nor are the symptoms, when they do arise, always characteristic of the presence of parasites alone. Discovery of their bodies, or of their eggs, in the stools is in most instances the only satisfactory proof of their presence. The parasites found in the bowel belong principally to two natural groups, Protozoa and Metazoa. The great class of the Protozoa furnish amœbæ, members of Sporozoa, and Infusoria. The amœbæ are almost invariably found in the large intestine; one species, indeed, is termed *amœba coli*. The frequently-observed relation between attacks of dysentery and the presence of amœbæ in the stools has led to the proposition that an *amœba dysenterica* exists, causing the disease,—a theory supported by the detection of amœbæ in the contents of dysenteric abscesses of the liver. No symptoms of injury to health appear to accompany the presence of Sporozoa in the bowel, while the species of Infusoria found in it, the *Cercomonas*, and *Trichomonas intestinalis*, and the *Balantidium coli*, may or may not be guilty of prolonging conditions within the bowel such as have previously set up diarrhœa.

The Metazoa supply examples of intestinal parasites from the classes Annuloida and Nematoidea. To the former class belong the various tapeworms found in the small intestine of man. They, like other intestinal parasites, are destitute of any power of active digestion, simply absorbing the nutritious proceeds of the digestive processes of their hosts. Nematode worms infest both the small and large intestine; *Ascaris lumbricoides*, the common round worm, and the male *Oxyuris vermicularis* are found in the small bowel, the adult female *Oxyuris vermicularis* and the *Tricocephalus dispar* in the large.

The eggs of the *Trichina spiralis*, when introduced with the food, develop in the bowel into larval forms which invade the tissues of the body, to find in the muscles congenial spots wherein to reach maturity. Similarly, the eggs of the *Echinococcus* are hatched in the bowel, and the embryos proceed to take up their abode in the tissues of the body, developing into cysts capable of growth into mature worms after their ingestion by dogs.

Table showing the more important Vegetable Organisms and Animal Parasites.

Vegetable Organisms.

Mouth and Fauces.	Stomach.	Small Intestine.	Large Intestine.
A. Simple. Spirochæta buccalis. Leptothrix buccalis. Micrococcus tetragenus. Various fission bacilli.	Bacillus acidi lactici. Bacterium lactis aërogenes. Bacillus coli communis. Sarcina ventriculi. Bacillus subtilis. Proteus vulgaris. Bacillus pyocyaneus. Yeasts. Moulds. Bacillus geniculatus. Bacillus butyricus. Bacillus amylobacter. B. mycoides. Vibrio rugula. Micrococcus tetragenus. Bacillus ramosus.	Bacillus coli communis. Bacillus butyricus. B. amylobacter. B. acidi lactici. B. lactis aërogenes. Streptococcus liquefaciens ilei. Bacterium liquefaciens ilei. Bacterium ilei. Micrococci. Yeasts. Moulds.	Moulds. Yeasts. Bacillus coli communis. B. subtilis. Micrococci.
B. Pathogenic. Tubercle bacillus. Bacillus diphtheriæ. Pneumococcus. Staphylococcus pyogenes aureus. Staphylococcus pyogenes aureus. Staphylococcus albus. Streptococcus pyogenes albus. Oïdium albicans. Actinomycosis.	Comma bacillus (rarely). Tubercle bacillus. Actinomycosis. Bacillus typhosus.	Bacillus typhosus. Comma bacillus (cholera). Tubercle bacillus. (Bacillus coli communis.)	Bacillus typhosus. Comma bacillus. Amœbæ coli. Tubercle bacillus. Finkler-Prior bacillus. (Bacillus coli communis.)

Animal Parasites.

Mouth.	Small Intestines.	Large Intestines.
Larvæ.	Coccidia. Cercomonas. Tænia solium. Tænia saginata. Bothriocephalus latus. Distoma hepaticum. D. lanceolatus. Ascaris lumbricoides. Anchylostoma duodenale. Tricocephalus dispar. Trichina spiralis.	Monadines. Coccidia. Oxyuris vermicularis. Larvæ of insects.

Vegetable parasites.

Numbers of bacterial forms habitually infest the alimentary canal. The names of the more common species are given in the foregoing table. Many of them are non-pathogenic; some develop pathogenic characters only under provocation or when a suitable environment induces them to act in such a manner; others may form the *materies morbi* of special lesions, or be casual visitors capable of originating disease if opportunity occurs. Apart from those organisms associated with acute infective diseases, disturbances of function and physical lesions may be the result of abnormal bacterial activity in the canal; and these disturbances may be both local and general. Many of the bacteria commonly present produce putrefactive changes in the contents of the tract by their metabolic processes. They render the medium they grow in alkaline, produce different gases, and elaborate more or less virulent toxins. Other species set up an acid fermentation, seldom accompanied by gas or toxin formation. The products of either class are inimical to the free growth of members of the other. The species which produce acids are more resistant to the action of acids. Thus, when the contents of the stomach possess a normal or excessive proportion of free hydrochloric acid, a much larger number of putrefactive and pathogenic organisms in the food are destroyed or inhibited than of the bacteria of acid fermentation. Diminished gastric acidity allows of the entry of a greater number of putrefactive (and pathogenic) types, with, as a consequence, increased facilities for their growth and activity, and the appearance of intestinal derangements.

It is still a moot question if bacteria can penetrate the coats of the bowel and enter surrounding tissues when no solution of continuity exists. The frequent septic conditions of abscesses adjoining but not communicating with the bowel seem to favour the possibility of bacterial penetration; and the occurrence of acute peritonitis without any appreciable peritoneal lesion supports it. Bacterial forms are said to be able to pass through the mucous membrane of the canal and reach the blood-stream, where, unless they are of excessive number, they are killed. Passage of bacteria from the blood through the peritoneal membrane into the abdominal cavity has been recorded.

Whenever putrefactive processes are excessive in the bowel, and in prolonged constipation, symptoms of auto-intoxication may occur, caused by absorption of poisonous bacterial products in larger amount than can be dealt with by the defensive power of the liver.

The fæces have been shown to be composed in large part of various species of bacteria.

Physical abnormalities.

Hare-lip, cleft palate, hernia, and imperforate anus belong to the subject of Surgery. The œsophagus may be the seat of a diverticulum, or blind pouch, usually situated in its lower half, which in most instances is probably partly acquired and partly congenital; a local weakness succumbing to pressure. Hypertrophy of the muscular coat of the pyloric region is an infrequent congenital gastric anomaly in infants, preventing the passage of food into the bowel, and causing death in a short time. Incomplete closure of the vitelline duct results in the presence of a diverticulum—Meckel's—generally connected with the ileum, mainly important by reason of the readiness with which it occasions intestinal obstruction. Idiopathic congenital dilatation of the colon has been described.

Traction diverticula of the œsophagus not uncommonly occur as sequels to suppurative inflammation of cervical lymphatic glands. More frequently dilatation of a section is met with, due as a rule to the presence of a stricture. The stomach often diverges from the normal in size, shape, and position. Normally capable in the adult of containing from fifty to sixty ounces, either by reason of organic disease, or as the result of functional disturbance, its capacity may vary enormously. The writer has seen post mortem a stomach which held a gallon (160 ounces), and again, one holding only two ounces. Cancer spread over a large area and cirrhosis of the stomach wall cause diminution in capacity; pyloric obstruction, weakness of the muscular coat, and nervous influences are associated with dilatation. A peculiar distortion of the shape of the stomach follows cicatrization of ulcers of greater or lesser curvature; the gastric cavity becomes "hour-glass" in shape. In addition, the stomach may be displaced downwards as a whole, a condition known as gastroptosis: if the pyloric portion only be displaced, the lesion is termed pyloroptosis. Ptoses of other abdominal organs are described; the liver, transverse colon, spleen, and kidneys may be involved. Displacements downwards of the stomach and transverse colon, along with a movable right kidney and associated with dyspepsia and neurasthenia, form the malady termed by Glénard enteroptosis. Displacements of the abdominal viscera are almost invariably accompanied by symptoms of dyspepsia of a neurotic type. The rectum is liable to prolapse, consequent upon constipation and straining at stool, or following local injuries of the perineal floor.

Every pathological lesion shown by digestive organs is closely associated with the state of the nervous system, general or local; so stoppage of active gastric digestive processes after profound nervous shock, and occurrence of nervous diarrhœa from the same cause. Gastric dyspepsia of nervous origin presents most varied and contradictory symptoms: diminished acidity of the gastric juice; hyperacidity; over-production; arrest of secretion; lessened or increased movements; greater sensitiveness to the presence of contents; dilatation; or spasm. Often the nervous cause can be traced back farther. In females, frequently to the pelvic organs; in both sexes, to the condition of the blood, the brain, or the bowel. Unhealthy conditions related to evacuation of the bowel-contents commonly induce reflex nervous manifestations of abnormal character referred to the stomach and liver. Gastric disturbances similarly react upon the proper conduct of intestinal functions.

Influence of the nervous system.

Local Diseases.

The Mouth.—The lining membrane of the cheeks inside the mouth, of the gums and the under-surface and edges of the tongue, is often the seat of small irritable ulcers, usually associated with some digestive derangement. A crop of minute vesicles over these parts has been lately stated by Koplik to be an early symptom of measles. Xerostomia, or dry mouth, is a rare condition, connected with lack of salivary secretion. Gangrenous stomatitis, cancrum oris, or noma, occasionally attacks debilitated children, or patients convalescing from acute fevers, more especially after measles. It commences in the gums or cheeks, and causes widespread sloughing of the adjacent soft parts; it may be of the bones.

The Stomach.—It were futile to attempt to enumerate all the protean manifestations of disturbance which proceed from a disordered stomach. The possible permutations and combinations of the causes of gastric vagaries almost reach infinity. Idiosyncrasy, past and present gastric education, penury or plethora, actual digestive power, motility, bodily requirements and conditions, environment, mental influences, local or adjacent organic lesions, and, not least, reflex impressions from other organs, all contribute to the variance.

Ulcer of the stomach, however—the perforating gastric ulcer—occupies a unique position among diseases of this organ. Gastric ulcers are circumscribed, punched out, rarely larger than a sixpenny-bit, funnel-shaped, the narrower end towards the peritoneal coat, and distributed in those regions of the stomach wall which are most exposed to the action of the gastric contents. They occur most frequently in females, especially if anæmic, and are usually accompanied by excess of acid, actual or relative to the state of the blood, in the stomach contents. Local pain, dorsal pain, generally to the left of the eighth or ninth dorsal spinous process, and hæmatemesis or melæna, are symptomatic of it. The amount of blood lost varies with the rapidity of ulcer formation and the size of vessel opened into. Fatal results arise from ulceration into large blood-vessels, followed by copious hæmorrhage, or by perforation of the ulcer into the peritoneal cavity. Scars of such ulcers may be found post mortem, although no symptoms of gastric disease have been exhibited during life; gastric ulcers, therefore, may be latent.

Irritation of the sensory nerve-endings in the stomach wall from the presence of an increased proportion of acid, organic or mineral, in the stomach contents is accountable for the well-known symptom, heartburn. Water-brash is a term applied to eructation of a colourless, almost tasteless fluid, probably saliva which has collected in the lower part of the œsophagus from failure of the cardiac sphincter of the stomach to relax; reversed œsophageal peristalsis causing regurgitation. A similar reversed action serves in merycism, or rumination, occasionally found in man, to raise part of the food, lately ingested, from the stomach to the mouth. Vomiting also is aided by reversed peristaltic action, both of the stomach and the œsophagus, with the help of the diaphragm and the muscles of the anterior abdominal wall. Emesis may be caused both by local nervous influence, and through the central nervous mechanism either reflexly or from the direct action of substances circulating in the blood. Further, the causal agent acting on the central nervous apparatus may be organic or functional, as well as medicinal. Vomiting without any apparent cause suggests nervous lesions, organic or reflex. The obstinate vomiting of pregnancy is a case in point. Here the primary cause proceeds reflexly from the pelvis. In females the pelvic organs are often the true source of emesis. Hæmatemesis accompanies gastric ulcer, cancer, chronic congestion with hæmorrhagic erosion, congestion of the liver, or may follow violent acts of vomiting. In cases of ulcer the blood is usually bright and in considerable amount; in cancer, darker, like coffee-grounds; and in cases of erosion, in smaller quantity and of bright colour. The reaction of the stomach contents, if the cause be doubtful, yields valuable aid towards a diagnosis. Of normal or increased acidity in gastric ulcer, normal in hepatic congestion, it is diminished in cancer; but as the acid present in cancer is largely lactic, analysis of the gastric contents must often be a *sine quâ non*, because hyperacidity from lactic may obscure hypoacidity of hydrochloric acid.

Flatulence usually results from fermentative processes in the stomach and bowel, as the outcome of bacterial activity. The gases evolved are various and complex in nature. Proteid decomposition sometimes leads to the formation of sulphuretted hydrogen; while inflammable marsh gas, formed by the same in the stomach, has been accidentally set alight at the mouth in a few instances. A different form of flatulence is common in neurotic individuals; in such the gas evolved consists simply in carbonic acid liberated from the blood, and its evolution is generally characterized by rapid development and by lack of all fermentative signs.

The Liver.—The liver is an organ frequently libelled for the delinquencies of other organs, and regarded as a common source of ill. In catarrhal jaundice it is in most cases the bowel that is at fault, the liver acting properly, but unable to get rid of all the bile produced. The liver suffers, however, from several diseases of its own. Its fibrous or connective tissue is very apt to increase at the expense of the cellular elements, destroying their functions. This cirrhotic process usually follows long-continued irritation, such as is produced by too much alcohol absorbed from the bowel habitually, the organ gradually becoming harder in texture and smaller in bulk. Hypertrophic cirrhosis of the liver is not uncommonly met with, in which the liver is much increased in size, the "unilobular" form, also of alcoholic origin. In still-born children and in some infants a form of hypertrophic cirrhosis is occasionally seen, probably of hereditary syphilitic origin. Acute congestion of the liver forms an important symptom of malarial fever, and often leads in time to establishment of cirrhotic changes; here the liver is generally enlarged, but not invariably so, and the part played by alcohol in its causation has still to be investigated. Acute yellow atrophy of the liver is a disease *sui generis*. Of rare occurrence, possibly of toxic origin, it is marked by jaundice, at first of usual type, later becoming most intense; by vomiting; hæmorrhages widely distributed; rapid diminution in the size of the liver; the appearance of leucin and tyrosin in the urine, with lessened urea; and in two or three days, death. The liver after death is soft, of a reddish colour dotted with yellow patches, and weighs only about a third part of the normal—about $1\frac{1}{2}$ lb in place of $3\frac{3}{4}$ lb. A closely analogous affection of the liver, known as Weil's disease, is of infectious type, and has been noted in epidemic form. Hepatic abscess is another condition not infrequent among dwellers in tropical climates, especially should they have suffered previously from dysentery. There is strong reason to believe that the *amœba coli* has a direct connexion with its causation. Injuries of the liver are sometimes followed by abscess formation, while septic abscesses in this organ are common in blood-poisoning.

The Gall-Bladder.—The formation of biliary calculi in the gall-bladder is the chief point of interest here. At least 75 per cent. of such cases occur in women, especially in those who have borne children. Tight-lacing has been stated to act as an exciting cause, owing to the consequent retardation of the flow of bile. Gall-stones may number from one to many thousands. They are largely composed of cholesterin, combined with small amounts of bile-pigments and acids, lime and magnesium salts. Their presence may give rise to no symptoms, or may cause violent biliary colic, and if the bile-stream be obstructed, to jaundice. Inflammatory processes may be initiated in the gall-bladder or the bile-ducts, catarrhal or suppurative in character.

The Pancreas.—Hæmorrhages into the body of the pancreas, acute and chronic inflammation, calculi, cysts, and tumours, among which cancer is by far the most common, are recognized as occurring in this organ; the point of greatest interest regarding them lies in the relations established between pancreatic disease and diabetes mellitus, affections of the gland frequently being complicated by, and probably causing, the appearance of sugar in the urine.

The Small Intestine.—Little remains to be added to the account of inflammatory lesions in connexion with the small intestine. It offers but few conditions peculiar to itself, save in typhoid fever, and the ease with which it contrives to become kinked, or intussuscepted, producing obstruction, or to take part in hernial protrusions, for which the article on SURGERY should be consulted. The first section, the duodenum, is subject to development of ulcers very similar to those of the gastric mucous membrane. For long duodenal ulceration has been regarded as a common complication of extensive burns of the skin, but the relationship between them still lacks evidence sufficiently trustworthy to disprove the possibility of coincidence in lieu of effect. The condition of colic in the bowel usually arises from over-distension of some part of the small gut with gas, the frequent sharp turns of the gut facilitating temporary closure of its lumen by pressure of the dilated gut near a curve against the part beyond. In the large bowel accumulations of gas seldom cause such acute symptoms, having a readier exit.

The Large Intestine.—The colon, especially the ascending portion, may become immensely dilated, usually after prolonged constipation and paralysis of the gut; occasionally the condition is congenital. Straining efforts made in defæcation may often account for prolapse of the lower end of the rectum through the anus. Hæmorrhage from the bowel is usually a sign of disease situated in the large intestine: if bright in colour, the source is probably low down; if dark, from the cæcum or from above the ileocæcal valve. Blood after a short stay in any section of the alimentary canal darkens, and eventually becomes almost black in colour. (A. L. G.)

V. RESPIRATORY SYSTEM.

The term respiratory system comprises the nose, part of the pharynx, the larynx, trachea, bronchial tubes, lungs and pleura, together with the framework of the chest, the muscles of respiration, and that part of the nervous and circulatory systems concerned in the aëration of the blood. It is proposed, however, in the present article not to consider in detail the morbid changes affecting all these parts, but to give an account of the more important pathological processes which affect the lungs, pleuræ, and bronchial tubes. In the ætiology of pulmonary affections, the relations between the lungs and the external air, and also between them and the circulatory system, are important. The lungs are, so to speak, placed between the right and left cavities of the heart, and the only way for the blood to pass from the right ventricle to the left side of the heart, except in cases of a patent foramen ovale or other congenital defect forming a communication between the two sides of the organ, is by passing through them. The result is that not only may they become diseased by foreign material carried into them by the blood, but any obstruction to the flow of blood through the left side of the heart tends sooner or later to engorge or congest them, and lead to further changes. Through the nose and mouth they are in direct connexion with the external atmosphere. Hence the variable condition of the air as regards temperature, degree of moisture, and density, is liable to produce directly various changes in the lungs, or to predispose them to disease; and the contamination of the air with various pathogenic germs and irritating particles in the shape of dust, is a direct source of many lung affections.

Bronchitis. Bronchitis, or inflammation of the bronchial tubes, is one of those affections generally attributed to exposure to inclement atmospheric conditions, although we are quite unaware what is the essential condition that gives rise to it. We know, however, that it is much more common in the winter than the summer months in the United Kingdom, and that exposure to inclement weather is apt to be followed by the disease, especially when the nasal and laryngeal passages are themselves in a state of catarrh, the catarrhal inflammation apparently then spreading directly from the upper respiratory passages to the bronchi. Although it is possible that micro-organisms play a part in the production of bronchitis, we know of no specific organism which is its cause. Bronchitis may affect the whole bronchial tract, or more especially the larger or the smaller tubes. It may occur as an acute or as a chronic affection. In the acute form the inflammation may remain limited to the bronchial tubes and gradually subside, or it may lead to inflammation of the surrounding lung tissue, giving rise to disseminated foci of inflammation of greater or less extent throughout the lungs (catarrhal or broncho-pneumonia). This is a common complication of bronchitis, especially where the smaller tubes are affected, and is more frequently seen in children than adults. In cases of chronic bronchitis the affection as a rule begins as a slight ailment during the winter, and recurs in succeeding winters. The intervals of freedom from the trouble get shorter, and in the course of a few years it persists during the summer as well as the winter months. A condition of chronic bronchitis is thus established. The persistent cough which this occasions is one of the chief causes of the development of the condition of *emphysema*, where there is a permanent enlargement of the air cells of the lungs with an atrophy of the walls of the air vesicles. The emphysema occasions an increase in the shortness of breath from which the person had previously suffered, and later, in consequence of the greater difficulty with which the blood circulates through the emphysematous lungs, the right side of the heart becomes dilated, and from that we have the development of a general dropsy of the subcutaneous tissues, and less and less perfect aëration of the blood.

Diseases of Occupations.—We all inhale a considerable amount of carbonaceous and other foreign particles, which in health are partly got rid of by the action of the ciliated cells lining the bronchial tubes, and are partly absorbed by cells in the wall of the tubes, and carried in the lymph channels to the bronchial lymphatic glands, where they are deposited, and cause a more or less marked pigmentation of the tissues. Part of such pigment is also deposited in the walls of the bronchial tubes and the interstitial tissue of the lungs, giving rise to the grey appearance presented by the lungs of all adults who live in large cities. The ordinary occupations of life are, however, not associated with the presence of such an amount of foreign particles in the atmosphere as to cause any serious inconvenience, the foreign particles being either got rid of or stored up in the tissues in the manner above described without causing the individual any great discomfort. In certain dusty occupations, however, such as those of stonemasons, knife-grinders, colliers, &c., the foreign particles inhaled do cause trouble. The most common affection so produced is chronic bronchitis, to which becomes added emphysema. In some cases not only is bronchitis developed, but the foreign particles lead to an increase of the fibrous tissue round the bronchi and in the interstitial tissue of the lungs, and so to a greater or lesser extent of fibroid consolidation. As this fibrous tissue may later undergo softening and cavities be formed, a form of consumption is produced, which is named according to the particular occupation giving rise to it; *e.g.*, stonemasons' phthisis, knife-grinders' phthisis, colliers' phthisis. It should, however, be pointed out that these dusty occupations are probably not so frequently the cause as was at one time taught of these simple inflammatory fibroid changes in the lungs with their subsequent cavity formation; individuals engaged in such occupations are apt to suffer from a chronic tuberculosis of the lung associated with the formation of much fibrous tissue, and the occupation simply predisposes the lung to the attacks of the tubercular virus.

Pneumonia.

The term pneumonia is frequently used of different forms of inflammation of the lungs, and includes affections which run different clinical courses, present diverse appearances after death, and probably have different exciting causes. It would be better if the term *acute pneumonia* were reserved for that form of acute inflammation of the lungs which is usually characterized by sudden onset, and runs an acute course, which terminates generally by crisis from the fifth to the tenth day, the inflammation leading to the consolidation by fibrinous effusion of the greater part or whole of one lobe of a lung. Acute pneumonia usually occurs in a sporadic form, and is most prevalent in the United Kingdom from November to March. Occasionally, however, it is epidemic, and there is evidence to show that sometimes it is an infective disease, a healthy individual contracting it directly from an affected one. There is great difficulty, however, in being quite certain that the occurrence of the disease in those who have been attending upon or brought into intimate connexion with sufferers from pneumonia is the result of infection, for such cases may be due to an epidemic of the disease, or to the various individuals attacked having been exposed to the same cause. Still, after allowing for this fallacy, it seems probable that some cases of pneumonia are infective, presenting a virulence and danger to the attendants not associated with the ordinary run of cases. Formerly acute pneumonia was considered to be a disease occasioned by what was termed "catching cold," and by some it is still so regarded. The tendency, however, at the present time is to look upon it as caused by the invasion of a specific virus, a micro-organism, and to relegate the exposure to inclement weather to the less important position of a predisposing cause, by which the conditions are rendered favourable for the development and growth of the germ. It cannot, however, be said that we are at present certain of the particular micro-organism which is the cause of pneumonia, or that all cases of acute pneumonia as above defined are due to one and the same germ. The various forms of pneumonia do not appear to have been sufficiently differentiated by the observers who have considered the relationship of the micro-organisms found in the inflamed lung to the ætiology of the disease, and it is probable that they are not all excited by one and the same micro-organism. Fraenkel's pneumococcus is an organism which is found in the inflamed lung in the large majority of cases, though not in all, and it has further been shown to be capable of producing pneumonia when inoculated into mice and guinea-pigs. But in other cases different forms of micro-organisms have been detected, and it is a debatable point what relation these bear to the causation of the disease. Fraenkel's pneumococcus is the organism most commonly present, and has the largest amount of evidence in its favour as the exciting cause of the disease. It must, however, be remembered that an organism which is apparently identical with that bearing Fraenkel's name frequently occurs in the saliva of healthy individuals. If, therefore, it is the most common exciting factor, some other element must be necessary before it can exert its action and produce pneumonia. This other element is commonly supposed to be the resisting power of the individual, by virtue of which the tissues of healthy persons, in whose saliva the pneumococcus is present, are able to offer a resistance to the multiplication of the germ and to the production of the inflammatory process in the lungs. Many conditions appear to lessen this resisting power. Exposure to inclement weather has already been referred to in this connexion, but even in idiopathic pneumonia it is frequently impossible to satisfy one's self that the patient has been exposed to unsuitable atmospheric conditions immediately before the attack. In other words, the effects of a so-called chill as a frequent cause of acute pneumonia have probably been exaggerated. A lowered state of general health usually precedes the onset of the disease, and anything producing a depressed nervous condition would appear to be important as a predisposing cause. Chronic alcoholism is one of the most important of such causes, and pneumonia frequently comes on in the course of Bright's disease and acute rheumatism, or as a sequela of influenza. Unlike many acute diseases, pneumonia does not render a person less liable to future attacks; on the contrary, those who have been once attacked must be looked upon as more prone to be affected again. Acute pneumonia usually attacks the whole or greater part of one lobe of one lung, but more than one lobe may be affected, or both lungs may be involved. The disease produces a solid and airless condition of the affected part owing to a fibrinous exudation taking place into the air cells and smaller bronchial passages. In favourable cases the exudation is partly absorbed and partly expectorated, and the lung returns to its normal healthy condition; in others, death may ensue from the extent of lung affected, or from the spread of the inflammation to other parts, as for instance the pericardium or meninges of the brain. In such cases it is interesting to note that the same micro-organism has been found in the inflammatory exudation in the pericardium or on the meninges as in the pneumonic lung; probably the organism had been absorbed from the lung, and was the cause of the secondary inflammations. In cases of death from uncomplicated pneumonia a very variable extent of lung is involved. Sometimes it is comparatively small, and we are surprised that it has been sufficient to lead to a fatal termination. In some such cases this result may be ascribed to the weakness of the individual and especially of the heart, but in others the virulence of the micro-organisms and the toxins which they have produced is probably the more correct explanation. The improvement in a patient suffering from pneumonia usually commences suddenly, with a rapid fall in the temperature. The day on which this "crisis" takes place varies, but most commonly it appears to be the seventh from the initial rigor (22 per cent. of the cases, Jürgensen). It may, however, occur a few days earlier or later, being observed in about 74 per cent. between the fifth and the ninth day of the disease (Jürgensen). The disease occasionally ends in the formation of an abscess, in gangrene, or in fibroid induration of the lung, but these terminations are rare.

Broncho-pneumonia.—It is usual to recognize a form of inflammation of the lungs which differs from the above lobar pneumonia, and in which small patches of consolidation are usually scattered throughout the lower lobes of both lungs. This broncho or catarrhal [1] pneumonia is usually preceded by an attack of bronchitis, to which it bears an intimate relation. In some cases the small foci of inflammation may run together so as to affect the greater part of a lobe of a lung, and the distinction between such a form of broncho-pneumonia and lobar pneumonia presents such difficulties in the view of some observers, that they have refused to recognize any essential difference between the two. Usually, however, it is not difficult to distinguish the two affections both clinically and anatomically. Broncho-pneumonia is especially seen as a complication of bronchitis, and while it more frequently attacks children than young adults, it is not uncommon in old people, especially secondary to bronchitis. It is frequent in children after acute infectious fevers, especially measles and diphtheria, and in cases of whooping-cough. It differs from the above-mentioned pneumonia in that it does not usually attack the whole of a lobe of a lung, but occurs in small disseminated patches more especially throughout the lower lobe of both lungs. The accompanying fever is more irregular than in the preceding form, and the disease usually runs a more prolonged course. It is an extremely fatal affection in both the very young and old. Young persons who have suffered from it are not unfrequently attacked by pulmonary tuberculosis subsequently. It must be admitted that we are even less certain of its bacteriology than we are of that of lobar pneumonia. In some cases Fraenkel's pneumococcus is found, and in others various other micro-organisms. Many of the latter are doubtless saprophytic, and are not the essential cause of the disease, but it is not probable that any one particular form of organism accounts for all forms of broncho-pneumonia.

Tubercle. The tubercular virus, the tubercle bacilli, may gain entrance to the lungs through the inspired air or by means of the blood or lymph currents. In the latter cases an acute eruption of tubercle takes place throughout the lungs in the form of small scattered foci forming the so-called miliary tubercles. Such miliary tuberculosis of the lungs is frequently only a part of a general tuberculosis, a similar tubercular affection being found in other organs of the body. In other cases the lungs may be the only or the principal seat of the affection. The source whence the tubercular virus is derived varies in different cases. Old tubercular glands in the abdomen, neck, and elsewhere, and tubercular disease of bones or joints, are common sources whence tubercular bacilli may become absorbed, and occasion a general dissemination of miliary tubercles in which the lungs participate. Where the source of infection is an old tubercular bronchial gland or a focus of old tubercle in the lung, the pulmonary organs may be the only seat of the development of miliary tuberculosis for a time; but even then, if life is sufficiently prolonged, other parts of the body become involved. Acute miliary tuberculosis of the lungs is not unfrequently a final stage in the more chronic tubercular lesions of the different forms of pulmonary phthisis.

[1] The term catarrhal pneumonia has been usually regarded as synonymous with the term broncho-pneumonia, and this usual nomenclature has been maintained in the present article. We must, however, recognize that all simple acute broncho-pneumonias are not purely catarrhal in the strict pathological sense. For instance, a considerable amount of fibrinous exudation is not unfrequently present in the patches of broncho-pneumonia, and some of the cases of septic broncho-pneumonia can scarcely be accurately termed *catarrhal.*

Phthisis. Pulmonary phthisis, or consumption, arises from the action of tubercle bacilli which have usually gained entrance with the inspired air. The disease usually commences at the apex of one lung, but runs a very variable course. In a large majority of cases it remains confined to one small focus, and not only does not spread, but undergoes retrograde changes and becomes arrested. In such cases fibrous tissue develops round the focus of disease and the tubercular patch dries up, often becoming the seat of the deposit of calcareous salts. This arrest of small tubercular foci in the lung is doubtless of very frequent occurrence, and in post-mortem examinations of persons who have died from injuries or various diseases other than tubercle it is common to find in the lungs arrested foci of tubercle, which in the majority of instances have never been suspected during life, and probably have occasioned few, if any, symptoms. It has been shown that in more than 37 per cent. of persons, over 21 years of age, dying in a general hospital of various diseases, there is evidence of arrested tubercle in the lungs. As such persons are chiefly drawn from the poorer classes, among whom tubercle is more common than among the well-to-do, this high percentage may not be an accurate indication of the frequency with which pulmonary tubercle does become arrested among the members of the community in general. It does, however, show that the arrest and the healing of tuberculosis of the lungs is by no means infrequent, and that it occurs among those who from their position in life are not only very prone to become infected, but whose circumstances commonly preclude them from putting themselves in the most favourable circumstances to promote the arrest of the disease. These facts indicate that the human organism does offer a resistance to the growth of the tubercle bacilli, and that the tissues of man, although so frequently attacked by the disease, do not afford the best conditions for the spread of tubercular disease. The knowledge of the frequency with which early cases of pulmonary tubercle become arrested must also be of the greatest comfort to those who are attacked, and one of the most encouraging factors for treatment. Consumption is still too frequently regarded by the general public as an incurable disease. In the advanced cases that view is doubtless correct, but in the early stage of the disease the process may become arrested, and the individual restored to health and rendered capable of leading a useful life.

A focus of pulmonary tubercle may become arrested for a time and then resume activity. In many cases it is difficult to say why this is so, but often it is clearly associated with a lowering in the general health of the individual, so that we must assume his resisting power to have been lessened. Frequently this is due to his premature return to his occupation and previous habits of life. It cannot be too strongly insisted that the arrest of a tubercular focus in the lung is a slow process and requires a long time. Commonly a person in the early stage of phthisis goes away to a health resort, and in the course of a few weeks or months improves so much that he returns to a densely populated town and resumes his former employment. In a short time his symptoms return and the disease shows renewed activity, because the improved conditions under which he was placed were not maintained long enough to ensure the complete arrest of the disease.

Instead of the tubercular focus becoming arrested, it may continue to spread and to give rise to other separate foci in its immediate neighbourhood. The original focus and the secondary ones are at first patches of consolidated lung. Later, their central parts soften and burst into a bronchus; then the softened portion is coughed up, and a small cavity is left, which tends gradually to increase in size by peripheric extension and by merging with other cavities. This process is repeated again and again, and sooner or later the other lung becomes similarly affected. At any stage of the softening process the blood-vessels may become involved and give rise by rupture to a large or a small hæmorrhage (*hæmoptysis*). It not unfrequently happens that such hæmoptysis occurs at a very early stage of the disease, and it may be the first symptom that seriously attracts attention. At a later period hæmorrhage frequently takes place in large or small amounts from the rupture of vessels, which frequently are dilated and form small aneurysms in the walls of cavities. A fatal termination may be hastened by the absorption by means of the blood-vessels and lymphatics of the tubercular virus from some of the foci of disease, and the occurrence therefrom of a local miliary tuberculosis of the lungs or a general tuberculosis of other organs. The rapidity with which the destructive process spreads throughout the lung varies considerably. In some cases we have extensive destruction in the course of a few weeks, in others the disease progresses slowly and extends over many years. We therefore recognize acute phthisis or galloping consumption, and chronic phthisis. In the acute cases the softening progresses rapidly and is associated with the development of very little fibrous tissue; probably various forms of micro-organisms other than the tubercle bacilli assist in the rapid softening. In the more chronic cases there is development of much fibroid tissue, and the disease is associated with periods of temporary arrest of the tubercular process.

The expectoration from cases of phthisis contains tubercle bacilli, and under favourable conditions is a source of danger to healthy individuals, in whom it may produce the disease. There is very little danger of infection from the sputum when freshly expectorated, but when it becomes dry and pulverized it is undoubtedly dangerous; hence the prevention of this drying is an important sanitary precaution. Attendance on persons suffering from phthisis involves very little risk of infection if proper care is taken to prevent the expectoration becoming dry and disseminated as dust; but it has been conclusively shown that the dust taken from rooms inhabited by phthisical persons does contain the virus of tubercle, and is capable of producing the disease when inoculated into healthy animals. Perfect cleanliness is therefore to be insisted upon in the rooms inhabited by a phthisical person. The tubercle bacilli soon lose their virulence in the presence of fresh air and sunshine, and therefore these agents are not only desirable for the direct benefit of the phthisical patient, but also are agents in preventing the development of fresh disease in healthy individuals.

Although the tubercle bacilli are the essential agents in the development of pulmonary tuberculosis, there are other conditions which must be present before they will produce the disease. Were this not so, tuberculosis would certainly be a much more common malady in the human subject than it is at present. It is probable that large numbers of individuals are exposed to the action of tubercle bacilli which gain entrance to the pulmonary tract, and yet do not give rise to the disease because the conditions of their growth and multiplication do not exist. In such cases we may consider that the seed is present, but that the soil is unsuitable for its growth. We do not know all the conditions that are favourable or inimical to the growth of the tubercular virus, but we are aware of some. Certain families appear more predisposed to tuberculosis than others. In some instances there would appear to be a direct transmission from parent to offspring of a liability to the disease, but in others a large number of cases of tuberculosis occur in a family though neither parent is apparently affected. Age has an important influence on the development of phthisis, which is most frequent in early adult life. Insanitary conditions of all kinds, especially overcrowding and the absence of fresh air and sunlight from dwellings and workrooms, are important predisposing causes. Anything which impairs the general health is likewise of importance, such as insufficient and improper food, chronic alcoholism, frequent childbearing, and prolonged lactation. Occupations associated with deficient ventilation and the presence of much dust in the atmosphere also furnish a large number of cases of consumption. The deteriorated state of health brought about by diabetes is not uncommonly associated with the development of pulmonary phthisis, and previous disease of the lungs also renders them more liable to a tubercular affection.

The most important circulatory disturbances met with in the lungs are those seen in cases of dilated heart, with or without disease of the mitral valve, when engorgement of the pulmonary vessels sets up a condition of venous engorgement of the lungs. This may lead to various changes. After it has lasted a variable time, and if it is very intense, serous transudation occurs into the substance of the lung and the alveoli, and thus a condition of pulmonary dropsy or œdema is established. The venous engorgement also predisposes the subjects of such heart affections to bronchitis and pneumonia. In disease of the mitral valve, in cardiac dilatation, and in simple feebleness of the heart, such as is seen in old age and after debilitating fevers, especially typhoid, there is commonly developed a venous congestion of the bases of the lungs, forming the so-called hypostatic congestion of those organs, and to this is frequently added pneumonia. In long-standing cases of pulmonary congestion brought about by disease of the mitral valve and dilatation of the heart, a certain amount of fibrous tissue may be found in the interstitial tissue of the lungs, and from transudation of certain elements of the blood we get the formation in the newly-formed fibrous tissue of blood pigment. In these cases blood pigment is found in the cells, in the pulmonary alveoli, and such cells also carry the pigment into the interstitial tissue. This condition constitutes the state known as *brown induration of the lungs*. Acute congestion of the lungs occurs as part of the first stage of pneumonia. It also probably exists during violent exertion, and may possibly be brought about by excitement.

Congestion.

Embolism and Thrombosis.—Another circulatory disturbance of great importance is that arising from blocking of the pulmonary artery or its branches by an embolus or thrombus. Where the obstruction takes place in the main vessel, death rapidly ensues. Where, however, a small branch of the vessel is occluded, as frequently occurs from a coagulum forming in the right side of the heart, or in the pulmonary vessels in cases of disease of the mitral valve, or in dilatation of the heart, or from the detachment of a small vegetation from disease of the tricuspid or pulmonary valves, a hæmorrhagic exudation takes place, forming a patch of consolidation in the lung (*hæmorrhagic infarct*). As this hæmorrhagic exudation takes place not only into the substance of the lung, but also into the bronchial tubes, such lesions are usually associated with spitting of blood (*hæmoptysis*). The increased tension produced in the pulmonary vessels in cases of mitral disease may also probably lead to the formation of hæmorrhagic exudations into the lungs, apart from the occurrence of embolism or thrombosis. Usually the occurrence of pulmonary embolism and the formation of hæmorrhagic infarcts in the lungs mark an important epoch in the course of a case of heart disease. It usually occurs at a late stage of the affection, and not unfrequently contributes materially to a fatal termination. It is probable that many of the cases of pneumonia and pleuritic effusion, coming on in cases of valvular heart disease and of cardiac dilatation, owe their origin to an embolus and to the formation of a hæmorrhagic infarct.

Asthma.

The term asthma is commonly applied to a paroxysmal dyspnœa of a special type which is associated with a variety of conditions. In true spasmodic asthma there may be no detectable organic disease, and the paroxysms are generally believed to be due to a nervous influence which, acting upon the bronchial muscles, produces a spasm of the tubes, or, acting through the vasomotor branches of the sympathetic, produces a congestion of the bronchial mucous membrane. The exciting cause may not be at all apparent even on the most careful observation and examination of the sufferer, but in other cases the attacks may be brought about by some reflex irritation. Nasal polypi and other diseases of nasal mucous membrane have been shown in some cases to be a cause of asthma. Flatulence and constipation are other occasional exciting causes. Irritation of the bronchial mucous membrane appears to be one of the most common, but it is usually difficult to say exactly in what the irritation consists. It is known that a locality is sometimes responsible, and change of residence to a very short distance may make all the difference. The condition of the weather has a very variable influence. In some asthmatic subjects dust and fog in the atmosphere have a marked effect; in other cases, however, a foggy atmosphere has no influence, and an asthmatic individual may be actually better in foggy weather than in a clear dry atmosphere. Emotion and various nervous disturbances may occasionally produce the attacks. Allied to true asthma is the bronchial asthma frequently met with in the subjects of bronchitis and emphysema. In such cases the irritation evidently proceeds from the inflamed bronchial mucous membrane. Hay asthma is the variety in which the pollen of certain plants, especially grasses, is the exciting cause of the paroxysms. In cardiac feebleness, in valvular disease of the heart, and in cardiac dilatation, we may get dyspnœic attacks of a more or less paroxysmal nature, to which the term cardiac asthma has been applied. Similarly, to a form of dyspnœa met with occasionally as a manifestation of uræmia in chronic Bright's disease the term of renal asthma has been given. It is probable that in both these latter conditions the state of the central nervous system brought about by the cardiac and renal affections respectively is the important element producing the paroxysms of dyspnœa.

Pleurisy.

Pleurisy, or inflammation of the pleura, is a very common affection, and is met with under different forms. In many instances we have simply the pouring out, over a greater or less area of the surface of the pleura, of a fibrinous exudation which may become absorbed or undergo organization, a certain amount of thickening of the pleura, and adhesions of the two layers resulting. Such cases form the group known as cases of dry pleurisy. In other instances a greater or lesser amount of serous exudation takes place into one or other pleural cavity, forming the cases of serous pleuritic effusion. In others the exudation into the pleural cavity is purulent, giving rise to the condition known as empyema or purulent pleuritic effusion. The occurrence of dry pleurisy is probably very frequent, and leads to small pleural adhesions which cause little or no inconvenience. In post-mortem examinations of persons who have died from various diseases, it is common to find such pleural adhesions present, although they have never been suspected during life. Pleurisy in one or other of the above forms may come on in a person apparently in good health (idiopathic pleurisy), or it may follow a fracture of the ribs or other injury to the chest. It is not uncommonly secondary to some other disease; thus it is almost a constant accompaniment of acute lobar pneumonia. In such cases the effusion is most commonly a simple fibrinous one, which with the subsidence of the primary disease is in great part absorbed. In other cases of pneumonia we get a certain amount of serous effusion into the pleura; and sometimes, especially in children, the pneumonia is followed by the development of an empyema. Pleurisy with effusion is also frequently a complication of valvular heart disease and dilatation of the heart, and in such cases is often associated with the formation of superficial pulmonary infarcts. It is also seen in many other diseases of the lungs. For instance, in chronic phthisis pleuritic adhesions over various parts of the lungs are the rule; and we also frequently get serous effusion into the pleura as a complication of the various forms of pulmonary tuberculosis. Purulent effusion is less common in phthisis, but it is the rule where the pleura is perforated by the necrosis of a tubercular focus in the lung and the establishment of a communication between the pleura and a tubercular cavity and the bronchial tubes (*pyopneumonothorax*), a combination in which there is both air and pus in the pleural cavity. Secondary pleurisy is also seen in an extension of the disease from neighbouring parts, as from peritonitis, sub-diaphragmatic abscess, and suppuration in the liver or spleen. As a secondary disease pleurisy is also known in the course of various forms of nephritis, rheumatism, and the acute specific diseases.

The cases of so-called idiopathic pleurisy arising in apparently healthy individuals are very interesting and of great importance from an ætiological point of view. In them the pleurisy is commonly attributed to catching cold, but, as in pneumonia, such an occurrence is now generally regarded rather as a predisposing element, and as rendering the pleura a favourable seat for the action of various micro-organisms. It has long been known that persons who have been the subjects of apparently idiopathic serous pleuritic effusion become at a later date the subjects of pulmonary phthisis. More recently it has been shown that the effusion removed from the pleura in such cases is frequently capable of producing tuberculosis when inoculated into guinea-pigs, and hence it is probable that a large number of what are apparently cases of simple inflammation of the pleura are really cases of tuberculosis of the pleura. In many such cases, although at the time of the pleuritic effusion no sign of disease is manifest in the lungs, a tubercular focus does exist which remains for a time latent and subsequently assumes renewed activity. In other cases the pneumococcus appears to be the cause of a purulent or, in rarer instances, of a serous pleuritic effusion; and this may be in cases where pneumonia is, or previously has been present. It is probable also that the pneumococcus sometimes produces a pleurisy without the intervention of pneumonia. In other cases, again, of purulent effusion into the pleura, streptococci seem to be the essential agents of the disease, and account for the production of the pleurisy secondary to various lung affections, and for the spread of inflammation from the peritoneum and other parts, secondary to various general diseases, such as the acute specific diseases, scarlet fever, diphtheria, and erysipelas. (T. H*.)

VI. The Blood.

The changes in the blood in disease are probably as numerous and varied as the diseases which attack the body, for the blood is not only the medium of respiration, but also of nutrition, of defence against organisms, and of many other functions, none of which can be affected without corresponding alterations occurring in the circulating fluid. The immense majority of these changes are, however, so subtle that they escape detection by our present methods. We are beginning to recognize such reactions of infection as the agglutination of the typhoid bacillus by the blood of patients suffering from enteric fever; we are groping for the changes associated with immunity from various diseases; but, speaking generally, we know comparatively little about changes in the blood unless these betray themselves by somewhat coarse alterations in its morphological elements. The changes in the plasma are as yet very imperfectly known, and chemical methods of investigation are still only clinical curiosities. The methods at present employed in examining the blood are: the enumeration of the red and white corpuscles per cubic millimetre; the estimation of the percentage of hæmoglobin and of the specific gravity of the blood; the microscopic examination of freshly-drawn blood and of blood films made upon cover-glasses, fixed and stained. In special cases the alkalinity and the rapidity of coagulation may be ascertained, or the blood may be examined bacteriologically. We have no universally accepted means of estimating, during life, the total amount of blood in the body, though the method of Haldane and Lorrain Smith, in which the total oxygen capacity of the blood is estimated, and its total volume worked out from that datum, seems to promise important results (*Journ. of Physiol.*, vol. xxv., p. 331, 1900). After death the amount of blood sometimes seems to be increased, and sometimes, as in pernicious anæmia, it is certainly diminished. But the high counts of red corpuscles which are occasionally reported as evidence of plethora or increase of the total blood, are really only indications of concentration of the fluid. It is necessary, therefore, in examining blood diseases, to confine ourselves to the study of the blood-unit, which is always taken as the cubic millimetre, without reference to the number of units in the body.

Anæmia is often used as a generic term for all blood diseases, for in almost all of them the hæmoglobin is diminished, either as a result of diminution in the number of the red corpuscles in which it is contained, or because the individual red corpuscles contain a smaller amount of hæmoglobin than the normal. As hæmoglobin is the medium of respiratory interchange, its diminution causes obvious symptoms, which are much more easily appreciated by the patient than those caused by alterations in the plasma or the leucocytes. It is customary to divide anæmias into "primary" and "secondary": the primary are those for which no adequate cause has as yet been discovered; the secondary, those whose cause is known. Among the former are usually included chlorosis, pernicious anæmia, and sometimes the leucocythæmias; among the latter, the anæmias due to such agencies as malignant disease, malaria, chronic metallic poisoning, chronic hæmorrhage, tubercle, Bright's disease, infective processes, &c. As our knowledge advances, however, this distinction will probably be given up, for the causes of several of the primary anæmias have been discovered. For example, the anæmia due to *bothriocephalus*, an intestinal parasite, is clinically indistinguishable from the other forms of pernicious anæmia with which it used to be included, and leucocythæmia has been declared by Löwit, though probably erroneously, to be due to a blood parasite closely related to that of malaria. In all these conditions there is a considerable similarity in the symptoms produced and in the pathological anatomy. The general symptoms are pallor of the skin and mucous membranes, weakness and lassitude, shortness of breath, palpitation, a tendency to fainting, and usually also gastro-intestinal disturbance, headache, and neuralgia. The heart is often dilated, and on auscultation the systolic murmurs associated with that condition are heard. In fatal cases the internal organs are found to be pale, and very often their cells contain an excessive amount of fat. In many anæmias there is a special tendency to hæmorrhage. Most of the above symptoms and organic changes are directly due to diminished respiratory interchange from the loss of hæmoglobin, and to its effect on the various organs involved. The diagnosis depends ultimately in all cases upon the examination of the blood.

Though the relative proportions of the leucocytes are probably continually undergoing change even in health, especially as the result of taking food, the number of red corpuscles remains much more constant. Through the agency of some unknown mechanism, the supply of fresh red corpuscles from the bone-marrow keeps pace with the destruction of effete corpuscles, and in health each corpuscle contains a definite and constant amount of hæmoglobin. The disturbance of this arrangement in anæmia may be due to loss or to increased destruction of corpuscles, to the supply of a smaller number of new ones, to a diminution of the amount of hæmoglobin in the individual new corpuscles, or to a combination of these causes. It is most easy to illustrate this by describing what happens after a hæmorrhage. If this is small, the loss is replaced by the fully-formed corpuscles held in reserve in the marrow, and there is no disturbance. If it is larger, the amount of fluid lost is first made up by fluid drawn from the tissues, so that the number of corpuscles is apparently diminished by dilution of the blood; the erythroblasts, or formative red corpuscles, of the bone-marrow are stimulated to proliferation, and new corpuscles are quickly thrown into the circulation. These are apt, however, to be small and to contain a subnormal amount of hæmoglobin, and it is only after some time that they are destroyed and their place taken by normal corpuscles. If the loss has been very great, nucleated red corpuscles may even be carried into the blood-stream. The blood possesses a great power of recovery, if time be given it, because the organ (bone-marrow) which forms so many of its elements never, in health, works at high pressure. Only a part of the marrow, the so-called red marrow, is normally occupied by erythroblastic tissue, the rest of the medullary cavity of the bones being taken up by fat. If any long-continued demand for red corpuscles is made, the fat is absorbed, and its place gradually taken by red marrow. This compensatory change is found in all chronic anæmias, no matter what their cause may be.

It is often very difficult, especially in "secondary" anæmias, to say which of the above processes is mainly at work. In acute anæmias, such as those associated with septicæmia, there is no doubt that blood destruction plays the principal part. But if the cause of anæmia is a chronic one, a gastric cancer, for instance, though there may possibly be an increased amount of destruction of corpuscles in some cases, and though there is often loss by hæmorrhage, the cancer interferes with nutrition, the blood is impoverished and does not nourish the erythroblasts in the marrow sufficiently, and the new corpuscles which are turned out are few and poor in hæmoglobin. In chronic anæmias, regeneration always goes on side by side with destruction, and it is important to remember that the state of the blood in these conditions gives the measure, not of the amount of destruction which is taking place so much as of the amount of regeneration of which the organism is capable. The evidence of destruction has often to be sought for in other organs, or in secretions or excretions.

Of the so-called primary anæmias the most common is *chlorosis*, an anæmia which occurs only in the female sex, between the ages of fifteen and twenty-five as a rule. Its symptoms are those caused by a diminution of hæmoglobin, and though it is never directly fatal, and is extremely amenable to treatment with iron preparations, its subjects very frequently suffer from relapses at varying intervals after the first attack. Its causation is probably complex. Bad hygienic conditions, over-fatigue, want of proper food, especially of the iron-containing proteids of meat, the strain put upon the blood and blood-forming organs by the accession of puberty and the occurrence of menstruation, all probably play a part in it. It has also been suggested that internal secretions may be concerned in stimulating the bone-marrow, and that in the female sex in particular the genital organs may act in this way. Imperfect assumption of function by these organs at puberty, caused perhaps by some of the above-mentioned conditions, might lead to sluggishness in the bone-marrow, and to the supply to the blood of the poorly-formed corpuscles deficient in hæmoglobin which are characteristic of the disease. Chlorosis is the type of anæmias from imperfect blood-formation. Lorrain Smith has produced evidence to show that the total amount of hæmoglobin in the body is not diminished in this disease, but that the blood-plasma is greatly increased in amount, so that the hæmoglobin is diluted and the amount in each blood-unit greatly lessened.

Pernicious anæmia is a much rarer disease than chlorosis, occurs usually later in life, and is distributed nearly equally between the two sexes. But it is of great importance because of its almost uniformly fatal termination, though its downward course is generally broken by temporary improvement on one or more occasions. The symptoms are those of a progressive anæmia, in which gastro-intestinal disturbance usually plays a large part, and they become at last much more severe than those of any secondary anæmia. The patient may die in the first attack, but more usually, when things seem to be at their worst, improvement sets in, either spontaneously or as the result of treatment, and the patient slowly regains apparent health. This remission may be followed by a relapse, that again by a remission, and so on, but as a rule the disease is fatal within, at the outside, two or three years. The outstanding feature in its pathology is the occurrence of blood-destruction in some part of the portal system, as is proved by the storage in the liver of the iron from the broken-down red corpuscles, and by other facts. This blood-destruction is almost certainly caused by the absorption of toxic substances from the stomach and intestine, but the source of these substances is quite unknown, except in one set of cases, those in which the dead and decomposing *bothriocephalus* poisons its host. The statement of Hunter, that the disease is due to a chronic poisoning by streptococcal micro-organisms, is in direct contradiction to all our knowledge of the behaviour of the blood in streptococcous infections. The condition of the blood in this disease is sharply distinguished from that in any other anæmia. The red corpuscles are enormously diminished; it is usual to find 1,000,000 or less in the cubic millimetre, instead of the normal 5,000,000. The special characteristic of the disease is that though the hæmoglobin is of course absolutely diminished, it is often present in relatively higher percentage than the blood corpuscles. The meaning of this is that the individual corpuscles are on the average larger than usual, and this again occurs because the erythroblasts of the hypertrophied bone-marrow are not of the normal size (normoblasts), but are much larger than normal (megaloblasts). This is a reversion to the type of blood-formation in the fœtus, and the occurrence of megaloblasts in the circulating blood is practically pathognomonic of pernicious anæmia.

Other anæmias, such as those known as *lymphadenoma*, or Hodgkin's disease, *splenic anæmia*, and the *anæmia pseudo-leucæmica* of children, need not be described here, as they are either rare or their occurrence or nature is still too much under discussion.

The number and nature of the leucocytes in the blood bears no constant or necessary relation to the number or condition of the red corpuscles, and their variations depend on entirely different conditions. The number in the cubic millimetre is usually about 7000, but may vary in health from 5000 to 10,000. A diminution in their number is known as *leucopenia*, and is found in starvation, in some infective diseases, as for example in the later weeks of typhoid fever, and in pernicious anæmia. An increase is very much more frequent, and is known as *leucocytosis*, though in this term is usually connoted a relative increase in the proportion of the polymorphonuclear neutrophile leucocytes (see ANATOMY). Leucocytosis occurs under a great variety of conditions, normally to a slight extent during digestion and after violent exercise, and abnormally after hæmorrhage, in the course of inflammations and many infective diseases, in malignant disease, in such toxic states as uræmia, and after the ingestion of nuclein and other substances. It does not occur in some infective diseases, the most important of which are typhoid fever, malaria, influenza, measles, and uncomplicated tuberculosis. In all cases where it is sufficiently severe and long continued, the reserve space in the bone-marrow is filled up by the active proliferation of the leucocytes normally found there, and is used as a nursery for the leucocytes required in the blood. The nature and cause of leucocytosis are not yet determined for all cases, but in many it is known to be associated with the defence of the organism from injurious influences, and its amount depends on the relation between the severity of the attack and the power of resistance. There may be an increase in the proportions present in the blood of lymphocytes (*lymphocytosis*), and of eosinophile cells (*eosinophilia*), but these are of interest only to the clinician.

The disease in which the number of leucocytes in the blood is greatest is *leucocythæmia* or leucæmia. There are two main forms of this disease, in both of which there are anæmia, enlargement of the spleen and lymphatic glands, or of either of them, leucocytic hypertrophy of the bone-marrow, and deposits of leucocytes in the liver, kidney, and other organs. The difference lies in the kind of leucocytes present in excess in the blood, blood-forming organs, and deposits in the tissues. In the one form these are lymphocytes, which are found in health mainly in the lymph glands and in the lymphatic tissue round the alimentary canal; in the other they are the kinds of leucocytes normally found in the bone-marrow—myelocytes, neutrophile and eosinophile, and polymorphonuclear cells, also both neutrophile and eosinophile. The clinical course of the two forms may differ. The first, known as lymphatic leucæmia or *lymphæmia*, may be acute, and prove fatal in a few weeks or even days, or may be chronic and last for one or two years or longer. The second, known as spleno-myelogenous leucæmia or *myelæmia*, is almost always chronic, and may last for several years. Recovery does not take place, though remissions may occur. The most recent view of the pathology of the disease is that of Löwit, who believes, on grounds of pathological observation and experimental inoculation, that both forms are due to blood parasites, sporozoa not unlike the malarial plasmodium, which are found in myelæmia in the leucocytes of the peripheral blood, in lymphæmia in those of the blood-forming organs, and differ somewhat in appearance in the two forms. The former disease he regards as the expression of parasitism *in* the leucocytes; the latter as due to the poison produced by the parasites stimulating the lymphocytes to proliferation and to passage into the blood. It is right to say that Löwit's observations are as yet unconfirmed, and do not seem altogether conclusive.

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VII. CIRCULATION.

On account of its intimate relations with every part of the body, the circulation is prone to disturbances arising from a great series of causes. Some of these produce effects which may be regarded as functional—mere changes in metabolism, whose disturbances react upon the rest of the body; others give rise to definite structural alterations. In considering the pathology of the circulation, it is useful to take up the subject under the headings of (1) *Causes*, (2) *Processes*, and (3) *Effects*.

1. *Causes.*—The factors leading to abnormal conditions of the circulation naturally fall into two groups. I. *Intrinsic*, *i.e.* belonging to the individual. Chief amongst these are: heredity—certain families inherit tendencies

to reactive processes in the cardiac serous membranes, or to degenerative changes in the heart and vessels; age—young persons are more prone to acute reaction changes in the serous membranes, while elderly people are more liable to chronic degenerative alterations in the walls of the heart and of the blood-vessels; sex—males are more subject to degenerative, and females to acute, diseases of the heart; occupation—those engaged in physical over-exertion are liable to sclerotic changes in the vessels and hypertrophy of the heart, while sufficient, but not excessive, muscular activity only serves to maintain a healthy condition of the circulation; habits—healthy modes of life preserve the integrity of the circulatory mechanism, while indolence and indulgence induce fatty changes. II. *Extrinsic, i.e.* arising from without. These causes may be classified under two heads. (1) *General.*—Infective agents, as in the different fevers, give rise to acute affections of the serous membranes of the heart, and to some extent also of the muscular walls; metabolic disturbances, as in gout and its allies, produce chronic fibrous changes, particularly in the vessels, but also to a certain degree in the heart itself; wasting diseases and blood impoverishment lead to retrograde processes, such as fatty degeneration of the heart muscle. (2) *Local.*—Certain diseases originally restricted in distribution produce considerable effects on the circulation. Thus some diseases of the kidneys involve alterations in the systemic arteries and in the left side of the heart, while many affections of the lungs cause analogous effects in the pulmonary blood-vessels and in the right side of the heart.

2. *Processes.*—The changes undergone by the heart and vessels in disease are similar to those which occur in other parts of the body, but are necessarily modified by the special conditions of the circulatory system. Arising in consequence of one or more of the factors just mentioned, the changes may be regarded, for convenience, as belonging to one or other of two great classes—*degenerative* or *retrograde*, and *inflammatory* or *reactive*.

Degenerative.—From the presence of toxic substances in the blood (whether introduced from without or arising within the body) the cells of the muscle fibres are apt to undergo what is termed *cloudy swelling*—the simplest form of degenerative process. The cells become larger and duller, with a granular appearance, and the nuclei are less distinct. As a result of interference with nutrition, whether by simple diminution or perverted processes, *fatty degeneration* ensues. It may be associated, but is not necessarily connected, with adipose accumulation and encroachment, commonly termed infiltration. In true fatty degeneration the muscle cells have part of their protoplasm converted into adipose tissue. The fibres become granular, and the cells lose their definition, while the nuclei are obscure. In some of the acute infective diseases *hyaline degeneration* of muscle fibre takes place, apparently as the effect of coagulative processes. The tissues assume a somewhat glassy appearance, with a distinct tendency towards segmentation. *Calcareous infiltration* is brought about by the deposition of lime salts in tissues which have previously undergone fatty or fibroid changes; it particularly affects the arteries in senile affections. In elderly persons, as well as in cachectic conditions at earlier periods of life, *pigmentary atrophy* takes place. The change consists in a diminution of the size of the muscle fibres, with a great increase of pigment around the nuclei of the cells. And, lastly, *simple atrophy* occurs, through a diminution in the number as well as in the size of the cells in cases of wasting disease.

Reactive.—The acute and chronic processes grouped together under this head form a series characterized by many points of resemblance, but differing widely, according to the tissues in which they are found. They are all due to the reaction of the tissues to irritation, but they vary as they occur in serous membranes, muscular textures, or connective tissues. As regards the serous membranes, their results are quite different in the case of the pericardium, which is highly vascular, and the endocardium upon the valves, which is not rich in blood-vessels. In the case of the pericardium, an exudation of a sero-fibrinous character, which may tend more towards either of these types—serous and fibrinous—is poured out, and to some extent coagulates in most instances, but little emigration or proliferation of cells is found. Analogous processes affecting the endocardium produce granulations or vegetations, sometimes attended by sclerotic changes, causing retraction and deformity of the cusps, at other times accompanied by destructive lesions leading to loss of tissue. The myocardium undergoes both acute and chronic reaction changes. In the former there is enlargement of the nuclei, with proliferation but without karyokinesis. The muscle cells become swollen and lose their striation, while they are softer in texture and altered in outline. The intermuscular tissues are swollen, and may be invaded by leucocytes; this may end in abscess formation, or in the production of newly-formed fibrous tissue. Chronic processes affecting the myocardium give rise to a large amount of fibrosis, and the newly-formed fibrous tissue separates and compresses the areas of muscle fibres, giving rise to what is commonly known as chronic interstitial myocarditis. The analogous changes occurring in connective tissues, such as enter so largely into the structure of the aorta and other large vessels, may be also acute or chronic. In the acute form there are considerable swelling and softening, attended both by exudation and proliferation, the latter of which may, but does not by any means frequently, go on to the formation of pus. The chronic type is characterized by the development of a large amount of newly-formed fibrous tissue, resulting in considerable thickening of the walls, and leading to fatty or calcareous changes.

As a sequel to what has been said regarding pathological processes, it may be added that there are certain efforts of nature by which some of their effects are obviated or lessened. Hypertrophy, when within physiological limits, is to be considered as a means of adaptation. When occurring in pathological circumstances, it must be regarded as a method of compensation. Every structure and every function in a healthy body has greater or lesser reserve of energy. In healthy conditions the ordinary demands made upon various organs are far below their possible responses, and if these be excessive in extent or duration, the organs adapt themselves to the conditions imposed on them. In abnormal circumstances the process of hypertrophy is brought about by the power which the structures have of responding to the demands made upon them, and so long as the process is adequate, all disturbances may be averted. As an example of such readjustment may be cited the fact that in chronic renal cirrhosis, with increased thickness of the middle tunic of the arteries, there is hypertrophy of the left ventricle.

Restitution or recovery may occur to a varying extent in almost all of the disease-processes which have been considered, but it has to be kept in view that in certain of the degenerative affections there is little if any possibility of getting rid of the results of the process, while in the reactive changes terminating in the formation of much fibrous tissue, or its conversion into adipose or calcareous material, the same holds true. Many of the changes, which are no doubt in their essence conservative, lead to far-reaching consequences, by their interference with nutritive possibilities.

3. *Effects.*—The disturbances of the circulation resulting from the processes which have been analysed can be conveniently arranged in a limited number of groups, according as their chief morbid effects are experienced by the heart, the vessels, or the blood. No doubt many factors operate by influencing two or all of these divisions, but it renders the subject clearer to classify the various agencies.

Disturbances connected with the heart may, in the first place, be mainly of *pericardial* origin. An effusion of serous fluid into the pericardial sac causes considerable embarrassment to the course of the blood, by rendering the negative pressure, normally present in the sac, positive. The reason for the interference with the circulation, brought about by this alteration of pressure, is that the auricles are by compression rendered incapable of accommodating the blood-return from the veins. Analogous effects are produced by pressure upon the heart from without, whether by aneurysm or tumour, and pleural effusion or pneumothorax, affecting the viscera from without. In pericarditis it has further to be remembered that the effect of the process itself upon the muscle fibres lying beneath the membrane is to cause a softening of texture and weakening of function, whereby the driving power of the heart is diminished. In obliteration of the pericardium, again, the presence of the adhesions between these two layers leads to interference with the contraction of the myocardium, whereby its functions are interfered with. Alterations in the *endocardial* tissues bring into play another group of causes. The affections of the orifices and valves, so largely produced by alterations of the endocardium, lead to much disturbance of the circulation, either by obstructing the orifices or by permitting regurgitation. In the case of obstruction there must be a lessened current through the orifice, unless the obstacle is in some way overcome; while in the case of regurgitation, unless it be in some way compensated, too little blood is present in the cardiac cavities for propulsion in the right direction. In both lesions, therefore, whether obstructive or regurgitant, the onward flow of the blood is lessened, either by an obstacle to the ongoing current, or a loss of part of it backwards. The action of the ventricles in drawing blood into them is also interfered with directly or indirectly, since obstruction interferes with the direct aspiratory action, while regurgitation, in consequence of the backward escape, causes some of the blood to be drawn towards the heart more than once.

The causes which operate by means of the *myocardium* are almost invariably of a secondary character. The various degenerations already detailed, and the different forms of myocarditis, as well as simple debility of the muscle, are all examples of changes due to general or local disturbance. All processes which directly or indirectly interfere with the energy of the walls of the heart produce twofold effects, by diminishing the aspiratory or suction-pump action during diastole, and by lessening its expulsive or force-pump action during systole. The immediate result upon the heart itself of such disturbances is dilatation of that cavity immediately affected. This may occur under perfectly healthy conditions. In these, however, the dilatation is evanescent, while in the circumstances now under consideration it is permanent, and, although compensated, it leads to persistent dilatation. Upon the blood-vessels the result, whether on account of diminished aspiratory or propulsive energy, is that the amount of blood in the arterial system is decreased, while it is increased in the venous. It is not a necessary consequence that because there is less blood in the arteries the arterial pressure will be diminished, or the venous pressure increased because the veins contain more than their normal amount of blood, seeing that the blood pressure depends upon many different factors. It is a fact, nevertheless, that in consequence of the alteration in the relative amount of blood in the arteries and veins there is a considerable disturbance of blood pressure. Gravitation may overcome the contractile and elastic factors, and several consequences arise from the resulting venous engorgement. From transudation, œdema of the dependent parts of the body and the serous membranes occurs. From the sluggish nature of the current, the blood absorbs too much carbonic acid and loses too much oxygen, hence cyanosis is the result. On account, also, of the slowness of the circulation, there is a longer period for radiation of heat, and the superficial parts of the body accordingly become cold.

The engorgement of internal organs leads to distinct changes in them. The solid viscera, such as the liver, the spleen, the kidney, and the lung, become enlarged and hyperæmic, and if the disturbance be continued, cyanotic atrophy ensues. Change in structure, with loss of function, takes place from blocking of the vessels by blood-clot, whether due to coagulation on the spot, or by the conveyance thither of clots formed elsewhere; a cirrhotic termination also is not infrequent, although there is still some doubt whether in this latter condition other concomitant causes have not at the same time been operative. The brain, although suffering less from hyperæmia, is subject to disturbance of the circulation through it, while it is a common seat of embolic and thrombotic processes. The heart itself, lastly, suffers in consequence of the disturbed circulation through it, and by undergoing venous stasis, with weakening of its walls and increase of its fibrous tissue, it completes the final link in a vicious circle. Effusion into the serous sacs, such as the pleura, the pericardium, and the peritoneum, leads to great disturbance of the viscera with which they are connected. The mucous membranes, both respiratory and digestive, become the seat of catarrhal changes in consequence of the backward pressure and impure blood.

The *blood-vessels* possess the properties of contractility and elasticity in different degrees. Their contractility is characterized by great tonicity, considerable rhythmic action, and little or no rapidity of contraction. Their elasticity stores up energy in a potential condition, and this may be liberated in kinetic form as required. The vessels are supported in various degrees by the different tissues in which they are found. In the more solid viscera they are strongly supported, as in the liver and kidney, while in those which are less dense, as in the case of the brain and the lungs, they are not so well sustained.

In many conditions the contractility and elasticity of the blood-vessels become diminished. As part of a senile change, in consequence of many toxic agencies and as the effect of long-continued stress, the blood-vessels undergo a loss of their normal properties. This is compensated by the growth of an excessive amount of fibrous tissue, leading to various forms of *arterial sclerosis.* As the result of these fibrous changes there is interference with the blood current, since the vessels become unyielding yet frangible, instead of distensile and elastic, tubes. The sclerotic changes lead, moreover, to dilatation of blood-vessels, as well as to the formation of definite aneurysms. They also pave the way for coagulation of blood within them, *i.e.* thrombosis, while in certain situations, more particularly in the brain and in the kidney, rupture is apt to take place. Upon the heart also these changes bring about far-reaching effects. Dilatation, accompanied by hypertrophy, is a certain result of generalized arterial degeneration, while changes in the coronary arteries lead to some of the definite results in the walls of the heart which have already been considered.

The condition of the *blood* is always in a state of fluctuation in consequence of the tissue changes throughout the entire system. It may be temporarily increased or diminished in quantity, and it undergoes great changes not merely as regards the proportion of its different elements, but in respect of many different substances which are apt to circulate through it. The result of such changes is to produce degenerative and reactive processes in the heart and blood-vessels such as have been fully referred to.

The various disturbances which have been considered are compensated by certain of the processes which have been detailed. Chief amongst the compensatory changes is cardiac hypertrophy. A considerable amount of disturbance may take place without the production of hypertrophy, seeing that there is so much reserve of energy in the healthy heart. If the disturbances are permanent, so that the organ labours under continuous stress, the changes summed up under the term hypertrophy ensue, whereby the circulation is sustained. In addition to an absolute increase in the size and number of the muscle fibres of the heart, there is very commonly some fibroid change, and not infrequently some fatty degeneration along with the hypertrophy. Hypertrophy is only possible when the nutrition of the heart is good—when the blood is healthy and the coronary arteries are adequate. It is, however, subject to individual possibilities.

The loss of the normal properties in the blood-vessels is followed by the fibroid changes which have been remarked upon, and these may be regarded as compensatory; but they lead, as has been seen, to further changes, and are to be regarded also as part of a vicious circle.

The alterations in the blood are probably compensated for by an increase in those elements which are of vital importance, such as the coloured and colourless corpuscles.

(G. A. G.)

VIII. Metabolic Diseases.

All disease is primarily due to alterations, quantitative or qualitative, in the chemical changes in the protoplasm of some or all of the tissues of the body. But while in some pathological states these modifications lead to structural changes, in others they do not produce gross lesions, and these latter conditions are commonly classified as Functional Diseases. When such functional disturbances affect the general nutrition of the body they have been termed Metabolic Diseases (*Stoffwechselkrankheiten*). It is impossible to draw a hard and fast line between functional and organic disease, since the one passes gradually into the other, as is well seen in gout. Nor is it always easy to decide how far the conditions are due merely to quantitative alterations in the metabolism and how far to actual qualitative changes, for, as is pointed out in the article Physiology, it is highly probable that many of the apparently qualitative alterations are really quantitative disturbances in one part of the protoplasmic mechanism, leading to an apparent qualitative change in the total result of the activity. The clinical features of such metabolic diseases have been fully treated in the ninth edition of this work, and in the present article the advances in our knowledge of their pathology are alone considered.

A. *Changes in Metabolism mainly Quantitative.*

Obesity.—It is as fat that the surplus food absorbed is stored in the body; but the power of storing fat varies enormously in different individuals, and in some it may be considered pathological. The reasons of this are very imperfectly understood. One undoubted cause of obesity is taking a supply of food in excess of the energy requirements of the individual. The amount of food may be *absolutely* large or large *relatively* to the muscular energy evolved in mechanical work or in heat-production; but in either case, when fat begins to be deposited, the muscular activity of the body tends to diminish and the loss of heat from the surface is reduced; and thus the energy requirements become less, and a smaller diet is sufficient to yield the surplus for further storage of fat. Fat is formed from carbohydrates, and either directly or indirectly from proteids (see Physiology: *Nutrition*). Individuals probably vary in their mode of dealing with these substances, some having the tendency to convert them to fat, some to burn them off at once. Von Noorden, however, who has studied the metabolism in cases of obesity, finds no marked departure from the normal. It may be that in some there is a very perfect absorption of food, but so far no scientific evidence for this view is forthcoming. In all cases the fat stored is available as a source of energy, and this circumstance is taken advantage of in the various fat "cures," which consist in giving a diet containing enough proteids to cover the requirements of the body, with a supply of fats and carbohydrates insufficient to meet the energy requirement of the individual. This is illustrated by the dietaries of some of the best known of these "cures":—

	In Grms. per Diem.			
	Proteid.	Fat.	Carbohydrates.	Calories.
Banting's cure	172	8	81	1112
Oertel's ,,	156–170	25–45	75–120	1180–1608
Ebstein's ,,	102	85	47	1401

In a normal individual in moderate muscular activity about 3000 to 3500 calories per diem are required (see Dietetics), and therefore under the diets of these "cures," especially when accompanied by a proper amount of muscular exercise, the fats stored in the body are rapidly used up.

Diabetes is produced by a diminution in the power of the tissues to use sugar, which thus accumulates in the blood and escapes in the urine. One great source of energy being unavailable, the tissues have to use more fats and more proteids to procure the necessary amount, and hence, unless these are supplied in very large amounts, there is a tendency to emaciation.

The power of using sugar in the tissues is strictly limited, and varies considerably in healthy individuals. Normally, when about 200 grms. of glucose is taken at one time, some of it appears in the urine within one hour. In some individuals the taking of even 100 grms. leads to a transient glycosuria, while others can take 250 grms. or more and use it all. But even in the same healthy individual the power of using sugar varies at different times and in different conditions, muscular exercise markedly increasing the combustion. Again, some sugars are more readily used than others, and therefore have a less tendency to appear in the urine when taken in the food. Milk-sugar and lævulose appear in the urine more readily than glucose. This power of using sugar possessed by an individual may depend to a small extent on the capacity of the liver to store as glycogen any excess of carbohydrates absorbed from the food, and some slight cases of transient glycosuria may be accounted for by a diminution of this capacity. But the typical form of diabetes cannot be thus explained. It has been maintained that increased production of sugar is a cause of some cases of the disease, and this view has been supported by Bernard's classical experiment of producing glycosuria by puncturing the floor of the fourth ventricle. But after such puncture the glycosuria occurs only when glycogen is present in the liver, and it is transient and has nothing to do with true diabetes. The fact that various toxic substances, *e.g.*, carbon monoxide, produce glycosuria has been used as an argument in support of this view, but they too seem to act by causing a conversion of glycogen to glucose, and are effective only when the liver is charged with the former substance. At one time it was thought that the occurrence of glycosuria under the administration of phloridzin proved that diabetes is due to a poison. But the fact that, while sugar appears abundantly in the urine under phloridzin, it is not increased in the blood, shows that the drug acts not by diminishing the power of the tissues to use sugar, but by increasing the excretion of sugar through the kidneys and thus causing its *loss* to the body. Hence the tissues have to fall back upon the proteids, and an increased excretion of nitrogen is produced. This, however, is a totally different condition from diabetes.

Anything which produces a marked diminution in the normally limited power of the tissues to use sugar will cause the disease in a lighter or graver form. As age advances the activity of the various metabolic processes may diminish irregularly in certain individuals, and it is possible that the loss of the power of using sugar may be sooner impaired in some than in others, and thus diabetes be produced. But Minkowski and von Mering have demonstrated, by experiments upon animals, that pathological changes in the pancreas have probably a causal relationship with the disease. They found that excision of that organ in dogs, &c., produced all the symptoms of diabetes—the appearances of sugar in the urine, its increased amount in the blood, the rapid breaking-down of proteids, and the resulting emaciation and azoturia. At the same time the absorption from the intestine of proteids, fats, and carbohydrates was diminished. How this pancreatic diabetes is produced has not been explained. It has been suggested that the pancreas forms an internal secretion which stimulates the utilization of sugar in the tissues. Though in a certain number of cases of diabetes disease of the pancreas has been found, other cases are recorded where grave disease of that organ has not produced this condition. But the apparent extent of a lesion is often no measure of the depth to which the functions of the structure in which it is situated are altered, and it is very possible that the functions of the pancreas may in many cases be profoundly modified without our methods of research being able to detect the change. The pancreas consists of two parts, the secreting structure and the epithelial islets, and one or other of these may be more specially involved, and thus alteration in digestion and absorption on the one hand, and changes in the utilization of carbohydrates on the other, may be separately produced. The subcutaneous injection of large doses of extracts of the supra-renal bodies causes glucosuria and an increase of sugar in the blood, but the relationship of this condition to diabetes has not yet been investigated.

The disease may be divided into two forms:—

1. *Slight cases.*—The individual can use small quantities of sugar, but the taking of larger amounts causes glycosuria. Supposing that the energy requirements of an individual are met by a diet of—

Proteid . .	100 grms.	410 calories.
Fat . .	100 ,,	930 ,,
Carbohydrate	400 ,,	1640 ,,
		2980 ,,

then if only 100 grms. of glucose can be used, the energy value of 300 grms., *i.e.*, 1230 calories, must be supplied from proteids and fats. To yield this, 300 grms. of proteids or 132 grms. of fats would be required. If these are not forthcoming in the diet, they must be supplied from the tissues, and the individual will become emaciated; hence a diabetic on an ordinary diet is badly nourished, and hence the huge appetite characteristic of the disease.

2. *Grave cases.*—From the products of the splitting of proteids sugar can be formed, probably in the liver, and in the more serious form of the disease, even where carbohydrates are excluded from the food, a greater or lesser quantity of the sugar thus formed escapes consumption and may be excreted. Theoretically, 100 grms. of proteid can yield 113·6 grms. of glucose, *i.e.*, 1 grm. of nitrogen will be set free for each 7·5 grms. of glucose formed. In the urine of grave cases of diabetes on a proteid diet, the proportion of nitrogen to sugar is about 1 to 2. This may mean that the theoretically possible amount of sugar is not yielded, or that some of the sugar formed is used in the economy. Both hypotheses may be correct, but the latter is supported by the fact that even in grave cases the decomposition of proteid may be diminished by giving sugar, and that in muscular exercise the proportion of sugar falls.

In the course of the disease the amount of sugar which the tissues can use varies from day to day. It is in the utilization of glucose—the normal sugar of the body—that the tissues chiefly fail. Many diabetics are able to use lævulose, or the inulin from which it is derived, and lactose (milk-sugar) to a very considerable extent. It has, however, been observed that under the administration of these sugars the excretion of glucose may be increased, the tissues, apparently by using the foreign sugar, allowing part of the glucose which they would have consumed to escape. The increased decomposition of proteid, rendered necessary to supply the energy not forthcoming in the sugar, leads to the appearance of a large quantity of nitrogen in the urine—*azoturia*—and it also leads to the formation of various acids. Sulphuric acid and phosphoric acid are formed by oxidation of the sulphur and phosphorus in the proteid molecule, and they are neutralized by the production of ammonia. Hence in the urine of diabetics the proportion of nitrogen as ammonia to the nitrogen as urea is always high. But in the breaking-down of proteids organic acids are also liberated, chiefly belonging to the lower fatty acid series—lactic acid, aceto-acetic acid, and β-oxybutyric acid—and these also are, in part at least, neutralized by ammonia. By the development of these various acids the alkalinity of the blood is diminished. These acids appear in the urine, and their presence in large quantities is indicative of extensive decomposition of proteid, and is sometimes associated with the onset of a comatose condition, which seems to be due rather to an acid intoxication than to the special toxic action of any particular acid.

Myxœdema.—The thyroid gland forms a material which has the power of increasing the metabolism of proteids and of fats; and when the thyroid is removed, a condition of sluggish metabolism, with low temperature and a return of the connective tissues to an embryonic condition, supervenes, accompanied by the appearance of depression of the mental functions and other nervous symptoms. The disease myxœdema, which was first described by Gull in 1873, was shown by Ord in 1878 to be due to degenerative changes in the thyroid gland. It affects both sexes, but chiefly females, and is characterized by a peculiar puffy appearance of the face and hands, shedding of the hair, a low temperature, and mental hebetude. The symptoms are similar to those produced by removal of the thyroid, and are indicative of a condition of diminished activity of metabolism. The nervous symptoms may be in part due to some alteration in the metabolism, leading to the formation of toxic substances. The administration of thyroid gland extract causes all the symptoms to disappear.

Cretinism, the symptoms of which are fully described in the ninth edition, may now be defined as myxœdema in the infant, and it has been definitely proved to be associated with non-development or degeneration of the thyroid gland. The characters of the disease are all due to diminished metabolism, leading to retarded development, and the treatment which has proved of service, at least in some sporadic cases, is the administration of various thyroid preparations.

Exophthalmic Goître—Graves's Disease or Basedow's Disease.—This disease chiefly affects young women, and is characterized by three main symptoms: increased rate and force of the heart's action, protrusion of the eyeballs, and enlargement of the thyroid gland. The patient is nervous, often sleepless, and generally becomes emaciated and suffers from slight febrile attacks. The increased action of the heart is the most constant symptom, and the enlargement of the thyroid gland may not be manifest. Various theories as to the pathology of the condition have been advanced, but in the light of our knowledge of the physiology of the thyroid the most probable explanation is an increased functional activity of that gland.

B. *Changes in Metabolism probably Qualitative.*

At one time the list of diseases ascribed to quantitative changes in the metabolism was considerable. Thus oxaluria was looked upon as a disease due to increased formation of oxalic acid, rheumatism as due to excessive formation of lactic acid, and gout as caused by the formation of uric acid in too large quantities. But oxaluria is now regarded as a form of acid dyspepsia, and rheumatism as an acute infective disease, while evidence against the causal relationship between uric acid and gout is accumulating. Primary qualitative alterations in the metabolism are doubtful. Possibly the production of such substances as glycuronic acid in apparently normal individuals is one of the best examples of such a condition, while probably acute gout is due to a change of this nature.

Gout has often been divided into the typical and atypical forms. The first is undoubtedly a clinical and pathological entity, but the second, though containing cases of less severe forms of true gout, is largely constituted of imperfectly diagnosed morbid conditions. The accumulation of urate of soda in the tissues in gout formerly led physicians to believe in a causal relationship between an increased formation of that substance and the onset of the disease. Garrod's investigations, however, seemed to indicate that diminished excretion rather than increased production is the cause of the condition. He found an accumulation of uric acid in the blood and a diminution in its amount in the urine during the attack. That uric acid is increased in the blood is undoubted, but the changes described by Garrod in the urine, and considered by him as indicative of diminished excretion and retention, are rendered of less value by the imperfections of the analytic method employed. More recent work with better methods has thrown still further doubt upon the existence of such a relationship, and points rather to the accumulation of uric acid being, like the other symptoms of the condition, a result of some unknown modification in the metabolism, and a purely secondary phenomenon. The important fact that in leucæmia (von Jaksch), in lead-poisoning (Garrod), and in other pathological conditions, uric acid may be increased in the blood and in the urine without any gouty symptoms supervening, is one of the strongest arguments against the older views. That the gouty inflammation is not caused by the deposit of urate of soda, seems to be indicated by the occurrence of cases in which there is no such deposition. The results of modern scientific investigation have overthrown the uric-acid theory of gout, but so far they offer no definite explanation of the ætiology of the disease. Nevertheless, while they have not confirmed the view as to the causal relationship of the uric acid to the inflammation and other symptoms of the gouty paroxysm, they have thrown interesting light upon the probable source of the uric acid which is so apt to be deposited, and they also offer a more or less intelligible explanation of the process of deposition. From the true nucleins, which form so important a constituent of living protoplasm, a series of bodies which were formerly classed as the xanthin bases, but which are now more generally known as the purin bases, are formed. Uric acid is a member of this series, and its excretion is increased when substances rich in nuclein, *e.g.*, sweetbreads, &c., are administered. While uric acid itself has not been demonstrated to have any injurious action, the closely allied adenin has been found to produce toxic symptoms. After the discovery of this source of uric acid, physiologists for a time inclined to regard it as the only mode of production. But it must be remembered that in birds uric acid is formed from the lactate of ammonia of the intestine and muscles, just as urea is formed from the same substance in mammals. Uric acid is a di-ureide—a body composed of two urea molecules linked by acrylic acid—an unsaturated propionic acid. Now sarolactic acid is a hydroxy-propionic acid, and hence uric acid is either upon the direct road, or very slightly off the direct road, of the transformation of lactate of ammonia to urea. It is therefore highly probable that in many conditions the conversion of lactate of ammonia to urea is not complete, and that a certain amount of uric acid is formed apart from the decomposition of nucleins.

Sir William Roberts has adduced evidence to show that uric acid circulates in the blood in a freely soluble combination or quadurate—that is, a compound in which one molecule of an acid salt $BH\bar{U}$ is linked to a molecule of the acid $BH\bar{U}.\ H_2\bar{U}$. These compounds are said to be readily decomposed and the bi-urates formed, which are at first gelatinous but become crystalline. The deposition of urate of soda in joints, &c., has been ascribed to this change. Tunnicliffe, however, has published the results of certain investigations which throw doubt upon this explanation.

Rheumatism.—Rheumatic fever was formerly regarded as due to some disturbance in the metabolism, but at the present time the trend of opinion is towards the view that it is a specific micro-organismal disease. The whole clinical picture is that of an infective fever, and it is closely related to gonorrhœal rheumatism and to certain types of pyæmia. A number of independent observers, among them Poynton and Paine in Great Britain, have succeeded in isolating from cases of rheumatic fever a diplococcus which produces similar symptoms in the rabbit to those which characterize the disease in man.

Excluding the peculiar changes in the joints which occur in *rheumatoid arthritis* and in *Charcot's disease*, and which are almost certainly primary affections of the nervous system, it is found that a large number of individuals suffer from pain in the joints, in the muscles, and in the fibrous tissues, chiefly on exposure to cold and damp or after indiscretions of diet. This so-called *chronic rheumatism* appears to be a totally distinct condition from rheumatic fever; and although its pathology is not investigated, it looks as if it were due either to a diminished elimination or an increased production of some toxic substance or substances, but so far we have no evidence as to their nature.

Rickets is undoubtedly a manifestation of a profound alteration of the metabolism in childhood, but how far it is an idiopathic condition and how far a result of the action of toxin introduced from without is not yet definitely known. Kassowitz long ago showed that the bone changes are similar to those which can be produced in animals by chronic phosphorus poisoning, and that they are really irritative in nature. Spillmann, in his work *Le Rachitisme*, discusses the evidence as regards the action of various conditions, and comes to the conclusion that there is no evidence that it is due to a mere primary disturbance of the metabolism, or to excessive production of lactic acid, or to any specific micro-organismal poisoning. But he adduces evidence, perhaps not very convincing, that in the disease there is a specific intoxication derived from the alimentary canal and provoking inflammatory lesions in the bones.

See Dr Carl von Noorden, *Lehrbuch der Pathologie des Stoffwechsels.* Berlin, 1893. (D. N. P.)

IX. Fever.

The term fever is generally used to include all conditions in which the normal temperature of the body is markedly exceeded for any length of time. Every rise of temperature is due to a disturbance in the heat-regulating mechanism, the chief variable in which is the action of the skin in eliminating heat (see Physiology: *Animal Heat*). Although for all practical purposes this mechanism works satisfactorily, it is not by any means perfect, and many physiological conditions cause a transient rise of temperature; *e.g.*, severe muscular exercise, in which the cutaneous eliminating mechanism is unable at once to dispose of the increased amount of heat produced in the muscles. Pathologically, the heat-regulating mechanism may be disturbed in three different ways: 1st, by mechanical interference with the nervous system; 2nd, by interference with heat elimination; 3rd, by the action of various poisons.

1. In the human subject, fever the result of *mechanical interference* with the nervous system rarely occurs, but it can readily be produced in the lower animals by stimulating certain parts of the great brain, *e.g.*, the anterior portion of the corpus striatum. This leads to a rise of temperature with increased heat production and increased excretion of carbonic acid and of urea. Possibly some of the cases of high temperature recorded after injuries to the nervous system may be caused in this way; but some may also be due to stimulation of vaso-constrictor fibres to the cutaneous vessels diminishing heat elimination. So far the pathology of this condition has not been studied with the same care that has been devoted to the investigation of the third type of fever.

2. Fever may readily be produced by *interference with heat elimination.* This has been done by submitting dogs to a temperature slightly below that of the rectum, and it is seen in man in *Sunstroke* (*Ency. Brit.*, 9th edition, vol. xxii. p. 666). The typical nervous symptoms of fever are thus produced, and the rate of chemical change in the tissues is accelerated, as is shown by the increased excretion of carbonic acid. The protoplasm is also injured and the proteids are broken down, and thus an increased excretion of nitrogen is produced and the cells undergo degenerative changes.

3. The products of various micro-organisms have a toxic action on the protoplasm of a large number of animals, and among the symptoms of this toxic action one of the most frequent is a rise in temperature. While this is by no means a necessary accompaniment, its occurrence is so general that the term *Fever* has been applied to the general reaction of the organism to the microbial poison. Toxins which cause a marked rise of temperature in men may cause a fall in other animals. It is not the alteration of temperature which is the great index of the severity of the struggle between the host and the parasite, but the death and removal to a greater or lesser extent of the protoplasm of the host. In this respect fever resembles poisoning with phosphorus and arsenic and other similar substances. The true measure of the intensity of a fever is the extent of disintegration of protoplasm, and this may be estimated by the amount of nitrogen excreted in the urine. The increased disintegration of protoplasm is also indicated by the rise in the excretion of sulphur and phosphorus and by the appearance in the urine of acetone, diacetic acid, and oxybutyric acids (see PHYSIOLOGY: *Nutrition*). Since the temperature is generally proportionate to the intensity of the toxic action, its height is usually proportionate to the excretion of nitrogen. But sometimes the rise of temperature is not marked, while the excretion of nitrogen is very decidedly increased. When the temperature is sufficiently elevated, the heat has of itself an injurious action on the protoplasm, and tends to increase disintegration just as when heat elimination is experimentally retarded. But the increase due to rise of temperature is small compared to that produced by the destructive action of the microbial products. In the beginning of a fever the *activity of the metabolism* is not increased to any marked extent, and any increase is probably due to the greater activity of the muscles of the heart and respiratory mechanism, and to the muscular contractions which produce the initial rigors. Thus the excretion of carbon dioxide—the great measure of the activity of metabolism—is not usually increased, and there is no evidence of an increased combustion. In the later stages the increased temperature may bring about an acceleration in the rate of chemical change; but this is comparatively slight, less in fact than the increase observed on taking muscular exercise after rest. The *rise of temperature* is really due to diminished heat elimination. This diminished giving off of heat was demonstrated by means of the calorimeter by Rosenthal, while Maragliano showed that the cutaneous vessels are contracted. Even in the later stages, until defervescence occurs, heat elimination is inadequate to get rid of the heat produced.

The toxic action is manifested not only by the increased disintegration of protoplasm, but also by disturbances in the functions of the various organs. The activity of the *digestive glands* is diminished and appetite is lost. Food is therefore not taken, although when taken it appears to be absorbed in undiminished quantities. As a result of this the patient suffers from inanition, and lives largely on his own fats and proteids, and for this reason rapidly emaciates. The functions of the *liver* are also diminished in activity. Glycogen is not stored in the cells, and the bile secretion is modified, the essential constituents disappearing almost entirely in some cases. The production of urea is also interfered with, and the proportion of nitrogen in the urine not in the urea increases. This is in part due to the increased disintegration of proteids setting free sulphur and phosphorus, which, oxidized into sulphuric and phosphoric acids, combine with the ammonia which would otherwise have been changed to urea. Thus the proportion of ammonia in the urine is increased. Concurrently with these alterations in the functions of the liver-cells, a condition of granular degeneration and probably a state of fatty degeneration makes its appearance. That the functional activity of the *kidneys* is modified, is shown by the frequent appearance of proteoses or of albumen and globulin in the urine. Frequently the toxin acts very markedly on the protoplasm of the kidney epithelium, and causes a shedding of the cells and sometimes inflammatory reaction. The *muscles* are weakened, but so far no satisfactory study has been made of the influence of microbial poisons on muscular contraction. A granular and fatty degeneration supervenes, and the fibres waste. The *nervous structures*, especially the nerve-cells, are acted upon, and not only is their functional activity modified, but they also undergo structural changes of a chromatolytic nature. The *blood* shows two important changes—first, a fall in the alkalinity due to the products of disintegration of protoplasm, and, secondly, an increase in the number of leucocytes, and chiefly in the polymorpho-nuclear variety This is best marked in pneumonia, when the normal number is often increased twofold and sometimes more than tenfold, while it is altogether absent in enteric fever.

An interesting general modification in the metabolism is the enormous fall in the excretion of chlorine, a fall far in excess of what could be accounted for by inanition, and out of all proportion to the fall in the sodium and potassium with which the chlorine is usually combined in the urine. The fevered animal in fact stores chlorine in its tissues, though in what manner and for what reason is not at present known.

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(D. N. P.)

X. THE KIDNEYS.

The results of morbid processes in the kidney may be grouped under three heads: (1) the actual lesions produced in the kidneys, (2) the effects of these on the composition of the urine, and (3) the effects of the kidney lesion on the body at large.

(1) Lesions of the kidney are either congenital or acquired, and when acquired they may be either the sole result of a pathological process limited to the kidney, in which case they are spoken of as primary, or else the morbid process in the kidney may be an accompaniment or sequel of disease in other parts of the body, and they are then often spoken of as secondary.

Congenital Lesions.—The principal congenital lesions are—(1) anomalies in the number or position of the kidneys or of their ducts, (2) atrophy of one kidney, (3) cystic disease of the kidney, and (4) growths. The most common abnormality is the existence of a *single kidney*—very rarely a third or supernumerary kidney may be present—or both may be absent; the last, however, is only of embryological interest, and is found most frequently in acephalous monsters. The presence of a single kidney may be due to the absence of development of one, or to the atrophy of one, in fœtal life; it may also be dependent on the fusion of originally separate kidneys, and this fusion commonly occurs in such a way as to lead to the formation of a horse-shoe kidney, the two organs being connected at their lower extremities by a mass of renal tissue. In some cases the apparently single horse-shoe kidney is really double, the organs being united by fibrous tissue. Occasionally the two kidneys are fused end to end, producing an apparently single organ with two ureters opening in their normal situations. A third variety is that where the fusion is more complete, producing a disc-like mass from which the ureters issue and follow their normal course. The kidneys may be situated in *abnormal positions;* thus they may be found in front of the sacro-iliac articulation, or they may sink into the pelvis or the iliac fossa. The main importance of such displacements lies in the fact that the organs may be mistaken clinically for tumours. Congenital displacements of one or other kidney are sometimes associated with malformation of the large intestine. The causes of *atrophy* during fœtal life are obscure. In some cases it is associated with maldevelopment, so that only the medullary portion of the kidney is developed; in others it is apparently associated with arterial obstruction, and sometimes it may be dependent upon obstruction of the ureter, as this has been found experimentally to be capable of causing very complete atrophy. *Congenital cystic disease* is not uncommon, the organ being transformed into a mass of cysts, and the enlargement of the kidneys may be so great as to produce difficulties in birth. The cystic degeneration is generally looked upon as dependent upon either obstruction of the uriniferous tubules or else upon anomalies in development, with persistence of portions of the Wolffian body. In some cases cystic degeneration of the kidneys is accompanied by anomalies in the ureters and in the arterial supply; in others these are normal. *Growths of the kidney* are sometimes found in infants. They are not uncommonly malignant, and may consist of a peculiar form of sarcoma, which has been spoken of as rhabdo-sarcoma owing to the presence in the tumour mass of involuntary muscular fibre. The existence of these peculiar tumours is thought to be dependent on anomalies of development, inasmuch as the tissue which forms the primitive kidney belongs to the same layer as that which gives rise to the muscular system (mesoblast). *Anomalies of the excretory ducts* of the kidneys are of no great importance. Sometimes the ureter is double, in others it is greatly dilated; in others the pelvis of the kidney may be greatly dilated, with or without dilatation of the ureter.

Acquired Diseases.

One or both kidneys in the adult may be preternaturally mobile (nephroptosis). This condition is more common in women than in men; and although sometimes dependent on congenital anomalies, it is more usually acquired as a result of injury, or owing to the abdominal walls becoming lax as a sequel to abdominal distension or to the effects of tight-lacing. The more extreme forms of movable kidney are dependent, generally, on congenital anomalies in the arrangement of the peritoneum, so that the organ has a partial mesentery; and to this condition, where the kidney can be moved more or less freely from one part of the abdomen to another, the term *floating kidney* is applied. More usually the organ is loose under the peritoneum, and is not efficiently supported in its fatty bed by peritoneal bands. It is possible that, in addition to the causes just enumerated, emaciation may produce mobility of the kidney. Movable kidney produces a variety of symptoms—pain in the loin and back, nausea, and vomiting—and the function of the organ may be seriously interfered with owing to the structures in the hilum becoming kinked. In this way hydronephrosis, or distension of the kidney with urine, may be produced. The return of blood through the renal vein may also be hindered, and in this way temporary vascular engorgement of the kidney, with hæmaturia, may be produced.

1. *Embolism.*—The anatomical arrangement of the kidney vessels is one which is peculiarly favourable to the production of wedge-shaped areas of necrosis dependent on blocking of the renal arterioles by emboli, and renal infarcts are commonly seen in all conditions in which embolism is liable to occur. Sometimes the embolus is a blood-clot detached from the interior of the heart, or even a calcareous plate from the interior of the aorta, and the effects produced are simply mechanical, from the arrest of the circulation in the part of the kidney supplied by the blocked artery. In other cases, the embolus, in addition, is infective owing to the presence of a variety of micro-organisms; and in these circumstances the necrotic area undergoes other changes dependent on the presence of these organisms, leading not uncommonly to abscess in the kidney. The small vessels are sometimes blocked by masses of organisms only, producing minute embolisms. It is exceptional for the larger branches of the renal artery to be blocked by emboli, so that the symptoms produced in the ordinary cases are only temporary derangements of the secretion, *e.g.*, the sudden appearance of hæmaturia, albuminuria, and pain in the back.

2. *Thrombosis*, or blocking of the renal vessels as a result of disease of the walls of the vessels, is also not uncommon, and in exceptional cases it may lead to complete disorganization of one or both kidneys. Thrombosis of the veins, leading to extreme congestion of the kidney, also occurs, either limited to the renal vein or extending into it from the vena cava. It is most frequently seen in cachectic conditions produced by general diseases causing extreme weakness and wasting, sometimes in septic conditions, as in puerperal pyæmia, where a clot, formed first in one of the pelvic veins, may spread up the vena cava and secondarily block the renal veins. Thrombosis of the renal vein also occurs in malignant disease of the kidney, and in certain forms of chronic Bright's disease.

3. *Passive congestion* of the kidneys is seen more especially in heart diseases and lung diseases, where the return of venous blood to the heart is seriously interfered with. It may also be produced by tumours and other lesions pressing on or involving the vena cava. The passively engorged kidneys become brownish red in colour, considerably enlarged and fibroid, and they secrete a scanty high-coloured dense urine.

4. *Active congestion* is difficult to separate from the earlier stages of inflammation or nephritis, and these two conditions are often produced by the excretion in the urine of irritating bodies, *e.g.*, turpentine and cantharides, and the toxins of various diseases. These irritants produce engorgement and inflammation of the kidney, much in the same way as they would that of other structures with which they come in contact. It is probable that a great many varieties of active congestion of the kidney and of nephritis in general diseases are produced by the excretion of microbic poisons. Further, it is thought that extreme congestion of the kidneys may be produced by exposure to cold, owing to some intimate relationship existing between the skin vessels and the kidney vessels, the constriction of the one being accompanied by the dilatation of the other. There is at present no experimental evidence to justify this view. Infective diseases, such as typhoid fever, pneumonia, scarlet fever, and, in fact, most acute specific diseases, produce during their height a transitory or temporary nephritis, which is not usually followed by any permanent or serious alteration in the kidney; but some acute specifics tend, in addition, to cause a more severe nephritis, which may lay the foundation of fatal or permanent renal disease. This is much more frequent as a result of scarlet fever than as a sequel to pneumonia, typhoid, or other febrile diseases. It is probable that the lesions in so-called transitory nephritis are often partial, involving only some portion of the kidney.

5. *Bright's disease* is the term applied to certain varieties of acute and chronic nephritis. Three forms are usually recognized—acute, chronic, and the granular or cirrhotic kidney. The position of this third lesion, however, is a little doubtful, as one form of cirrhotic or contracted kidney is sometimes the sequel to acute or chronic Bright's disease, and in these cases it is a purely kidney lesion and a variety of Bright's disease. In the other and more common form of granular kidney the kidney lesion is only part of a widespread affection involving the whole arterial system, and is not in any way related to Bright's disease. Chronic Bright's disease is sometimes the sequel to acute Bright's disease, but in a great number of cases the malady is chronic from the beginning. The lesions of the kidney are probably produced in the majority of cases by the irritation of the kidney structures owing to the excretion of toxic substances which have either been ingested or formed in the body; it is thought by some that the malady may sometimes arise simply as a result of exposure to cold. The principal causes of Bright's disease are alcoholism, pregnancy, the action of certain poisons, *e.g.*, lead, gout, &c.; it may also occur as

a sequel to acute diseases, more especially acute specifics such as scarlet fever. Persons following certain occupations are peculiarly liable to certain forms of Bright's disease, *e.g.*, engineers who work in hot shops and pass out into the cold air scantily clothed; and painters, in whom the malady is apparently dependent on the action of lead on the kidney. In the case of alcohol and lead the poison is ingested; in the case of scarlet fever, pneumonia, and perhaps pregnancy, the toxic agent causing the renal lesion is formed in the body and probably excreted by the urine. In Bright's disease all the elements of the kidney, the glomeruli, the tubular epithelium, and the interstitial tissue, are affected. In the different varieties of the disease these structures are affected to different degrees. Thus in Bright's disease following scarlet fever, the glomerular structures are mostly affected, the capsules being greatly thickened by the formation of fibrous tissue, and the glomerular tuft compressed, atrophied, and degenerated. The epithelium of the convoluted tubules undergoes degeneration, and considerable quantities of it are shed, and form the well-known casts that are found in the urine. The tubules, too, become blocked by the shed epithelium, and become distended above with the pent-up urine; this is one of the causes of the very considerable increase in size that the kidneys undergo in certain forms of Bright's disease. The lesions in the tubules and in the glomeruli are not usually uniform, certain portions being more affected than others. The interstitial tissue is always affected to a certain extent, and exudation, proliferation, and formation of fibrous tissue all occur. In the granular and contracted kidney the lesion in the interstitial tissue reaches a high degree of development, so that in advanced cases but little renal secreting tissue is left in many places. Such renal tubules as remain are often dilated, and the epithelium lining them is greatly altered, the cells becoming hyaline and losing their characteristic structure. The vessels also undergo changes, becoming greatly narrowed owing to thickening of the sub-endothelial layer of the inner coat; and the muscular coat undergoes hypertrophy and fibroid changes, so that the vessels are abnormally rigid as well as narrow. When the overgrowth of fibrous tissue is considerable, the surface of the organ loses its smooth character and becomes uneven, owing to the irregular development of fibrous tissue, and it is for this reason that the term granular kidney has been applied to this condition. In acute Bright's disease the kidney is considerably increased in size, engorged with blood, and the changes described above are in active progress. In the chronic form the kidney may be large or small, and is usually white or mottled in colour. If large, the cortex is thickened, pale and waxy-looking on section, and the pyramids are congested; if small, the fibrotic change has advanced to a greater extent, and the cortex is greatly diminished in width. Bright's disease, both in its acute and chronic forms, is essentially a disease of the cortical secreting portion of the kidney. The true granular kidney, classified by some as a third variety of Bright's disease, is usually part of a general arterial degeneration, and the overgrowth of fibrous tissue in the kidney and the lesions in the arteries are well marked.

6. *Degenerations.* — The principal degenerations affecting the kidney are the fatty and the albuminoid. Fatty degeneration of the kidney often reaches a high degree in alcoholics, where fatty degeneration of the heart and liver are also present. Albuminoid disease of the kidney is frequently associated with some varieties of Bright's disease, and is also seen as a result of chronic bone disease, suppuration, and syphilis, involving other parts of the body; it is not so common as it was formerly, owing to the progress in the surgical treatment of the diseases causing it.

7. *Growths of the Kidney.*—The principal growths affecting the kidney are tubercle, adenoma, sarcoma, and carcinoma. In addition to these, lipomata and fibromata, the nodules of glanders and the gummata of syphilis, are sometimes found. Tuberculous disease of the kidney is sometimes primary; more frequently it is secondary to tubercle in other portions of the genito-urinary apparatus. The genito-urinary tract may be infected by tubercle in two ways, one ascending, the other descending. By ascending tuberculosis is meant a condition in which the primary lesion is in the testicle, epididymis, or urinary bladder, and the kidney becomes secondarily involved by the lesion travelling up the ureter or lymphatics to the kidney. A descending infection, on the other hand, is usually a result of a blood infection, where the tubercle bacillus reaches the kidney through the blood-vessels. In these circumstances, miliary tubercle, the condition in which scattered tuberculous granules are seen, more especially in the cortex of the kidney, is usually produced. With descending infection of the kidney the lesion is necessarily generally bilateral; in primary tuberculosis of the kidney and in ascending tuberculosis the lesion is at first unilateral. Malignant disease of the kidney generally takes the form of sarcoma or carcinoma. Sometimes it is dependent on the malignant growths starting in what are spoken of as adrenal rests in the cortex of the kidney. Sarcoma of the kidney is a condition most often seen in the young, carcinoma in the middle-aged and elderly. Carcinoma may be primary or secondary, but the kidney is an organ of the body that is not so prone to malignant disease as other organs, such as the stomach, bowel, &c.

8. *Cystic Kidneys.*—Several different varieties of cysts are found in the kidney. Thus single cysts occur, sometimes of large size, while scattered small cysts are more especially seen in cases of chronic Bright's disease and in the granular contracted kidney, where the dilatation of certain tubules reaches a high degree of development, ultimately forming cysts. Certain growths of the kidney, again, such as adenomata, are liable to undergo cystic degeneration, and in some cases of malignant disease cysts are found. Finally, there is a rare condition of general cystic disease somewhat similar to that seen congenitally. In this form the kidneys are greatly enlarged, and consist of a congeries of cysts separated by the remains of renal tissue.

9. *Parasitic Affections.*—The more common parasites affecting the kidney, or some other portion of the urinary tract, and causing disease, are filaria, bilharzia, and the cysticercus form of the tænia echinococcus. The presence of *filaria* in the thoracic duct and other lymph channels may cause the presence of chyle in the urine, together with the ova and young forms of the filaria, owing to the distension and rupture of a lymphatic vessel into some portion of the urinary tract. This is the common cause of chyluria in hot climates, but chyluria is occasionally seen in the United Kingdom without the presence of filaria. *Bilharzia*, especially in Egypt and South Africa, causes hæmaturia. The cysticercus form of the *tænia echinococcus* leads to the production of hydatid cysts in the kidney. This organ, however, is not so often affected in this manner as the liver.

10. *Nephrolithiasis.*—Calculi are frequently found in the kidney, consisting usually of uric acid, sometimes of oxalates, more rarely of phosphates. Calculous disease of the bladder is generally the sequel to the formation of a stone in the kidney, which passing down into the bladder, and owing to secondary changes produced by its presence in the bladder, is followed by the deposition of the salts in the urine round it as a nucleus. Calculi are usually formed in the pelvis of the kidney, and their formation is dependent either on the excessive amounts of uric acid, oxalic acid, &c., in the urine, or on an alteration in the composition of the urine, such as increased acidity, or on the crystals of the uric acid or of the oxalate of lime being present in an abnormal and large form. The formation of abnormal crystals is often dependent on the presence of some colloid, such as blood, mucus, or albumen, in the secretion, modifying the crystalline form. Once a minute calculus has been formed, its subsequent growth, owing to the deposition on it of the urinary constituent forming it, is easily understood. Calculi formed in the pelvis may be single and may reach a very large size, forming, indeed, an actual cast of the pelvis and calyces of the kidney. At other times they are multiple and of very varying size. When formed, they may give rise to no symptoms, or, on the other hand, they may give rise to renal colic of varying degrees of severity, especially when they are passed or attempted to be passed. A great variety of complications may result from the presence of a stone, such as hydronephrosis, from the urinary secretion being pent up behind the obstruction, or complete suppression, which is apparently produced reflexly through the nervous system, the presence of the stone in the pelvis or ureter leading to complete arrest of the function of the kidney. In such cases the surgical removal of the stone is often followed by the restoration of the renal secretion. Pyonephrosis, distension of the pelvis of the kidney with pus, abscesses of the kidney, and perinephritic abscess, are not uncommon complications of renal calculus. Finally, cancer of the kidney is thought by many to be associated with the long-continued irritation produced by the presence of stones.

11. *Pyelitis.*—Inflammation of the pelvis of the kidney is generally produced by the extension of inflammation upwards from the bladder and lower urinary tract, or by the presence of stones or of tubercle in the pelvis of the kidney. Pyonephrosis, distension of the kidney with pus, may result as a sequel to pyelitis or as a complication of hydronephrosis, and in many such cases the inflammation spreads to the capsule of the kidney, leading to the formation of what is described as a perinephritic abscess. In some cases a peri nephritic abscess results from a septic infarct of kidney, or may occur primarily, as the result of traumatism or of other causes, in the loose cellular tissue surrounding the kidney, without any lesion of the kidney or pelvis of the kidney.

12. *Hydronephrosis*, or distension of the kidney with pent-up urine, results from obstruction of the ureter, although all obstructions of the ureter are not followed by it, *e.g.*, calculous obstruction often causing complete suppression. Obstruction of the ureter, causing hydronephrosis, is most frequently dependent on the presence of a stone, or on pressure on the ureter from a tumour in the pelvis—as, for instance, cancer of the uterus—or on some abnormality of the ureter, more especially an abnormality in its attachment to the pelvis of the kidney, as, for instance, when attached at an angle, or when preternaturally narrow. Sometimes the ureter is obstructed sufficiently to cause hydronephrosis by

unnatural mobility of the kidney. The hydronephrosis produced by obstruction of the ureter is sometimes intermittent; and when a certain degree of distension is produced, either as a result of the shifting of the calculus or of some other cause, the obstruction is temporarily relieved and the urinary flow re-established. When the hydronephrosis has existed for any considerable length of time, the kidney is converted into a sac, the remains of the renal tissues being spread out as a thin layer.

(2) *Effects on the Urine.*—Diseases of the kidney produce alterations of two kinds in the composition of the urine: either the proportion of the normal constituents is altered, or substances not normally present are excreted in greater or less abundance. In most diseases the quantity of urinary water is diminished, especially in those in which the activity of the circulation is impaired. There are certain diseases, however, more especially the granular kidney and certain forms of chronic Bright's disease, in which the quantity of urinary water is considerably increased, notwithstanding the profound anatomical changes that have occurred in the kidney. When the quantity is diminished there may be actual suppression, and two forms of this are recognized—(1) obstructive suppression, seen where the ureter is blocked by stone or other morbid process, and (2) non-obstructive suppression, a condition which is more especially seen as a terminal phenomenon in advanced diseases of the kidney of inflammatory or other nature. In some cases complete suppression may occur as the result of injuries to other parts of the body. In some diseases in which the quantity of urinary water excreted is normal, or even greater than normal, the efficiency of the renal activity is really diminished, inasmuch as the urine secreted is very dilute and contains but few solids. In estimating the efficiency of the kidneys, it is necessary to take into consideration the so-called "solid urine," that is to say, the quantity of solid matter excreted per diem. The nitrogenous constituents—urea, uric acid, creatinin, &c.—vary greatly in amount in different diseases. In most renal diseases the quantities of these substances are diminished. The most important abnormal constituents of the urine present in disease are serum albumen, serum globulin, albumoses (albuminuria), blood (hæmaturia), blood pigment (hæmoglobinuria), pus (pyuria), chyle (chyluria), and abnormal pigments (melanuria, urobilinuria, &c.).

(3) *Effects on the Body at large.*—Diseases of the kidney tend to produce certain effects on the body at large, all of which are not usually seen to accompany any single disease of the kidney, nor are they equally developed in different cases of the same disease. These effects may be divided into the persistent and the intermittent or transitory. The most important persistent remote effects produced by disease of the kidney are, first, nutritional changes leading to wasting, cachexia, &c.; and, secondly, certain cardio-vascular phenomena, such as enlargement (hypertrophy) of the heart, and thickening of the inner and degeneration of the middle coats of the smaller arteries. The intermittent or transitory effects liable to be produced by kidney disease are: (1) dropsy, (2) secondary inflammations of certain organs and serous cavities, and (3) uræmia. Some of these effects are seen in every form of severe kidney disease; thus uræmia may occur in any kidney disease which progresses to an extent sufficient to inflict serious damage on the kidneys. On the other hand, renal dropsy is more especially seen in certain forms of Bright's disease, and the cardiac and arterial changes are particularly common in the granular or contracted kidney, but may be conspicuous by their absence in other diseases which destroy the kidney tissue, such as hydronephrosis. *Uræmia* is a toxic condition, and clinically three varieties are usually recognized: the acute, the chronic, and the latent, according to the severity and character of the symptoms. Many of these effects are dependent upon the action of poisons retained in the body owing to the deficient action of the kidneys as excretory organs. It is also probable that abnormal substances having a toxic action are produced as a result of a perverted metabolism. All observers are agreed that uræmia is of toxic origin, and it is probable that the dropsy of renal disease is due to effects produced in the capillaries by the presence of abnormal substances in the blood. Some pathologists consider that high arterial tension, cardiac hypertrophy, and arterial degeneration are also of toxic origin, whilst others regard these results as produced by an attempt on the part of the body to maintain an active circulation through the greatly diminished amount of kidney tissue available. The exact manner in which high tension and all its results are produced is not thoroughly understood.

(J. R. B.)

XI. Skin.

The diseases of the skin do not essentially differ from those of the other organs of the body. Like these, the skin is composed of cells resting on a connective tissue framework, in which run the vessels which nourish it and the nerves which keep up its communications with the rest of the body. But it has certain differences from other organs, some dependent on its structure and some on its exposed position. Thus, instead of, like the kidney, to which it may best be compared, having its epithelium faced by epithelium, all lies open, and the various processes are all "one-sided." There are no depths to be attacked, and any diseases, if they spread, must do so superficially: spreading as they often do equally in all directions, the diseases of the skin have a tendency to assume a circular form, independently of any parasitic cause, though when such cause is present the patches are of a more perfectly circular shape. Further, from the extent of its superficial area and its exposed position, the skin is liable to be attacked by more forms of irritation, parasitic or other, than any other organ of the body. Every stage and variety of disease is open to view; minute differences, minor or important, are at once noted; and thus it is that the recognized distinct maladies of the skin are so numerous. In no other organ, with the partial exception of the eye, can the changes be watched from day to day; in none can so many stages of the same disease be simultaneously observed; and in no other is it so simple a matter to remove and instantly fix for microscopic examination the living tissue. It is possible to distinguish on the skin between the effects of organisms which it is hardly possible to tell from each other by any other method, cultural or tinctorial; and the relative harmlessness of inoculation makes confirmatory experiments easy.

The multitude of its affections renders the difficulties of arranging the diseases of the skin very great, and the absence of any generally accepted scheme of classification has always been and still remains one of the main obstacles to their intelligent study. The older systems, constructed before the days of bacteriology, were commonly based on the form which the eruption assumed (scaly, moist, purulent), but they usually contained in addition a certain number of diseases under the heading of *Parasitic.* Though obviously illogical, such systems served well enough while the recognized parasitic diseases were few, such as those caused by such gross parasites as the *Acarus scabiei* (the itch mite), the *pediculi* (lice), and the hyphomycetic fungi such as the *Achorion Schönleinii.* The discoveries of bacteriology have enormously enlarged this class, but the difficulty is that one and the same disease is regarded as parasitic by one authority, as dependent on nerve influence by another, while a third sasumes an agnostic position. Dermatologists may perhaps be divided into three schools, though it must be understood that these merely represent the general trend of the countries referred to, and that members of each are found in all. The German school, most of its leaders being pupils of the great Hebra, tend to look to external irritants as the cause of the great majority of diseases, and they are often described as "externalists." The discoveries of bacteriology have greatly strengthened their position, for it seems a reasonable assumption that if a disease closely resembles in its course another which can be proved to be due to some micro-organism, it probably owns a similar origin, though the actual *causa causans* may have escaped detection. There are few who do not admit this argument in the case of small-pox, measles, and scarlatina. It is, however, incorrect to conclude that the German school regards all diseases as of external origin: some are manifestly due to internal causes, and it is in regard to the disputed cases that the term "externalist" is applied. The French school inclines to the theory of internal causes, and lays great stress on the influence of the nervous system and on diatheses (*e.g.*, rheumatic, lymphatic, and dartrous) as the cause or modifying factor in many diseases. The Anglo-Saxon school (Great Britain and America) endeavours to take the best from both. Of the disputed diseases it puts some in the one class and some in the other, while it confesses its inability to decide with regard to the remainder. The following is a useful working classification, based mainly on the lines laid down by Unna in his great work on the *Histo-Pathology of the Skin*:—

- I. Anomalies of Sensation: *Pruritus, Anæsthesia, Dermatalgia.*
- II. Anomalies of Secretion: *Hyperidrosis, Chromidrosis, Anidrosis.*
- III. Anomalies of Circulation: *Urticaria, Purpura.*
- IV. Inflammations:—
  - **Traumatic**: *Dermatitis venenata, Trade dermatitis, Dermatitis medicamentosa, Dermatitis artefacta.*
  - **Neurotic**: *Erythema, Prurigo, Hydroa, Pemphigus, Herpes.*
  - **Infective**: Inflammations of the surface epidermis (cutaneous catarrh)—*Scabies, Cheiropompholyx, Miliaria, Impetigo, Ecthyma, Eczema, Seborrhœa, Psoriasis, Pityriasis rosea, Pityriasis rubra, Pityriasis rubra pilaris, Ichthyosis.* Inflammations of the deep or submerged epidermis (glands and follicles)—*Acne, Sycosis, Favus, Ringworm, Alopecia areata.* Diseases of the nails. Inflammations of the corium—*Erysipelas, Furuncle, Anthrax, Glanders, Actinomycosis, Rhinoscleroma, Yaws, Mycosis fungoides, Lichen, Syphilis, Tuberculosis* (lupus), *Leprosy.*
- V. New Growths: Benignant and malignant.
- VI. Retrogressive Changes (Atrophies): *Lupus erythematosus, Scleroderma, Sclerema neonatorum.*
- VII. Malformations: *Hyperkeratosis congenitalis, Hypertrichosis.*
- VIII. Saprophytes: *Pityriasis versicolor, Erythrasma.*
- IX. Anomales of Pigmentation: *Ephelis, Chloasma, Vitiligo.*

The diseases grouped under the first two headings do not lend themselves to pathological description. They are usually dependent on some systemic disease the discussion of which would here be out of place. In the diseases placed under the heading "Anomalies of Circulation" many phenomena suggest a dependence on irritants brought to the skin by the blood. Thus in the group of diseases known as *purpura*, where hæmorrhages of varying size make their appearance on widely-separated parts of the skin, we know that in some cases the cause is a poison, either inorganic (phosphorus, mercury) or organic (small-pox, measles, typhus), and it does not seem too much to assume that in other cases, such as those associated with Bright's disease, a similar cause is at work, and that in all these cases the poisons, by weakening the vessels' walls, predispose them to rupture, for a lesion is found in all carefully examined specimens. In the disease known as *urticaria* or nettle-rash we meet with many cases of unknown origin. Reasoning from our knowledge of what happens where the disease is produced by some irritant poison introduced into the stomach, we may conjecture that in such cases some unknown irritant is circulating in the blood. The pathology of the lesions in this disease is as follows: reacting to some irritant, the blood-vessels dilate, serum is poured out from them into the tissues around, and compressing the vessels from without empties them of blood. This explains the white centre of the urticarial wheal, the red margin of which is the clinical expression of the dilated and uncompressed vessels at the border. In those diseases grouped together under the name of *erythema*, although the majority of authors place them under the heading of inflammation, there is a good deal suggestive of a close relation to *urticaria*. Some cases are caused by the ingestion of certain drugs, a good many are directly associated with the rheumatic poison, while others are apparently connected with fermentative changes in the gastro-intestinal tract. Thus all those examples of the disease with the cause of which we are approximately acquainted are readily enough attributed to some circulating irritant. This disease differs histologically from urticaria in the persistent dilatation of the vessels. Although serum is poured out from them as freely as in urticaria, the dilatation of the vessels is so active that they are not compressed as in that disease, while the presence of numerous cells around the vessels seems to suggest a more severe irritant, and the fact that the lesions are clinically more persistent further confirms that suggestion.

The inflammations of the skin are divided by Unna into *traumatic* (due to the application of some mechanical, chemical, or physical irritant), *neurotic* (a somewhat doubtful class, from which we have already suggested the removal of the diseases grouped as erythema), and *infective* (a group which includes the majority of the commoner skin diseases). With reference to this last class, it has already been pointed out that a large amount of assumption in regard to many of the diseases is necessary, for only in some of them has the actual infective agent been demonstrated. The inflammatory reaction takes many different forms, each no doubt due to some subtle variant in the irritant or in the surface to which it is applied, for the same irritant will produce different results on different subjects; but as yet we are only on the threshold of a knowledge by which we shall be able to recognize the irritant from the effects which it produces. If *scabies* be excluded, probably half the rest of the diseases of the skin are written down as *eczema*. A discussion of the pathological changes found in that and allied diseases will probably be the best method of explaining the pathology of the skin.

When certain irritants are applied to the skin we know beforehand what effects they will produce. Thus croton oil produces a vesicular and pustular eruption, that of cantharides is vesicular or bulbous, while other drugs are followed by results dependent on their concentration, ranging from a mere redness produced by dilute applications to actual death of the skin from concentrated ones. With the milder irritants which produce the results clinically known as *eczema* we have invariably more or less pronounced certain definite phenomena. The blood-vessels dilate; serum is exuded from them—it may be merely into the deeper layers of the skin, or it may reach into and among the epidermic cells, or burst its way through these and appear in drops on the surface. The epithelial cells are, immediately if the irritation be slight, later if it be more severe, stimulated to increased activity of growth and production; and this activity, often misdirected, is so great that the normal process of hardening in the cells is interfered with, and we have what is known as *parakeratosis* (irregular cornification) and the consequent production of scales. Should this be the prominent pathological change, the exudation spends itself among the cells of the scales, and a condition pathologically moist appears to the clinical observer as a dry eruption. Thus according to the reaction—which is presumably largely dependent on the irritant to which it is due—we have various degrees and forms of inflammation of the skin, all of them covered clinically by the term *eczema*. When such a dermatitis is produced experimentally by the application of such an irritant as croton oil we can more or less accurately predict the duration of the inflammation, which gradually becomes less and less and usually terminates in dry scaling. So in *eczema*, as long as the irritant continues to act so long will its results be evident on the skin. Unfortunately the irritant which is the cause of *eczema* still remains to be discovered.

In studying other inflammations we have the advantage of definitely knowing their cause. Thus in *Impetigo contagiosa* all of Koch's postulates have been fulfilled, and we now know, mainly owing to the work of Saboraud, that the cause of the disease is the streptococcus pyogenes. The first result of inoculation is a minute red spot (dilatation of the vessels), which is rapidly followed by the appearance on the surface of a vesicle or bleb (exudation of serum), which is soon converted into a pustule (exudation of leucocytes). The leucocytes apparently have a restraining influence on the activity of the organisms, for the whole dries up into a scab, which when thrown off discloses a healthy or slightly reddened skin. The organisms are not destroyed by the leucocytes, for if the case be not properly treated fresh areas are constantly attacked, and the disease lasts indefinitely.

In *ringworm*, where the cause of the disease is the growth in the superficial layers of the skin of one or other of the different varieties of fungus grouped together under the common name of ringworm, a reaction more resembling that of *eczema* is produced. There is the same dilatation of the vessel with exudation of fluid, sometimes reaching the surface in the form of vesicles, sometimes spending itself through and among the epidermic cells and only evidenced clinically by the presence of more or less scaling. In other cases the exudation early becomes purulent (this is said to occur regularly when the disease is contracted from the horse), a change which, though occasionally noted, is by no means frequent in *eczema*.

The inflammations of the corium or deeper layer of the skin are due, with very few exceptions, to the growth of well-known organisms, and where none have yet been discovered their existence is generally accepted. *Erysipelas*, *furuncle*, *anthrax*, and *glanders* are diseases which run an acute course and rapidly terminate, the two former usually in recovery, the two latter often fatally. The other more chronic affections all follow one course; in their earlier stages there is a new growth of connective tissue cells in their lowest forms (granuloma), and this later breaks down, either rapidly, as in *syphilis*, or slowly, as in *tuberculosis* and *leprosy*. Most of these diseases leave behind them a well-defined scar.

The new growths of the skin are the same as those found elsewhere. Only two present special characters requiring notice here. *Keloid* is a peculiar form of fibroma which, although benignant as regards any general infection, invariably recurs locally after removal. *Rodent ulcer* is a form of cancer which occurs usually on the face, and whose malignancy is almost entirely local. The class of atrophies of the skin comprises those diseases where the atrophy is primary, and those where it succeeds to previous hypertrophic or inflammatory changes. Under saprophytes are included those fungi which vegetate on the skin but produce very slight if any symptoms. Anomalies of pigmentation are those of excess and lack. *Chloasma*, in which dark patches appear, most frequently on the face, is usually associated with disease of some internal organ, such as the liver or uterus, being frequently observed in pregnancy. The cause of *vitiligo*, in which the pigment normally present disappears from certain areas, a phenomenon more striking in coloured than in white races, is unknown. (N. W.)

XII. Eye.

The specially important diseases of the eye are those which temporarily or permanently interfere with sight. In considering the pathology of the eye it may in the first place be remembered that it is a double organ.

A. The two eyes act together, under normal conditions, for all practical purposes exactly as if there were but one eye placed in the middle of the face. All impressions made upon either retina, to the one side of a vertical line through the *fovea centralis*, before giving rise to conscious perception cause a stimulation of the same area in the brain. Impressions formed simultaneously, for instance, on the right side of the right retina and on corresponding areas of the right side of the left retina, are conveyed to the same spots on the right occipital lobe of the brain. Pathological processes, therefore, which are localized in the right or left occipital lobes, or along any part of the course of the fibres which pass from the right or left optic tracts to these "visual centres," cause defects in function of the right or left halves of the two retinæ. *Hemianopia*, or half-blindness, arising from these pathological changes, is of very varying degrees of severity, according to the nature and extent of the particular lesion. The blind areas in the two fields of vision, corresponding to the outward projection of the paralysed retinal areas, are always symmetrical both in shape and degree. The central lesion may for instance be very small, but at the same time destructive to the nerve tissue. This will be revealed as a sector-shaped or insular symmetrical complete blindness in the fields of vision to the opposite side. Or a large central area, or an area comprising many or all of the nerve fibres which pass to the visual centre on one side, may be involved in a lesion which causes impairment of function but no actual destruction of the nerve tissue. There is thus caused a symmetrical weakening of vision (*amblyopia*) in the opposite fields. In such cases the colour vision is so much more evidently affected than the sense of form that the condition has been called *hemiachromatopsia*, or half-colour-blindness. Hemianopia may be caused by hæmorrhage, by embolism, by tumour growth which either directly involves the visual nerve elements or affects them by compression, and by inflammation.

The two eyes also act as if they were one in accommodating. It is impossible for the two eyes to accommodate simultaneously to different extents, so that where there is, as occasionally happens, a difference in focus between them, this difference remains the same for all distances for which they are adapted. In such cases, therefore, both eyes cannot ever be accurately adapted at the same time, though either may be alone. It often happens as a consequence that the one eye is used to receive the sharpest images of distant, and the other of near objects. Any pathological change which leads to an interference in the accommodating power of one eye alone must have its origin in a lesion which lies peripherally to the nucleus of the third cranial nerve. Such a lesion is usually one of the third nerve itself. Consequently, a unilateral accommodation paresis is almost invariably associated with pareses of some of the oculo-motor muscles. A bilateral accommodation paresis is not uncommon. It is due to a nuclear or more central cerebral disturbance. Unlike a hemianopia, which is practically always permanent, a double accommodation paresis is frequently transitory. It is often a post-diphtheritic condition, appearing alone or associated with other paresis.

Both eyes are also normally intimately associated in their movements. They move in response to a stimulus, or a combination of stimuli, emanating from different centres of the brain, but always equally distributed to the corresponding muscles in both eyes, so that the two lines of fixation meet at the succession of points on which attention is directed. The movements are thus associated in the same direction, to the right or left, upwards or downwards, &c. In addition, owing to the space which separates the two eyes, convergent movements, caused by stimuli equally distributed between the two internal recti, are required for the fixation of nearer and nearer-lying objects. These movements would not be necessary in the case of a single eye. It would merely have to accommodate. The converging movements of the double eye occur in association with accommodation, and thus a close connexion becomes established between the stimuli to accommodation and convergence. All combinations of convergent and associated movements are constantly taking place normally, just as if a single centrally-placed eye were moved in all directions and altered its accommodation according to the distance, in any direction, of the object which it fixed.

Associated and convergent movements may be interfered with pathologically in different ways. Cerebral lesions may abolish them altogether or impair them, or may give rise to involuntary spasmodic action, as the result of paralysing or irritating the centres from which the various co-ordinated impulses are controlled or emanate. Lesions which do not involve the centres may prevent the response to associated impulses in one eye alone by interfering with the functional activity of one or more of the nerves along which the stimuli are conveyed. Paralysis of oculo-motor nerves is thus a common cause of defects of association in the movements of the double eye. The great advantage of simultaneous binocular vision—viz., the appreciation of depth, or stereoscopic vision—is thus lost for some, or it may be all directions of fixation. Instead of seeing singly with two eyes, there is then double-vision (*diplopia*). This persists so long as the defect of association continues, or so long as the habit of mentally suppressing the image of the faultily-directed eye is not acquired.

In the absence of any nerve lesions, central or other, interfering with their associated movements, the eyes continue throughout life to respond equally to the stimuli which cause these movements, even when, owing to a visual defect of the one eye, binocular vision has become impossible. It is otherwise, however, with the proper co-ordination of convergent movements. These are primarily regulated by the unconscious desire for binocular vision, and more or less firmly associated with accommodation. When one eye becomes blind, or when binocular vision for other reasons is lost, the impulse is gradually, as it were, unlearnt. This is the cause of *divergent concomitant squint*. Under somewhat similar conditions a degree of convergence, which is in excess of the requirements of fixation, may be acquired from different causes. This gives rise to *convergent concomitant squint*.

B. Taking each eye as a single organ, we find it to be subject to many diseases. In some cases both eyes may be affected in the same way as where the local disease is a manifestation of some general disturbance. Apart from the fibrous coat of the eye, the sclera, which is little prone to disease, and the external muscles and other adnexa, the eye may be looked upon as composed of two elements, (*a*) the dioptric media, and (*b*) the parts more or less directly connected with perception. Pathological conditions affecting either of these elements may interfere with sight.

(*a*) The dioptric media, or the transparent portions which are concerned in the transmission of light to, and the formation of images upon, the retina, are the following:—the cornea, the aqueous humour, the crystalline lens, and the vitreous humour. Loss of transparency in any of these media leads to blurring of the retinal images of external objects. In addition to loss of transparency, the cornea may have its curvature altered by pathological processes. This necessarily causes imperfection of sight. The crystalline lens, on the other hand, may be dislocated, and thus cause image distortion.

(i.) The transparency of the cornea is mainly lost by inflammation, which causes either an infiltration of its tissues with leucocytes, or a more focal, more destructive ulcerative process. In the process of repair the loss of substance sustained in the latter case is made good by cicatricial tissue. This newly-formed tissue is always intransparent, and remains so, except in very young children, in whom it gradually, to a great extent, clears up, owing to the more rapid and more complete tissue changes of early life. The intransparency caused by a mere infiltration generally clears away in the course of time, though often not entirely. The process of clearing is usually associated with the formation of blood-vessels in the cornea. These eventually also undergo absorption. A vascularization of the cornea generally also accompanies ulceration, and is, indeed, often a necessary part of the process of reparation. According to the position occupied by the cicatrix following a corneal ulcer, and to its extent and density, is the degree of the resulting visual defect. Centrally placed intransparencies, which cover the pupil, are relatively the most disturbing. The larger losses of substance, even though marginal, may interfere greatly with sight, by causing changes in the corneal curvature. This is principally the case where the cicatricial tissue yields to the intra-ocular pressure before consolidation, and gives rise to partial *staphyloma* of the cornea. The same yielding may be met with, though rarely, where there has been an excessive degree of infiltration alone. Corneal ulcers, which perforate, lead not infrequently to hernia of the iris, a portion of which then becomes incorporated in the scar. A special form of corneal opacity is what is called *pannus*. This consists of a more or less dense development of superficial blood-vessels, offshoots of the conjunctival arteries and veins, with some infiltration of the outer layers of the cornea. Pannus is a frequent accompaniment of *trachoma*, a chronic destructive form of conjunctival inflammation. A somewhat rare condition of the cornea, by which, without any inflammatory symptoms, a marked change in its curvature is slowly produced, is what is called *conical cornea*. The pathology of this condition is unknown. *Primary tumours* of the cornea are exceedingly rare.

(ii.) Intransparency of the aqueous humour is always due to some exudation. This comes either from the iris or the ciliary processes, and may be blood, pus, or fibrin. An exudation in this situation tends naturally to gravitate to the most dependent part, and, in the case of blood or pus, is known as *hyphæma* or *hypopyon*.

(iii.) Intransparency of the crystalline lens is technically known as *cataract*. Cataract may be idiopathic and uncomplicated, or traumatic, or secondary to disease in the deeper parts of the eye. The modified epithelial structure of which the lens is composed is always being added to throughout life. The older portions of the lens are consequently the more central. They are harder and less elastic. This arrangement seems to predispose to difficulties of nutrition. In many people, in the absence altogether of general or local disease, the transparency of the lens is lost owing to degeneration of the incompletely-nourished fibres. This idiopathic cataract mostly occurs in old people; hence the term *senile cataract*. So-called senile cataract is not, however, necessarily associated with any general senile changes. An idiopathic uncomplicated cataract is also met with as a congenital defect due to faulty development of the crystalline lens. A particular and not uncommon form of this kind of cataract, which may also develop during infancy, is *lamellar* or *zonular cataract*. This is a partial and stationary form of cataract in which, while the greater part of the lens retains its transparency, some of the lamellæ are intransparent. Traumatic cataract occurs in two ways: by laceration or rupture of the lens capsule, or by nutritional changes consequent upon injuries to the deeper structures of the eye. The transparency of the lens is dependent upon the integrity of its capsule. Penetrating wounds of the eye involving the capsule, or rupture of the capsule from severe blows on the eye without perforation of its coats, are followed by rapidly developing cataract. Severe non-penetrating injuries, which do not cause rupture of the capsule, are sometimes followed, after a time, by slowly-progressing cataract. Secondary cataract is due to abnormalities in the nutrient matter supplied to the lens owing to disease of the ciliary body, choroid, or retina. In some diseases, as diabetes, the altered general nutrition tells in the same way on the crystalline lens. Cataract is then rapidly formed. All cases of cataract in diabetes are not, however, necessarily true diabetic cataracts in the above sense. *Dislocations of the lens* are traumatic or congenital. In old-standing disease of the eye the suspensory ligament may yield in part, and thus lead to lens dislocation. The lens is practically always cataractous before this takes place.

(iv.) The vitreous humour loses its transparency owing to exudation from the inflamed ciliary body or choroid. The exudation may be fibrinous or purulent; the latter only as a result of injuries by which foreign bodies or septic matter are introduced into the eye, or in metastatic choroiditis. Blood may also be effused into the vitreous from rupture of retinal, ciliary, or choroidal vessels. The pathological significance of the various effusions into the vitreous depends greatly upon the cause. In many cases effusion and absorption are constantly taking place simultaneously. The extent of possible clearing depends greatly upon the preponderance of the latter process.

(*b*) Inflammations of the *uveal* tract, the iris, ciliary body, and choroid, are of common occurrence. Inflammations of the iris (*iritis*), the causes of which are numerous, may lead, when untreated, to serious consequences. This is owing to the tendency towards adhesions being formed by the consolidation of plastic exudation between the posterior surface of the iris and the lens capsule. These so-called *synechiæ*, besides interfering with the free movements of the pupil, may introduce nutritional difficulties, especially in the case of recurrent attacks of inflammation. Inflammation of the ciliary body (*cyclitis*) leads to effusion into the anterior part of the vitreous. It may coexist with iritis (*irido-cyclitis*) or with inflammation of the choroid (*choroido-cyclitis*). The most serious form of irido-cyclitis is that which may follow penetrating wounds of the eye. Under certain conditions this leads to a similar inflammation in the other eye. This so-called *sympathetic ophthalmitis* is of a malignant type, causing destruction of the sympathizing eye. Choroidal inflammations are generally patchy, various foci of inflammation being scattered over the choroid. These patches may in course of time become more or less confluent. The effect upon vision depends upon the extent to which the external or percipient elements of the retina become involved. It is especially serious when the more centred portions of the retina are thus affected (*choroido-retinitis centralis*).

A peculiar and grave pathological condition of the eye is what is known as *glaucoma*. A characteristic of this condition is increase of the intra-ocular tension, which has a deleterious effect on the optic nerve end and its ramifications in the retina. The cause of the rise of tension is partly congestive, partly mechanical. The effect of glaucoma, when untreated, is to cause ever-increasing loss of sight, although the time occupied by the process before it leads to complete blindness varies within such extraordinarily wide limits as from a few hours to many years. The uveal tract may be the site of *sarcoma*.

The retina is subject to inflammation, to detachment from the choroid, to hæmorrhages from the blood-vessels, and to tumour. Retinal inflammation may primarily affect either the nerve elements or the connective tissue framework. The former is usually associated with some general disease such as albuminuria or diabetes, and is bilateral. The tissue changes are œdema, the formation of exudative patches, and hæmorrhage. Where the connective tissue elements are primarily affected, the condition is a slow one, similar to *sclerosis* of the central nervous system. The gradual blindness which this causes is due to compression of the retinal nerve elements by the connective tissue hyperplasia, which is always associated with characteristic changes in the disposition of the retinal pigment. This retinal sclerosis is consequently generally known as *retinitis pigmentosa*, a disease to which there is a hereditary predisposition. Besides occurring during inflammation, hæmorrhages into the retina are met with in phlebitis of the central retinal vein, which is almost invariably unilateral, and in certain conditions of the blood, as pernicious anæmia, when they are always bilateral.

The optic nerve is subject to inflammation (optic neuritis), and atrophy. Double optic neuritis, affecting, however, only the intra-ocular ends of the nerves, is an almost constant accompaniment of brain tumour. Unilateral neuritis has a different causation, depending upon an inflammation, mainly perineuritic, of the nerve in the orbit. It is analogous to peripheral inflammation of other nerves, such as the third, fourth, sixth, and seventh cranial nerves. (G. A. BE.)

Pathology of Plants.—Phytopathology comprises our knowledge of the symptoms, course, causes, and remedies of the maladies which threaten the life of plants, or which result in abnormalities of structure that are regarded, whether directly injurious or not to life, as unsightly or undesirable. In its systematized form, as a branch of botanical study, it is of recent date, and, as now understood, the subject first received special attention about 1850, when the nature of parasitism began to be intelligible; but many disjointed references to diseased conditions of plants had appeared long before this. The existence of blights and mildews of cereals had been observed and recorded in very ancient times, as witness the Bible, where half a dozen references to such scourges occur in the Old Testament alone. The epidemic nature of wheat-rust was known to Aristotle about 350 B.C., and the Greeks and Romans knew these epidemics well, their philosophers having shrewd speculations as to causes, while the people held characteristic superstitions regarding them, which found vent in the dedication of special festivals and deities to the pests. Pliny knew that flies emerge from galls. The few records during the Middle Ages are borne out by what is known of famines and pestilence. Shakespeare's reference in *King Lear* (Act III., sc. 4) may be quoted as evincing acquaintance with mildew in the 17th century, as also the interesting Rouen law of Loverdo (1660). Malpighi in 1679 gave excellent figures and accounts of leaf-rolling and gall insects, and Grew in 1682 equally good descriptions of a leaf-mining caterpillar. During the 18th century more academic treatment of the subject began to replace the scattered notes. Hales (1727–33) discussed the rotting of wounds, cankers, &c., but much had to be done with the microscope before any real progress was possible, and it is easily intelligible that until the theory of nutrition of the higher plants had been founded by the work of Ingenhouss, Priestley, and De Saussure, the way was not even prepared for accurate knowledge of cryptogamic parasites and the diseases they induce. Even in 1833 Turpin, and a far better observer, Unger, regarded parasitic fungi as diseased outgrowths of the plants themselves, views from which Meyen (1837) and Schleiden (1846) had not yet escaped. We can do no more than refer to the treatises of Wiegmann (1839), Meyer (1841), Raspail (1846), Kühn (1859), and other books as showing the interest the new subject was awakening, but the reader will find an admirable summary of what was known in 1854 in Berkeley's articles in the *Gardener's Chronicle* of that year. It was not till De Bary (1866) made known the true nature of parasitic Fungi, based on his researches between 1853–63, that the vast domain of epidemic diseases of plants was opened up to fruitful investigation, and such modern treatises as those of Frank (1880 and 1895), Sorauer (1886), Kirchner (1890), were gradually made possible.

The proper study of plant pathology involves knowledge of the physiology of plants—*i.e.*, of the normal relations of plants to the environment, and of the normal internal structure and working of the organism itself. It cannot be too strongly emphasized that pathology—disease—is abnormal physiology, and that the commonest misapprehensions and blunders arise from ignorance of this, and of the simplest principles of physiology. It is true, the boundary lines between normal physiology—*i.e.*, health—and disease are not fixed, and are often difficult to draw, but all our knowledge points to the conclusion that the statement, Disease is ill-health, is not a mere matter of words, but expresses the fact.

Plant pathology embraces several branches of study, and may be conveniently divided as follows:—

1. The observation and accurate description of symptoms (*Diagnosis*).

2. The study of causes or agencies inducing disease (*Ætiology*).

3. The practice of preventive and remedial measures (*Therapeutics*).

In plants, however, the *symptoms of disease* are apt to exhibit themselves in a very general manner. Our perceptions differentiate but imperfectly symptoms which are due to very different causes and reactions, probably because the organization of the plant is so much less highly specialized than that of higher animals. The yellowing and subsequent casting of leaves, for instance, is a very general symptom of disease in plants, and may be induced by drought, extremes of temperature, insufficient or excessive illumination, excess of water at the roots, the action of parasitic Fungi, insects, worms, &c., or of poisonous gases, and so forth; and extreme caution is necessary in dealing with amateur descriptions of such symptoms, especially when the untrained eye has taken no cognizance of, or has only vaguely observed, the numerous collateral circumstances of the case. It is chiefly due to these difficulties that most works on plant pathology, which classify the subject according to the causes, themselves often imperfectly understood, leave such vague impressions on the reader. It should be regarded as the distinct aim of future workers to perfect a system whereby classification of symptoms is possible; for, although remedial measures must always depend on the understanding of the causes at work in disease, the rational classification of symptoms is necessary to direct attention to the probable course of events.

The *causes of disease* may be provisionally classified somewhat as follows, but it may be remarked at the outset that no one of these proximal causes, or agents, is ever solely responsible; and it is very easy to err in attributing a diseased condition to any of them, unless the relative importance of primary and subordinate agencies is discoverable. For instance, a Fungus epidemic is impossible unless the climatic conditions are such as to favour the dispersal and germination of the spores; and when plants are killed off owing to the supersaturation of the soil with water, it is by no means obvious whether the excess of water and dissolved materials, or the exclusion of oxygen from the root-hairs, or the lowering of the temperature, or the accumulation of foul products of decomposition should be put into the foreground. In every case there are chains of causation concerned, and the same factors will be differently grouped in different cases.

Bearing in mind these precautions, we may classify the proximal causal agents of disease as—

- I. External agencies.
  - A. Non-living.
    - *a.* Material.
      - 1. Physical—
        - Soil.
        - Water.
        - Atmosphere.
      - 2. Chemical—
        - Soil.
        - Water.
        - Atmosphere.
    - *b.* Non-material—
      - 1. Temperature.
      - 2. Illumination.
      - 3. Other agencies.
  - B. Living.
    - *a.* Animals.
      - 1. Vertebrata.
      - 2. Invertebrata.
    - *b.* Plants.
      - 1. Phanerogams.
      - 2. Cryptogams.
- II. Internal agencies.

While such a classification may serve its purpose as a sort of index, it must be confessed that the limits of its usefulness are soon reached. In the first place, the so-called "internal causes" of disease is probably a mere phrase covering our ignorance of the factors at work, and although a certain convenience attaches to the distinction between those cases where tender breeds of plants apparently exhibit internal predisposition to suffer more readily than others from parasites, low temperatures, excessive growth, &c.—as is the case with some grafted plants, cultivated hybrids, &c.—the mystery involved in the phrase "internal causes" only exists until we find what action of the living or non-living environment of the essential mechanism of the plant has upset its equilibrium.

I. Passing to the recognized *external agencies*, the physical condition of the *soil* is a fruitful source of disease. If too closely packed, the soil particles present mechanical obstacles to growth; if too retentive of moisture, the root-hairs suffer, as already hinted; if too open or over-drained, the plant succumbs to drought. All those properties of soil known as texture, porosity, depth, inclination to the horizon, &c., are concerned here. Many maladies of plants are traceable to the chemical composition of soils—*e.g.*, deficiency of nutritive salts, especially nitrates and phosphates; the presence of poisonous salts of iron, copper, &c., or (in the soil about the roots of trees in towns) of coal-gas, and so forth. But it is worthy of special attention that the mere chemical composition of agricultural and garden soils is, as a rule, the least important feature about them, popular opinion to the contrary notwithstanding. Ordinary soils will almost always provide the necessary chemical ingredients if of proper physical texture, depth, &c. But, as showing how impossible it is sharply to classify the factors concerned, the absence of nitrifying bacteria, of humus constituents and mycorrhiza Fungi, of earth-worms and other organisms which beneficially affect plants, may decide the question of health or disease of plants in soils otherwise admirably suited to them (see articles FUNGI, and BACTERIOLOGY: *Schizomycetes*).

As regards *water*, its deficiency or excess is a relative matter, and although many of the minor maladies of pot-plants in windows and greenhouses controlled by amateurs depend on its misuse, water alone is probably never a primary cause of disease. Its over-supply is, however, a frequent cause of predisposition to the attacks of parasitic Fungi—*e.g.*, the damping off of seedlings—and in saturated soils not only are the roots and root-hairs killed by asphyxiation, but the whole course of soil fermentation is altered, and it takes time to "sweeten" such by draining, because not only must the noxious bodies be gradually washed out and the lost salts restored, but the balance of suitable bacterial and fungal life must be restored.

The *atmosphere* is a cause of disease in the neighbourhood of chemical works, large towns, volcanoes, &c., in so far as it carries acid gases and poisons to the leaves and roots; but it is usual to associate with it the action of excessive humidity which brings about those tender watery and more or less etiolated conditions which favour parasitic Fungi, and diminish transpiration and therefore nutrition. It is customary to speak of the disastrous effects of cold winds, snow, hail and frost, lightning, &c., under the heading of atmospheric influences, which only shows once more how impossible it is to separate causes individually.

Turning to the *non-material external agents*, probably no factors are more responsible for ill-health in plants than *temperature* and light. Every plant is constrained to carry out its functions of germination, growth, nutrition, reproduction, &c., between certain limits of temperature, and somewhere between the extremes of these limits each function finds an optimum temperature at which the working of the living machinery is at its best, and, other things being equal, any great departure from this may induce pathological conditions; and many disasters are due to the failure to provide such suitable temperatures—*e.g.*, in greenhouses where plants requiring very different optimum temperatures and illumination are kept together. Equally disastrous are those climatic or seasonal changes which involve temperatures in themselves not excessive but in wrong sequence: how many more useful plants could be grown in the open in the United Kingdom if the deceptively mild springs were not so often followed by frosts in May and June! The indirect effects of temperature are also important. Trees, of which the young buds are "nipped" by frost, would frequently not suffer material injury, were it not that the small frost-cracks serve as points of entry for Fungi; and numerous cases are known where even high temperatures can be endured on rich, deep, retentive soils by plants which at once succumb to drought on shallow or non-retentive soils. Nay, even on similar soils, a given plant may die where the surface is "caked," and live if the surface has been well stirred, again bringing out the complex interaction of various factors.

All chlorophyll plants require *light*, but in very different degrees, as exemplified even in the United Kingdom by the shade-bearing beech and yew contrasted with the light-demanding larch and birch; and as with temperature so with light, every plant and even every organ has its optimum of illumination. The "drawn" or etiolated condition of over-shaded plants is a case in point, though here again the soft, watery plant often really succumbs to other disease agents—*e.g.*, parasitic Fungi—supervening on its non-resistant condition.

Animals and plants as agents of disease or injury form part of the larger subject of the struggle for existence between living organisms, as is recognized even by those who do not so readily apprehend that diseased conditions in general are always signs of defeat in the struggle for existence between the suffering organism and its environment, living and non-living. Indeed, a comprehensive definition of disease generally would be: Variations in directions which threaten the existence of the patient.

The Vertebrata come within the scope of our subject, chiefly as destructive agents which cause wounds or devour young shoots and foliage, &c. Rabbits and other burrowing animals injure roots, squirrels and birds snip off buds, horned cattle strip off bark, and so forth. It is among the Invertebrata that epidemics of destruction are referred to, though we should bear in mind that it is only the difference in numerical proportion that prevents our speaking of an epidemic of elephants or of rabbits, though we use the term when speaking of blight insects; there is little consistency in the matter, as it is usual to speak of an invasion or scourge of locusts, caterpillars, &c. Insect injuries are very varied in degree and in kind. Locusts devour all before them; caterpillars defoliate the plant, and necessitate the premature utilization of its reserves; other insects (*e.g.*, *Grapholitha*) eat the buds, or the roots (*e.g.*, wireworms), and so maim the plant that its foliage suffers from want of water and assimilation is diminished, or actual withering follows. Many aphides, &c., puncture the leaves, suck out the sap, and induce various local deformations, arrest of growth, pustular swellings, &c., and if numerous all the evils of defoliation may follow. Others (*e.g.*, miners) tunnel into the leaf parenchyma, and so put the assimilating areas out of action in another way. It should be remembered that a single complete defoliation of a herbaceous annual may so incapacitate the assimilation that no stores are available for seeds, tubers, &c., for another year, or at most so little that feeble plants only come up. In the case of a tree matters run somewhat differently: most large trees in full foliage have far more assimilatory surface than is immediately necessary, and if the injury is confined to a single year it may be a small event in the life of the tree, but if repeated the cambium, bud-stores, and fruiting may all suffer. Many larvæ of beetles, moths, &c., bore into bark, and injure the cambium, or even the wood and pith; in addition to direct injury, the interference with the transpiration current and the access of other parasites through the wounds are also to be feared in proportion to the numbers of insects at work. Various local hypertrophies, including galls, result from the increased growth of young tissues irritated by the punctures of insects, or by the presence of eggs or larvæ left behind. They may occur on all parts, buds, leaves, stems, or roots, as shown by the numerous species of *Cynips* on oak, *Phylloxera* on vines, &c. The local damage is small, but the general injury to assimilation, absorption, and other functions may be important if the numbers increase. In addition to insects, various kinds of worms, molluscs, &c., are sometimes of importance as pests. The so-called eel-worms (*Nematodes*) may do immense damage on roots and in the grains of cereals, and every one knows how predatory slugs and snails are.

Plants as agents of damage and disease may be divided into those larger forms which as weeds, epiphytes, and so forth do injury by dominating and shading more delicate species, or by gradually exhausting the soil, &c., and true parasites which actually live on and in the tissues of the plants. It must be remembered that phanerogams also include parasitic species—*e.g.*, *Cuscuta*, *Loranthus*, *Viscum*, *Thesium*, *Rhinanthus*, &c.—with various capacities for injury. These enemies are as a rule so conspicuous that we do not look on their depredations as diseases, though the gradual deterioration of hay under the exhausting effects of root-parasites like *Rhinanthus*, and the onslaught of *Cuscuta* when unduly abundant, should teach us how unimportant to the definition the question of size may be. Weeds often do as much damage indirectly as directly. If grass and herbage are grown in orchards, they may increase the moisture and shade which favour certain Fungi at one season, and dry up the soil over the finer roots of the trees at another, as well as compete with these for nutritive salts. On the other hand, the action of such weeds in checking the development of surface roots has been claimed as advantageous, and it is evident that the nature and composition of the weed herbage in different localities may affect the matter.

It is, however, among the Fungi that we find the most disastrous and elusive agents of disease. *Parasitic Fungi* may be, as regards their direct action, purely local —*e.g.*, *Schinzia*, which forms gall-like swellings on the roots of rushes; *Gymnosporangium*, causing excrescences on juniper stems; numerous leaf Fungi such as *Puccinia*, *Æcidium*, *Septoria*, &c., causing yellow, brown, or black spots on leaves; or *Ustilago* in the anthers of certain flowers. In such cases the immediate damage done may be slight; but the effects of prolonged action and the summation of numerous attacks at numerous points are often enormous, certain of these leaf-diseases costing millions sterling annually to some planting and agricultural communities. In other cases the Fungus is virulent and rampant, and, instead of a local effect, exerts a general destructive action throughout the plant—*e.g.*, *Pythium*, which causes the "damping off" of seedlings, reducing them to a putrid mass in a few hours, and *Phytophthora*, the agent of the potato disease. Many Fungi, in themselves not very aggressive, slowly bring about important and far-reaching secondary effects. Thus, many Hymenomycetes (Agarics, Polyporei, &c.) live on the wood of trees. This wood is in great part already dead substance, but the mycelium gradually invades the vessels occupied with the transmission of water up the trunk, cuts off the current, and so kills the tree; in other cases such Fungi attack the roots, and so induce rot and starvation of oxygen, resulting in "fouling." We may not inaptly compare the procedure to various methods of reducing a besieged community by cutting off or poisoning the water supplies. Numerous Fungi, though conspicuous as parasites, cannot be said to do much individual injury to the host. The extraordinary malformations known as "Witches' Brooms," caused by the repeated branching and tufting of twigs in which the mycelium of *Exoascus* (on birch) or *Æcidium* (on silver fir) are living, may be borne in considerable numbers for years without any very extensive apparent injury to the tree. Again, the curious distortions on the stems of nettles attacked by the *Æcidium* form of the heterœcious *Puccinia caricis* (see FUNGI for Heterœcism), or on maize stems and leaves attacked by *Ustilago Maydis*, or on the inflorescence of cruciferæ infested with *Cystopus*, &c., are not individually very destructive; it is the cumulative effects of numerous attacks or of extensive epidemics which eventually tell. Some very curious details are observable in these cases of malformation. For instance, the *Æcidium Elatinum* first referred to causes the new shoots to differ in direction, duration, and arrangement, and even shape of foliage leaves from the normal; and the shoots of *Euphorbia* infested with the æcidia of *Uromyces pisi* depart so much from the normal in appearance that the attacked plants have been taken for a different species. Similarly with *Anemone* infested with *Puccinia* and *Vaccinium* with *Calyptospora*, and many other cases of deformations due to hypertrophy or atrophy. Instances of what we may term tolerated parasitism, where the host plant seems to accommodate itself very well to the presence of the Fungus, paying the tax it extorts and nevertheless not succumbing but managing to provide itself with sufficient material to go on with, are not rare; and these seem to lead to those cases where the mutual accommodation between host and guest has been carried so far that each derives some benefit from the association—symbiosis (see FUNGI).

II. The *kinds of disease* due to these various agencies are very different. A plant may be diseased as a whole, because nearly all its tissues are in a morbid or pathological condition, owing to some Fungus pervading the whole—*e.g.*, *Pythium* in seedlings—or to a poison diffusing from cell to cell; in the case of unicellular plants—*e.g.*, an alga infested with a *Chytridium*—indeed, matters can hardly be otherwise. But the case is obviously different where a plant dies because some essential organ or tissue-tract has been destroyed, and other parts have suffered because supplies are cut off—*e.g.*, when the upper parts of a tree die off owing to destruction of the roots, or to the ringing of the stem lower down, and consequent interference with the transpiration current. In a large number of cases, however, the disease is purely local, and does not itself extend far into the organ or tissue affected; *e.g.*, when an insect punctures a leaf at some minute point with its proboscis or ovipositor, killing a few cells and irritating those in the immediate neighbourhood; or when a knife-cut wounds the cambium, which soon covers up the injury by means of callus; or when a Fungus such as *Uromyces* infects a leaf by way of a stoma, the mycelium not spreading more than a few millimetres round the point of entry.

Attempts have been made to classify diseases according to the organs or tissues attacked—to speak of leaf diseases, root diseases, timber diseases, diseases of the bark, and so forth. Neither these nor any arrangement according to the functions deranged have proved satisfactory, and it is doubtful if in any circumstances phrases like "general functional disease," diseases of the absorptive organs, or of the respiratory organs can be usefully employed in plant pathology, the various organs and functions of plants being too vaguely marked off one from the other. Current terminology is responsible in part for some confusion of thought in other directions. Strictly speaking, wheat-rust is not a disease, but a symptom betraying the presence of a disease-inducing Fungus; similarly, chlorosis is a symptom of imperfect chlorophyll production. In both cases the fundamental disease itself consists in the starvation of the cell-protoplasm of carbohydrates, in the one case because the parasite steals them as fast as they are made, in the other because the machinery is too imperfect to make them.

If a mass of living plant-tissue is cut, the first change observed is one of colour: the white "flesh" of a potato or an apple turns brown as the air enters, and closer examination shows that cell walls and contents are alike affected. The cut cells die, and oxidized products are concerned in the change of colour, the brown juices exuding and soaking into the cell-walls. The next change observable after some hours is that the untouched cells below the cut grow larger, push up the dead surface, and divide by walls tangential to it, with the formation of tabloid cork-cells. The layer of cork thus formed cuts out the dead débris and serves to protect the uninjured cells below. Such healing by cork formation is accompanied by a rise of temperature: the active growth of the dividing cells is accompanied by vigorous metabolism and respiration, and a state of "wound fever" supervenes until the healing is completed. The phenomena described occur in all cases of cicatrization of wounds in nature—*e.g.*, leaf-tissue, young stems, roots, &c., when cut or pierced by insects, thorns, and so forth. They are concerned in the occlusion of broken twigs and of falling leaves, and it is from the actively growing "callus" developed at the surface of the wounded tissues of cuttings, buddings, prunings, &c., that the healing and renewal of tissues occur of which advantage is taken in the practice of what might well be termed plant surgery. A third phenomenon observable in such healing tissues is the increased flow and accumulation of plastic materials at the seat of injury. The enhanced metabolism creates a current of draught on the supplies of available food-stuffs around. The phenomenon of irritability here concerned is well shown in certain cases where a parasitic organism gains access to a cell—*e.g.*, *Pleotrachelus* causes the invaded *Pilobolus* to swell up, and changes the whole course of its cell metabolism, and similarly with *Plasmodiophora* in the roots of turnips, and many other cases.

Irritation and hypertrophy of cells are common signs of the presence of parasites, as evinced by the numerous malformations, galls, witches'-brooms, &c., on diseased plants. The now well-known fact that small doses of poisonous substances may act as stimuli to living protoplasm, and that respiratory activity and growth may be accelerated by chloroform, ether, and even powerful mineral poisons, such as mercuric chloride, in minimal doses, offers some explanation of these phenomena of hypertrophy, "wound fever," and other responses to the presence of irritating agents. Still further insight is afforded by our increasing knowledge of the enzymes, and it is to be remarked that both poisons and enzymes are very common in just such parasitic Fungi as induce discolorations, hypertrophies, and the death of cells—*e.g.*, *Botrytis*, *Ergot*, &c. Now it is clear that if an organism gains access to all parts of a plant, and stimulates all or most of its cells to hypertrophy, we may have the latter behaving abnormally—*i.e.*, it may be diseased throughout; and such actually occurs in the case of *Euphorbia* pervaded with *Uromyces pisi*, the presence of which alters the whole aspect of the host-plant. If such a general parasite carries its activities further, every cell may be killed and the plant forthwith destroyed—*e.g.*, *Phytophthora* in potatoes. If, on the other hand, the irritating agent is local in its action, causing only a few cells to react, we have the various pimples, excrescences, outgrowths, &c., exhibited in such cases as *Ustilago Maydis* on the maize, various galls, witches'-brooms, &c. If, again, a few cells are killed on one side only of a young organ, they and their progeny can no longer take part in growth, and so the still active cells on the other side of the organ push the newly-forming tissues over to the arrested side, as in lily buds deformed by *Botrytis*, currant leaves pierced by mites, pine shoots contorted by *Cæoma pinitorquam*, &c.

It must not be overlooked that the living cells of the plant react upon the parasite as well as to all external agencies, and the nature of disease becomes intelligible only if we bear in mind that it consists in such altered metabolism—deflected physiology—as is here implied. The reaction of the cells may be in two directions, moreover. For instance, suppose the effect of a lowering temperature is to so modify the metabolism of the cells that they fill up more and more with watery sap; as the freezing-point is reached this may result in destructive changes, and death from cold may result. If, on the contrary, the gradual cooling is met by a corresponding depletion of the cells of water, even intense cold may be sustained without injury.

Or, take another case. If the attack of a parasite is met by the formation of some substance in the protoplasm which is chemotactically repulsive to the invader, it may be totally incapable of penetrating the cell, even though equipped with a whole armoury of cytases, diastatic and other enzymes, and poisons which would easily overcome the more passive resistances offered by mere cell-walls and cell-contents of other plants, the protoplasm of which forms bodies chemotactically attractive to the Fungus. Only in some such way as this can we explain why a given Uredine parasite on one species of grass is quite incapable of penetrating a closely-allied species, and why a Fungus, such as *Penicillium*, one of the most pronounced saprophytes known, may be trained to parasitic habits by artificial treatment of the host-plants.

The various *degrees of parasitism* are to a certain extent explained by the foregoing. In order that a Fungus may enter a plant, it must be able to overcome not merely the resistance of cell-walls, but that of the living protoplasm: if it cannot do this, it must remain outside as a mere epiphyte, *e.g.*, *Fumago*, *Herpotrichia*, &c., or, at most, vegetate in the intercellular spaces and anchor itself to the cell-walls, *e.g.*, *Trichosphæria*. The inability to enter the cells may be due to the lack of chemotactic bodies, to incapacity to form cellulose-dissolving enzymes, to the existence in the host-cells of antagonistic bodies which neutralize or destroy the acids, enzymes, or poisons formed by the hyphæ, or even to the formation and excretion of bodies which poison the Fungus. But even when inside it does not follow that the Fungus can kill the cell, and many cases are known where the Fungus can break through the cell's first lines of defence (cell-wall and protoplasmic lining); but the struggle goes on at close quarters, and various degrees of hypertrophy, accumulation of plastic bodies or secretions, discolorations, &c., indicate the suffering of the still living cell. Finally, cases occur where the invaded cell so adapts itself to the presence of the intruder that life in common—symbiosis—results.

The *dissemination* of plant parasites is favoured by many circumstances not always obvious, whence an air of mystery regarding epidemics was easily created in earlier times. The spores of Rusts, Erysipheæ, and other Fungi may be conveyed from plant to plant by snails; those of tree-killing polyporei, &c., by mice, rabbits, rats, &c., which rub their fur against the hymenophores. Bees carry the spores of *Sclerotinia* as they do the pollen of the bilberries, and flies convey the conidia of ergot from grain to grain. Insects, indeed, are largely concerned in disseminating Fungi, either on their bodies or *viâ* the alimentary canal. Worms bring spores to the surface of soil, ducks and other birds convey them on their muddy feet, and, as is well known, wind and other physical agencies are very efficient in dissemination. The part played by man also counts for much. Gardeners and farm labourers convey spores from one bed or field to another; carted soil, manure, &c., may abound in spores of Smuts, Fusarium, Polyporei, and in sclerotia; and articles through the post and so forth often carry infective spores. Every time a carpenter saws fresh timber with a saw recently put through wood attacked with dry-rot, he risks infecting it with the Fungus; and similarly in pruning, in propagating by cuttings, &c. Nor are the Fungi themselves always passive agents, as their odours, mechanisms for disjunction, ejaculation, &c., show.

The annual losses due to epidemic plant diseases attain proportions not easily estimated. As regards money value alone the following figures may serve in illustration. In 1882 the United States was calculated to have lost £40,000,000 to £60,000,000 from insect and other pests. The wheat-rust costs Australia £2,000,000 to £3,000,000 annually, and in 1891 alone the loss which Prussia suffered from grain-rusts was estimated at £20,000,000 sterling. These and numerous similar statistics lead to the conclusion that it is probable that we might put the average annual loss the world endures from epidemic and other plant diseases at not less than £100,000,000 sterling.

The terrible losses sustained by whole communities of farmers, planters, foresters, &c., from plant diseases have naturally stimulated the search for remedies, but even now the search is too often conducted in the spirit of the believer in quack medicines, although the agricultural world is awakening to the fact that before any measures likely to be successful can be attempted, the whole chain of causation of the disease must be investigated. Experience with epidemics, dearly bought in the past, has shown that one fruitful cause is the laying open to the inroads of some Fungus or insect, hitherto leading a quiet endemic life in the fields and forests, large tracts of its special food, along which it may range rampant without check to its dispersal, nutrition, and reproduction. Numerous wild hypotheses as to changes in the constitution of the host-plant, leading to supposed vulnerability previously non-existent, would probably never have seen the light had the full significance of the truth that an epidemic results when the external factors favour a parasite somewhat more than they do the host, been grasped. It may be that in particular cases particular modes of cultivation disfavour the host; or that the soil, climate, or seasons do so; but overwhelming evidence exists to show that the principal causes of epidemics reside in circumstances which favour the spread, nutrition, and reproduction of the pest, and the lesson to be learnt is that precautions against the establishment of such favouring conditions must be sought. Nevertheless, epidemics occur, and practical measures are devised to meet the various cases and to check the ravages already begun. The procedure consists in most cases in spraying the affected plants with poisonous solutions or emulsions, or in dusting them with fungicidal or insecticidal powders, or applying the fumes of lethal gases. For the composition of the numerous liquids and powders special works must be consulted, but the following principles apply generally. The poison must not be strong enough to injure the roots, leaves, &c., of the host-plant, or allowed to act long enough to bring about such injury. Care and intelligence are especially needful with certain insecticides such as poisonous gases, or the operators may suffer. It is worse than useless to apply drastic remedies if the main facts of the life-history of the pest are not known; *e.g.*, the application of ordinary antiseptic powders to leaves inside which a Fungus, such as a *Uredo* or *Ustilago*, is growing can only result in failure, and similarly if tobacco fumes, for instance, are applied when the insects concerned are hibernating in the ground beneath. Such applications at the moment when spores are germinating on the leaves, *e.g.*, *Peronospora*, or to the young mycelia of epiphytic parasites, *e.g.*, *Erysiphe*, or the steeping in hot water of thoroughly ripe hard grains to which spores are attached, *e.g.*, *Ustilago*, and filling a greenhouse with hydrocyanic acid gas when young insects are commencing their ravages, *e.g.*, Red-spider—all these and similar procedures timed to catch the pest at a vulnerable stage are intelligent and profitable prophylactic measures, as has been repeatedly shown. Numerous special methods of preventing the spread of Fungi, or the migrations of insects, or of trapping various animals; of leaving infested ground fallow, or of growing another crop useless to the pest, &c., are also to be found in the practical treatises. More indirect methods, such as the grafting of less resistant scions on more vigorous stocks, of raising special late or early varieties by crossing or selection, and so on, have also met with success; but it must be understood that "resistant" in such cases usually means that some peculiarity of quick growth, early ripening, or other life-feature in the plant is for the time being taken advantage of. Although we are not devoid of hope that certain varieties may prove inimical in other ways to Fungi or insects, very few of the alleged cases of "disease-resisting" plants will bear scientific examination. Among the most interesting modern means of waging war against epidemic pests is that of introducing other epidemics among the pests themselves—*e.g.*, the infection of rats and mice with disease bacilli, or of locusts with insect-killing Fungi, and signs of the successful carrying out of such measures are not wanting. That the encouragement of insectivorous birds has been profitable is well established, and it is equally well known that their destruction may lead to disastrous insect plagues. Much can be done, in forests for instance, by growing mixed crops, thus avoiding the risks of epidemics due to the rapid spread of Fungi over large continuous tracts of suitable host-plants.

Diseases and Symptoms.—The symptoms of plant diseases are, as already said, apt to be very general in their nature, and are sometimes so vaguely defined that little can be learned from them as to the causes at work. We may often distinguish between primary symptoms and secondary or subordinate symptoms, but for the purposes of classification in an article of this scope I shall only attempt to group the various cases under the more obvious signs of disease exhibited.

1. *Discolorations* are among the commonest of all signs that a plant is "sickly" or diseased. The principal symptom may show itself in general pallor, including all cases where the normal healthy green hue is replaced by a sickly yellowish hue indicating that the chlorophyll apparatus is deficient. It may be due to insufficient illumination (*Etiolation*), as seen in geraniums kept in too shaded a situation, and is then accompanied by soft tissues, elongation of internodes, leaves usually reduced in size, &c. The laying of wheat is a particular case. False etiolation may occur from too low a temperature, often seen in young wheat in cold springs. Cases of pallor due to too intense illumination and destruction of chlorophyll must also be distinguished. *Chlorosis* is a form of pallor where the chlorophyll remains in abeyance owing to a want of iron, and can be cured by adding ferrous salts. Lack of other ingredients may also induce chlorotic conditions. Yellowing is a common sign of water-logged roots, and if accompanied by wilting may be due to drought. Over-transpiration in bright wintry weather, when the roots are not absorbing, often results in yellowing. In other cases the presence of insects, Fungi, or poisons at the roots may be looked for. *Albinism*, with which variegated foliage may be considered, concerns a different set of causes, still obscure, and usually regarded as internal, though experiments go to show that some variegations are infectious.

2. *Spotted Leaves, &c.*—Discoloured spots or patches on leaves and other herbaceous parts are common symptoms of disease, and often furnish clues to identification of causes, though it must be remembered that no sharp line divides this class of symptoms from the preceding. By far the greater number of spot-diseases are due to Fungi, as indicated by the numerous "leaf-diseases" described, but such is by no means always the case. The spot or patch is an area of injury; on, or in, it the cell-contents are suffering destruction from shading, blocking of stomata, loss of substance, or direct mechanical injury, and the plant suffers in proportion to the area of leaf surface put out of action. It is somewhat artificial to classify these diseases according to the colour of the spots, and often impossible, because the colour may differ according to the age of the part attacked and the stage of injury attained; many Fungi, for instance, induce yellow spots which become red, brown, or black as they get older, and so on. White or grey spots may be due to *Peronospora, Erysiphe, Cystopus, Entyloma*, and other Fungi, the mycelium of which will be detected in the discoloured area; or they may be scale insects, or the results of punctures by Red-spider, &c. Yellow spots, and especially bright orange spots, commonly indicate Rust Fungi or other Uredineæ; but *Phyllosticta, Exoascus, Clasterosporium, Synchytrium*, &c., also induce similar symptoms. Certain Aphides, Red-spider, Phylloxera, and other insects also betray their presence by such spots. It is a very common event to find the early stages of injury indicated by pale yellow spots, which turn darker, brown, red, black, &c., later—*e.g.*, *Dilophia, Rhytisma*, &c. Moreover, variegations deceptively like these disease spots are known—*e.g.*, *Senecio Kæmpferi*. Red spots may indicate the presence of Fungi—*e.g.*, *Polystigma*—or insects—*e.g.*, *Phytoptus*. Brown spots are characteristic of *Phytophthora, Puccinia*, &c., and black ones of *Fusicladium, Ustilago, Rhytisma*, &c. Both are common as advanced symptoms of destruction by Fungi and insects. Brilliantly-coloured spots and patches follow the action of acid fumes on the vegetation near towns and factories, and such parti-coloured leaves often present striking resemblances to autumn foliage. Symptoms of scorching owing to abnormal insolation—*e.g.*, in greenhouses where the sun's rays are concentrated on particular spots—and a certain class of obscure diseases, such as "silver-leaf" in plums, "foxy leaves" in various plants, may also be placed here.

3. *Wounds.*—The principal phenomena resulting from a simple wound, and the response of the irritated cells in healing by cork and in the formation of callus, have been indicated above. Any clean cut, fracture, or bruise which injures the cambium over a limited area is met with the same response. The injured cells die and turn brown; the living cells beneath grow out, and form cork, and under the released pressure bulge outwards and repeatedly divide, forming a mass of succulent regenerative tissue known as *callus*. Living cells of the pith, phloem, cortex, &c., may also co-operate in this formation of regenerative tissue, and if the wound is a mere knife-cut in the "bark," the protruding lips of callus formed at the edges of the wound soon meet, and the slit is healed over—occluded. If a piece of bark and cortex are torn off, the occlusion takes longer, because the tissues have to creep over the exposed area of wood; and the same is true of a transverse cut severing the

branch, as may be seen in any properly pruned tree. The details of healing by occlusion with callus must be sought in the special works, and are important in order to understand the results due to various checks and delays in the process, which have for their consequences the formation of cankers, wood-rot, &c. Here it must suffice to point out that wounds open the way to numerous Fungi and insects incapable of penetrating sound timber, and that their occurrence in nature is due to a variety of accidents, breakage by wind, overweighting by snow, abrasions, lightning strokes, hail, the gnawing of animals, such as rabbits, rats, squirrels, &c., the rubbing of horns by cattle and deer, and all kinds of minor injuries due to small animals being among the causes. Wounds may be artificially grouped under such heads as the following: Burrows and excavations in bark and wood due to boring insects, especially beetles. Breakages and abrasions due to wind, snow, lightning, and other climatic agents. Cuts, breakages, &c., due to man and other vertebrate animals. Erosions of leaves and herbaceous parts by caterpillars, slugs, earwigs, and so forth. Frost-cracks, scorching of bark by sun and fire, &c., and wounds due to plants which entwine, pierce, or otherwise materially injure trees, &c., on a large scale.

4. *Excrescences.*—Outgrowths, more or less abnormal in character, are frequent signs of diseased organs. They are due to hypertrophy of young tissues, which may undergo profound alterations subsequently, and occur on all parts of the plants. The injury which initiates them may be very slight in the first place—a mere abrasion, puncture, or Fungus infection—but the minute wound or other disturbance, instead of healing over normally, is frequently maintained as a perennial source of irritation, and the regenerative tissues grow on month after month or year after year, resulting in extraordinary outgrowths often of large size and remarkable shape. Excrescences may be divided into those occurring on herbaceous tissues, of which *Galls* are well-known examples, and those found on the woody stem, branches, &c., and themselves eventually woody, of which *Burrs* of various kinds afford common illustrations. Among the simplest examples of the former are the hairs which follow the irritation of the cells by mites. These hairs often occur in tufts, and are so coloured and arranged that they were long taken for Fungi and placed in the "genus" *Erineum.*

Cecidia or galls arise by the hypertrophy of the subepidermal cells of a leaf, cortex, &c., which has been pierced by the ovipositor of an insect, and in which the egg is deposited. The irritation set up by the hatching egg and its resulting larva appears to be the stimulus to development, and not a poison or enzyme injected by the insect. The extraordinary forms, colours, and textures of the true galls have always formed some of the most interesting of biological questions, for not only is there definite co-operation between a given species of insect and of plant, as shown by the facts that the same insect may induce galls of different kinds on different plants or organs, while different insects induce different galls on the same plant—*e.g.*, the numerous galls on the oak—but the gall itself furnishes well adapted protection and abundant stores of nutriment to its particular larva, and often appears to be borne without injury to the plant. This latter fact is no doubt due to the production of an excess of plastic materials over and above what the tree requires for its immediate needs. Galls in the wide sense—technically *Cecidia*—are not always due to insects. The nodules on the roots of leguminous plants are induced by the presence of a minute organism now known to do no injury to the plant (see BACTERIOLOGY: *Schizomycetes*). Those on turnips and other Cruciferæ are due to the infection of *Plasmodiophora*, a dangerously parasitic Myxomycete. Nodules due to "eel-worms" (Nematodes) are produced on numerous classes of plants, and frequently result in great losses—*e.g.*, tomatoes, cucumbers, &c.; and the only too well known Phylloxera, which cost France and other vine-growing countries many millions sterling, is another case in point. Fungus-galls on leaves and stems are exemplified by the "pocket-plums" caused by the *Exoasceæ*, the black blistering swellings of *Ustilago Maydis*, the yellow swellings on nettles due to *Æcidium*, &c.

In many cases the swellings on leaves are minute, and may be termed *pustules*—*e.g.*, those due to *Synchytrium*, *Protomyces*, *Cystopus*, many Ustilagineæ, &c. These cases are not easily distinguished superficially from the pustular outgrowth of actual mycelia and spores (stromata) of such Fungi as *Nectria*, *Puccinia*, &c. The cylindrical stem-swellings due to *Calyptospora*, *Epichloe*, &c., may also be mentioned here, and the tyro may easily confound with these the layers and cushions of eggs laid on similar organs by moths. There is a class of gall-like or pustular outgrowths for which no external cause has as yet been determined, and which are therefore often ascribed to internal causes of disease. Such are the cork-warts on elms, maples, &c., and the class of outgrowths known as *Intumescences*. Recent researches point to definite external conditions of moisture, affecting the processes of respiration and transpiration, &c., as being responsible for some of these. The "scab" of potatoes is another case in point. Frost blisters are pustular swellings due to the up-growth of callus-tissue into cavities caused by the uprising of the superficial cortex under the action of intense cold.

Turning now to outgrowths of a woody nature, the well-known *burrs*, or "knaurs," so common on elms and other trees are cases in point. They are due to some injury—*e.g.*, bruising by a cart-wheel, insects—having started a callus on which adventitious buds arise, or to the destruction of buds at an early stage. Then, stores of food-material being accumulated at the injured place, other buds arise at the base of or around the injured one. If matters are propitious to the development of these buds, then a tuft of twigs is formed and no burr; but if the incipient twigs are also destroyed at an early stage, new buds are again formed, and in larger numbers than before, and the continued repetition of these processes leads to a sort of conglomerate woody mass of fused bud-bases, not dead, but unable to grow out, and thus each contributing a crowded portion of woody material as it slowly grows. There are many varieties of burrs, though all woody outgrowths of old trees are not to be confounded with them, *e.g.*, the "knees" of *Taxodium*, &c. Many typical burrs might be described as witches'-brooms, with all the twigs arrested to extremely short outgrowths. Witches'-brooms are the tufted bunches of twigs found on silver firs, birches, and other trees, and often present resemblances to birds' nests or clumps of mistletoe if only seen from a distance. They are branches in which a perennial Fungus (*Æcidium*, *Exoascus*, &c.) has obtained a hold. This Fungus stimulates the main twig to shoot out more twigs than usual; the mycelium then enters each incipient twig and stimulates it to a repetition of the process, and so in the course of years large broom-like tufts result, often markedly different from the normal.

But undoubtedly the most important of the woody excrescences on trees are *cankers*. A canker is the result of repeated frustrated attempts on the part of the callus to heal up a wound. If a clean cut remains clean, the cambium and cortical tissues soon form callus over it, and in this callus—regenerative tissue—new wood, &c., soon forms, and if the wound was a small one, no trace is visible after a few years. But the occluding callus is a mass of delicate succulent cells, and offers a dainty morsel to certain insects—*e.g.*, Aphides—and may be easily penetrated by certain Fungi such as *Peziza*, *Nectria*; and when thus attacked, the repeated conflicts between the cambium and callus, on the one hand, trying to heal over the wound, and the insect or Fungus, on the other, destroying the new tissues as they are formed, results in irregular growths: the still uninjured cambium area goes on thickening the branch, the dead parts, of course, remain unthickened, and the portion in which the Fungus is at work may for the time being grow more rapidly. Such cankers often commence in mere insect punctures, frosted buds, cracks in the cortex, &c., into which a germinating spore sends its hypha. The seriousness of the damage done is illustrated by the ravages of the larch disease, apple canker, &c.

5. *Exudations and Rotting.*—The outward symptoms of many diseases consist in excessive discharges of moisture, often accompanied by bursting of over-turgid cells, and eventually by putrefactive changes. Conditions of hyper-turgescence are common in herbaceous plants in wet seasons, or when overcrowded and in situations too moist for them. This unhealthy state is frequently combined with etiolation: what is termed rankness is a particular case, and if the factors concerned are removed by drainage, weeding out, free transpiration, &c., no permanent harm may result. With seedlings and tender plants, however, matters are frequently complicated by the onslaughts of Fungi—*e.g.*, *Pythium*, *Peronospora*, *Completoria*, *Volutella*, *Botrytis*, &c. That such over-turgescence should lead to the bursting of fleshy fruits, such as gooseberries, tomatoes, and grapes, is not surprising, nor can we wonder that fermentation and mould Fungi rapidly spread in such fruits; and the same is true for bulbs and herbaceous organs generally. The rotting of rhizomes, roots, &c., also comes into this category; but while it is extremely difficult in given cases to explain the course of events in detail, certain Fungi and bacteria have been so definitely associated with these rots—*e.g.*, beet-rot, turnip disease, wet-rot of potatoes—that we have to consider each case separately. It is, of course, impossible to do this here, but I will briefly discuss one or two groups of cases.

Honey-dew.—The sticky condition of leaves of trees—*e.g.*, lime—in hot weather is owing to exudations of sugar. In many cases the punctures of Aphides and Coccideæ are shown to be responsible for such exudations, and at least one instance is known where a Fungus—*Claviceps*—causes it. But it also appears that honey-dew may be excreted by ordinary processes of over-turgescence pressing the liquid through water-pores, as in the tropical *Cæsalpinia*, *Calliandra*, &c. That these exudations on leaves should afterwards serve as pabulum for Fungi—*e.g.*, *Fumago*, *Antennaria*—is not surprising, and the leaves of limes are often black with them.

Flux.—A common event is the exudation of turbid, frothing liquids from wounds in the bark of trees, and the odours of putrefaction and even alcoholic fermentation in these are sufficiently explained by the coexistence of albuminous and saccharine matters with Fungi, yeasts, and bacteria in such fluxes. It is clear that in these cases the obvious symptom—the flux—is not the primary one.

Some wound in the succulent tissues has become infected by the organisms referred to, and their continued action prevents healing. At certain seasons the wound "bleeds," and the organisms—some of which, by the bye, are remarkable and interesting forms—multiply in the nutritious sap and ferment it. The phenomenon is, in fact, very like that of the fermentation of palm wine and pulque, where the juices are obtained from artificial cuts.

Comparable with these cases is that of *Cuckoo-spit*, due to the juices sucked out by *Aphrophthora* on herbaceous plants of all kinds. Outflows of resin—*Resinosis*—also come under this general heading; but although some resin-fluxes are traced to the destructive action of *Agaricus melleus* in Conifers, others, as well as certain forms of Gummosis, are still in need of explanation.

Bacteriosis.—Many of the plant diseases involving rot have been ascribed to the action of bacteria, and in some cases—*e.g.*, cabbage-rot, bulb-rot of hyacinths, &c., carnation disease—the evidence supports the contention that bacteria are causally connected with the disease. It is not sufficient to find bacteria in the rotting tissues, however, nor even to be successful in infecting the plant through an artificial wound, unless very special and critical precautions are taken, and in most of the alleged cases of bacteriosis the saprophytic bacteria in the tissues are to be regarded as merely secondary agents.

(For further details the reader is referred to special works and to the article BACTERIOLOGY.)

6. *Necrosis.*—A number of diseases the obvious symptoms of which are the local drying up and death of tissues, in many cases with secondary results on organs or parts of organs, may be brought together under this heading. No sharp line can be drawn between these diseases and some of the preceding, inasmuch as it often depends on the external conditions whether necrosis is a dry-rot, in the sense I employ the term here, or a wet-rot, when it would come under the preceding category. The "dying back" of the twigs of trees and shrubs is a frequent case. The cortical tissues gradually shrink and dry up, turning brown and black in patches or all over, and when at length the cambium and medullary ray tissues dry up the whole twig dies off. This may be due to frost, especially in "thin-barked" trees, and often occurs in beeches, pears, &c.; or it may result from bruising by wind, hailstones, gun-shot wounds in coverts, &c., the latter of course very local. It is the common result of fires passing along too rapidly to burn the trees; and "thin-barked" trees—hornbeam, beech, firs, &c.—may exhibit it as the results of sunburn, especially when exposed to the south-west after the removal of shelter. The effects of frost and of sunburn are frequently quite local. The usual necrosis of the injured cortex occurs—drying up, shrivelling, and consequent stretching and cracking of the dead cortex on the wood beneath. Such frost-cracks, sun-cracks, &c., may then be slowly healed over by callus, but if the conditions for necrosis recur the crack may be again opened, or if Fungi, &c., interfere with occlusion, the healing is prevented; in such cases the local necrosis may give rise to cankers. The dying back of twigs may be brought about by many causes. General attacks of leaf-diseases invariably lead to starvation and necrosis of twigs, and similarly with the ravages of caterpillars and other insects. Drought and consequent defoliation result in the same, and these considerations help us to understand how old-established trees in parks, &c., apparently in good general health, become "stag-headed" by the necrosis of their upper twigs and smaller branches: the roots have here penetrated into subsoil or other unsuitable medium, or some drainage scheme has deprived them of water, &c., and a dry summer just turns the scale. Such phenomena are not uncommon in towns, where trees with their roots under pavement or other impervious covering do well for a time, but suddenly fail to supply the crown sufficiently with water during some hot summer.

7. *Monstrosities.*—A large class of cases of departure from the normal form, depending on different and often obscure causes, may be grouped together under this heading; most of them are of the kind termed *Teratological*, and it is difficult to decide how far they should be regarded as pathological if we insist that a disease threatens the existence of the plant, since many of these malformations—*e.g.*, double flowers, phyllody of floral parts, contortions and fascinations, dwarfing, malformed leaves, &c.—can not only be transmitted in cultivation, but occur in nature without evident injury to the variety. In many cases, however, monstrosities of flowers have been shown to be due to the irritating action of minute insects or Fungi, and others are known which, although induced by causes unknown to us, and regarded as internal, would not be likely to survive in the wild condition. This subject brings the domain of pathology, however, into touch with that of variation, and we are profoundly ignorant as to the complex of external conditions which would decide in any given case how far a variation in form would be prejudicial or otherwise to the continued existence of a species. Under the head of malformations we place cases of atrophy of parts or general dwarfing, due to starvation, the attacks of Fungi or minute insects, the presence of unsuitable food-materials, and so on, as well as cases of transformation of stamens into petals, carpels into leaves, and so forth. Roots are often flattened, twisted, and otherwise distorted by mechanical obstacles; stems by excess of food in rich soils, the attacks of minute parasites, overgrowth by climbing plants, &c. Leaves are especially apt to vary, and although the formation of crests, pitchers, puckers, &c., must be put down to the results of abnormal development, it is often difficult to draw the line between teratological and merely varietal phenomena. For instance, the difference between the long-stalked and finely-cut leaves of *Anemone* attacked with rust and the normal leaves with broad segments, or between the urceolate leaves occasionally found on cabbages and the ordinary form—in these cases undoubtedly pathological and teratological respectively—is nothing like so great as between the upper and lower normal leaves of many Umbelliferæ or the submerged and floating leaves of an aquatic *Ranunculus* or *Cabomba*. When we come to phenomena such as proliferations, vivipary, the development of "Lammas shoots," adventitious buds, epicormic branches, and to those malformations of flowers known as peloria, phyllody, virescence, &c., while assured that definite, and in many cases recognizable, physiological disturbances are at work, we find ourselves on the borderland between pathological and physiological variation, where each case must be examined with due regard to all the circumstances, and no generalization seems possible beyond what has been sketched. This is equally true of the phenomena of apogamy and apospory in the light of recent researches into the effects of external conditions on reproduction.

In conclusion, this sketch of an enormous subject shows us that the pathology of plants is a special department of the study of variations which threaten injury to the plant, and passes imperceptibly into the study of variations in general. Moreover, we have good reasons for inferring that different constellations of external causes may determine whether the internal physiological disturbances induced by a given agent shall lead to pathological and dangerous variation, or to changes which may be harmless or even advantageous to the plant concerned. This position seems fully warranted by the recent progress of œcology and the study of the influence of external conditions on plants in a state of nature, and especially by what we now know of symbiosis, artificial cultures, grafting, and cross-breeding.

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Patiala, or PUTTIALA, a native state of India, within the Punjab. Area, 5951 square miles; population (1881), 1,467,433; (1891), 1,583,521; (1901), 1,586,030, showing an increase of 8 per cent. between 1881 and 1891, but of less than ·2 per cent. between 1891 and 1901; average density, 266 persons per square mile; estimated gross revenue, Rs.68,54,000; military force (including police), 8673 men; no tribute. The late maharaja, who died in 1900, was devoted to riding and sport. He personally took part in the Tirah campaign of 1897–98 with a battalion of his own Imperial Service infantry and a field troop of Imperial Service lancers. In recognition of his services on this occasion he received the G.C.S.I. The financial administration of the state is not altogether satisfactory. It is crossed by two lines of railway, and irrigated by the Sirhind canal and its branches. In 1896–97 the total number of schools was 186, attended by 9197 pupils, of whom 479 were girls; the proportion of boys at school was 1 to every 94 of the total male population. There is one college, with 86 students (including 52 in the Oriental department), of whom 13 passed university examinations; also thirteen Anglo-vernacular schools, with 2268 pupils, of whom 14 matriculated. The town of PATIALA is situated in 30° 20′ N. and 76° 25′ E., and has a station on the branch railway from Rajpura to Bhatinda. Population (1891), 55,785.

Patmore, Coventry Kersey Dighton (1823–1896), English poet and critic, the eldest son of Peter George Patmore, himself an author, was born at Woodford in Essex, 23rd July 1823. He was privately educated, being his father's intimate and constant companion, and derived from him his early literary enthusiasm. It was his first ambition to become an artist, and he showed much promise, being awarded the silver palette of the Society of Arts in 1838. In the following year he was sent to school in France, where he studied for six months, and began to write poetry. On his return his father contemplated the publication of some of these youthful poems; but in the meanwhile Coventry had evinced a passion for science, and the poetry was set aside. He soon, however, returned to literary interests, moved towards them by the sudden success of Tennyson; and in 1844 he published a small volume of *Poems*, which was not without individuality, but marred by inequalities of workmanship. It was widely criticized, both in praise and blame; and Patmore, distressed at its reception, bought up the remainder of the edition and caused it to be destroyed. What chiefly wounded him was a cruel review in *Blackwood*, written in the worst style of unreasoning abuse; but the enthusiasm of private friends, together with their wiser criticism, did much to help him and to foster his talent. Indeed, the publication of this little volume bore immediate fruit in introducing its author to various men of letters, among whom was Dante Gabriel Rossetti, through whose offices Patmore became known to Mr Holman Hunt, and was thus drawn into the eddies of the Pre-Raphaelite movement, contributing his poem "The Seasons" to *The Germ.* At this time Patmore's father became involved in financial embarrassments, which obliged the son to adopt some professional calling; and in 1846 Monckton Milnes secured him an assistant-librarianship in the British Museum, a post which he occupied industriously for nineteen years, devoting his spare time to poetry. In 1847 he married Emily, daughter of Dr Andrews of Camberwell. At the Museum he was austere and remote among his companions, but was nevertheless instrumental in 1852 in starting the Volunteer movement. He wrote an important letter to *The Times* upon the subject, and stirred up much martial enthusiasm among his colleagues. In the next year he republished, in *Tamerton Church Tower*, the more successful pieces from the *Poems* of 1844, adding several new poems which showed distinct advance, both in conception and treatment; and in the following year (1854) appeared the first part of his best known poem, "The Angel in the House," which was continued in "The Espousals" (1856), "Faithful for Ever" (1860), and "The Victories of Love" (1863). In 1862 he lost his wife, after a long and lingering illness, and shortly afterwards joined the Roman Catholic Church. In 1865 he married again, his second wife being Miss Mariane Byles, second daughter of James Byles of Bowden Hall, Gloucester; and a year later purchased an estate in East Grinstead, the history of which may be read in *How I managed my Estate*, published in 1886. In 1877 appeared *The Unknown Eros*, which unquestionably contains his finest work in poetry, and in the following year *Amelia*, his own favourite among his poems, together with an interesting, though by no means undisputable, essay on *English Metrical Law.* This departure into criticism he continued further in 1879 with a volume of papers, entitled *Principle in Art*, and again in 1893 with *Religio Poetæ.* Meanwhile his second wife died in 1880, and in the next year he married Miss Harriet Robson. The last years of his life were spent at Lymington, where he died 26th November 1896. A collected edition of his poems appeared in two volumes in 1886, with a characteristic preface which might serve as the author's epitaph. "I have written little," it runs; "but it is all my best; I have never spoken when I had nothing to say, nor spared time or labour to make my words true. I have respected posterity; and should there be a posterity which cares for letters, I dare to hope that it will respect me." The obvious sincerity which underlies this statement, combined with a certain lack of humour which peers through its naïveté, points to two of the principal characteristics of Patmore's earlier poetry; characteristics which came to be almost unconsciously merged and harmonized as his style and his intention drew together into unity. Earnestness of view and purpose marks every line which he wrote; and yet a rather keener appreciation of the unpoetic aspects of a too naked simplicity would have saved him from many of those sublimations of the trivialities of life which have already begun to seem old-fashioned, and were, indeed, never in the fashion of high poetry at all. But when Patmore is not occupied with the railway guard and the shop assistant, and when he discards pure narrative for philosophic reflection, he is a poet of the first and indisputable rank. His initial misfortune was that of subject, commonplace married life not being a topic rich in poetic opportunities; in particular, to one who saw details with Patmore's minuteness the theme was particularly dangerous. But in the higher flights, to which he arose as his practice in the art grew perfected, he is always noble and often sublime. His best work is found in the volume of odes called *The Unknown Eros*, which is full not only of passages but of entire poems in which exalted thought is expressed in poetry of the richest and most dignified melody. The animating spirit of love, moreover, has here deepened and intensified into a crystalline harmony of earthly passion with the love that is divine and transcending; the outward manifestation is regarded as a symbol of a sentiment at once eternal and quintessential. Spirituality informs his inspiration; the poetry is of the finest elements, glowing and alive. The magnificent piece in praise of winter, the solemn and beautiful cadences of "Departure," and the homely but elevated pathos of "The Toys," are in their various manners unsurpassed in English poetry for sublimity of thought and perfection of expression. Patmore is one of the few Victorian poets of whom it may confidently be predicted that the memory of his greater achievements will outlive all consideration of occasional lapses from taste and dignity. He wrote, at his best, in the grand manner, melody and thought according with perfection of expression, and his finest poems have that indefinable air of the inevitable which is after all the touchstone of the poetic quality. (A. WA.)

Patna, a city, district, and division of British India, in the Behar province of Bengal. The city lies on the right bank of the Ganges, a little distance below the confluence of the Soane and the Gogra, and opposite the confluence of the Gandak; it has a railway station, 332 miles north-west of Calcutta. Including the civil station of Bankipur to the west, the city stretches along the river bank for nearly 9 miles. Still farther west is the military cantonment of Dinapur. Municipal area, 6184 acres; population (1881), 170,654; (1891), 165,192; (1901), 135,172. One of the most interesting buildings in the city is the huge *gola*, or storehouse for grain, constructed in 1786, but never seriously used. Patna is the headquarters of the Government opium agency, where the drug grown throughout Behar is prepared for the Chinese market. Government College, founded in 1862, had 188 pupils in 1896–97. Other educational institutions include collegiate and *zilla* high schools, with 558 pupils; a law class, with 32 students; the Temple medical school, with 132 students, of whom 4 were women; the Behar school of engineering, organized in 1897, with 194 students; a normal school, with 51 students. There are nine printing-presses, most of which issue a newspaper either in English or in the vernacular, and there is an Oriental public library.

The district of PATNA has an area of 2076 square miles; population (1881), 1,751,834; (1891), 1,772,352; (1901), 1,623,856, showing an increase of only 1 per cent. between 1881 and 1891, but a decrease of 8·4 per cent. between 1891 and 1901; average density, 782 persons per square mile. Classified according to religion, Hindus in 1891 numbered 1,568,131; Mahommedans, 201,106; Christians, 2833, of whom 1662 were Europeans; "others," 282. The land revenue and rates in 1897–98 were Rs.17,17,939; number of police, 1325; boys at school (1896–97), 43,895, being 33·8 per cent. of the male population of school-going age; registered death-rate (1897), 31·92 per thousand. The district is traversed throughout by the main line of the East Indian Railway (84 miles), with a branch south to Gaya.

The division of PATNA extends across both sides of the Ganges. It comprises the seven districts of Patna, Gaya, Shahabad, Saran, Champaran, Muzaffarpur, and Darbhangarh. Total area, 23,675 square miles; population (1891), 15,811,014.

Patna, a feudatory state of India, in the Chhattisgarh division of the Central Provinces. Area, 2399 square miles; population (1881), 257,959; (1891), 332,197; (1901), 277,566; average density, 134 persons per square mile; estimated revenue, Rs.1,47,000; tribute, Rs.8500. The chief is a rajput of high lineage, whose ancestors formerly ruled over a large territory. The state was for many years under British administration, and the present chief was educated at the Rajkumar College.

Paton, Sir Joseph Noel (1821–1901), British painter, was born, on 13th December 1821, in Woolers Alley, Dunfermline, where his father, a fellow of the Scottish Society of Antiquaries, carried on the trade of a damask manufacturer. He showed strong artistic inclinations in early childhood, but had no regular art training, except a brief period of study in the Royal Academy School in 1843. He gained a prize of £200 in the first Westminster Hall competition, in 1845, for his cartoon, "The Spirit of Religion," and in the following year he exhibited at the Royal Scottish Academy his "Quarrel of Oberon and Titania" (see Plate). A companion fairy picture, "The Reconciliation of Oberon and Titania" (see Plate), went to Westminster Hall in 1847, and for it and his picture of "Christ bearing the Cross" he was awarded a prize of £300 by the Fine Arts Commissioners. The two Oberon pictures are in the National Gallery of Scotland, where they have long been a centre of attraction. His first exhibited picture, "Ruth Gleaning," appeared at the Royal Scottish Academy in 1844. He began to contribute to the Royal Academy of London in 1856. Throughout his career his preference was for allegorical, fairy, and religious subjects. Among his most famous pictures are "The Pursuit of Pleasure" (1855), "Mors Janua Vitæ" (1866), "Oskold and the Ellé-maids" (1874), and "In Die Malo" (1882). Sir Noel Paton also produced a certain amount of sculpture, more notable for design than for searching execution. He was elected an associate of the Royal Scottish Academy in 1847, and a full member in 1850; he was appointed Queen's Limner for Scotland in 1866, and received knighthood in 1867. In 1878 the University of Edinburgh conferred upon him the degree of LL.D. He was a poet of distinct merit, as his *Poems by a Painter* (1861) and *Spindrift* (1867) pleasantly exemplified. He was also well known as an antiquary, his hobby, indeed, being the collection of arms and armour. Sir Noel died in Edinburgh on the 26th of December 1901.

Patras (Greek, *Patrai*), the chief fortified seaport town on the west coast of Greece, and chief town of the province of Achaia and Elis, on a gulf of the same name, 70 miles west-north-west of Corinth. It has been rebuilt since 1821 (the War of Liberation), and is the seat of a Greek archbishop and an appeal court. It has a citadel and castle, and is the chief port of Greece, from which the great bulk of its currants are despatched. The port, formed by a mole and a breakwater, offers a fair harbour for vessels drawing up to 22 feet. The exports consist of currants, sultanas, valonea, tobacco, olive oil, olives in brine, figs, citrons, wine, brandy, cocoons, and lamb, goat, and kid skins. The imports consist chiefly of colonial produce, manufactured goods, and sulphate of copper. There are two railway stations, one in the north-east on the line to Athens (*viâ* Corinth), the other on the line to Pyrgos. Population (1889), 33,529; (1896), 37,958.

Patti, a town and episcopal see of the province of Messina, Sicily, Italy, 43 miles west by south of Messina by the north coast railway to Palermo, one mile from the shore of the Gulf of Patti. It has a modern cathedral, and silk and olive-oil mills, lime-kilns, sandstone quarries,

"The Quarrel of Oberon and Titania." By Sir J. Noel Paton.

"The Reconciliation of Oberon and Titania." By Sir J. Noel Paton.

(*The National Gallery, Edinburgh.*)

flour-mills, terra-cotta works, and tunny fishing. A little to the east are the ruins of the ancient city of *Tyndaris*. Population (1881), 7612; (1899), 9500.

Patti, Adelina (Baroness Cederström), the famous vocalist, daughter of an Italian, Salvalin Patti, was born at Madrid, 19th February 1843. Gifted with a fine soprano voice, she was trained in America under Maurice Strakosch, her brother-in-law, and made her first appearance as Lucia in *Lucia di Lammermoor* in New York in 1859. Her marvellous execution and brilliant singing at once made her famous. In 1861 she sang in *La Sonnambula* at Covent Garden, and from this time she became the leading operatic *prima donna*, her appearances in London, Paris, and the other principal musical centres being a long succession of triumphs, and her *rôles* covering all the great parts in Italian opera. In 1868 she married the marquis de Caux, from whom she was divorced in 1885; she then married Nicolini, the tenor, who died in 1898; and in 1899 she became the wife of Baron Cederström, a Swede, who was naturalized as an Englishman. Madame Patti ceased to appear on the operatic stage in public after the 'eighties, but at Craig-y-Nos, her place in Wales, she built a private theatre, and her occasional appearances for enormous fees at concerts at the Albert Hall continued to attract enthusiastic audiences, her singing of "Home, Sweet Home" becoming peculiarly associated with those events. Partly owing to her fine original training, partly to her splendid method, and partly to her avoidance of Wagnerian *rôles*, Madame Patti wonderfully preserved the freshness of her voice and her beautiful execution, and she will be remembered as, after Jenny Lind, the greatest singer of the 19th century.

Pattison, Mark (1813–1884), rector of Lincoln College, Oxford, born 10th October 1813, was the son of the rector of Hauxwell, Yorkshire, where he spent his younger days, being privately educated by his father. His youngest sister was the well-known Sister Dora. In 1832 he matriculated at Oriel College, where he took his B.A. degree in 1836 with second-class honours. After failing four times to obtain a fellowship, he was elected in 1839 to a Yorkshire fellowship at Lincoln, an anti-Puseyite College, then described as "low and slow." Pattison was at this time a Puseyite, and greatly under the influence of J. H. Newman, for whom he worked, translating *Aquinas*, and writing in the *British Critic* and *Christian Remembrancer*. He was ordained priest in 1843, and in the same year became tutor of Lincoln College, where he rapidly made a reputation as a clear and stimulating teacher and as a sympathetic friend of youth. The management of the college was practically in his hands, and his reputation as a scholar became high in the University. In 1851 the rectorship of Lincoln became vacant, and it seemed certain that Pattison would be elected, but he lost it by a disagreeable intrigue. The disappointment was acute, and his health suffered. In 1855 he resigned the tutorship, travelled in Germany to investigate Continental systems of education, and began his researches into the lives of Casaubon and Scaliger, which occupied the remainder of his life. In 1861 he was elected rector of Lincoln, marrying in the same year Emilia Frances Strong (afterwards Lady Dilke). The rector contributed largely to various reviews on literary subjects, and took a considerable interest in social science, even presiding over a section at a congress in 1876. The routine of university business he avoided with contempt, and refused the vice-chancellorship. But while living the life of a student, he was fond of society, and especially of female society. He was a keen fisherman, and interested in Nature. He died on the 30th of July 1884 at Harrogate, where he was buried. His principal works are *Isaac Casaubon*, 1875; *Milton*, in Macmillan's English Men of Letters series, 1879. The 18th century, alike in its literature and its theology, was a favourite study, as is illustrated by his contribution to the once famous *Essays and Reviews* (1860), and by his edition of Pope's *Essay on Man* (1869), &c. His *Sermons* and *Collected Essays* were published posthumously, as well as the painfully interesting *Memoirs*, an autobiography deeply tinged with melancholy and bitterness. His projected *Life of Scaliger* was never finished. Mark Pattison possessed an extraordinary distinction of mind. He was a true scholar, who lived entirely in the things of the intellect. He writes of himself, excusing the composition of his memoirs, that he has known little or nothing of contemporary celebrities, and that his memory is inaccurate: "All my energy was directed upon one end —to improve myself, to form my own mind, to sound things thoroughly, to free myself from the bondage of unreason. . . . If there is anything of interest in my story, it is as a story of mental development" (*Memoirs*, pp. 1, 2). He was never satisfied with his work: "It is impossible," he writes, "for me to see anything done without an immediate suggestion of how it might be better done" (*Memoirs*, p. 254). His aim was purely intellectual; he says of himself in 1857, "My ideal at this time was polluted and disfigured by literary ambition" (*Memoirs*, p. 309). Again, he says: "Since the year 1851, I have lived wholly for study. There can be no vanity in making this confession, for, strange to say, in a university ostensibly endowed for the cultivation of science and letters such a life is hardly regarded as a creditable one" (*Memoirs*, p. 331). The *Memoirs* is a morbid book, and Mark Pattison is merciless to himself throughout. He certainly cherished a rare and unique ideal, which he pursued through disappointments which nearly unhinged his mind. It is evident from his *Memoirs* that he carried rationalism in religion to an extent that seems hardly consistent with his position as an ordained minister of the English Church. (A. C. Be.)

Pau, chief town of the department of Basses-Pyrénées, France, 470 miles south-south-west of Paris, on the railway from Toulouse to Bayonne. A winter palace was erected in 1896 in Beaumont Park (24 acres), at the east end of the town. A statue of Maréchal Bosquet was unveiled in 1894. Pau is the seat of a Court of Appeal for the departments Basses- and Hautes-Pyrénées and Landes. It has a library of 55,000 volumes, and a museum. Population (1881), 25,734; (1901), 30,811.

Pauli, Georg Reinhold (1823–1882), German historian, was born in Berlin, 25th May 1823. After an education at Berlin and Bonn Universities, he went to England in 1847, and before long was immersed in the study of English literature and history. From 1850 to 1852 he acted as private secretary to the Prussian ambassador in London. In 1851 he published his *König Aelfred und seine Stelle in der Geschichte Englands*, a work which aroused considerable interest and was translated into English in the following year. On his return to Germany in 1855 he was for a short time at the University of Bonn as *privat-docent*, and subsequently at Rostock from 1857 to 1859, and at Tübingen from 1859 to 1867 as professor of history. His political convictions, which strongly favoured the Prussians, were the cause of his removal from Tübingen to Marburg in 1867. From there he went, in 1870, to Göttingen, where he filled the chair of history till his death. He was an enthusiastic and successful teacher, and may be said to have founded the school of historical research with which Sir John Seeley's reputation is associated in England. Besides the work on King Alfred mentioned above, his chief publications were a continuation in three volumes of Lappenberg's *Geschichte von England* (1853–58); *Bilder aus Alt-England* (1860); three volumes, dealing with the history of England from 1815 to 1852, in the *Staatengeschichte der neueren Zeit; Simon de Montfort* (1867); *Aufsätze zur englischen Geschichte*, 2 series (1869, 1883). His historical researches gained him honorary degrees from the Universities of Oxford and Edinburgh. He died at Bremen, 3rd June 1882. (R. F. S.)

Paulicians.—An important Oriental sect, probably named after Paul of Samosata. Their older name was Pauliani; the form *Paulicians* is from an Armenian diminutive meaning "contemptible Paul," as *Manichean* from Manes. Paul was bishop of Antioch from *c.* 260 to 268, and was affected by the Jewish tone, which spread from the Jewish population of Antioch, and long influenced the Christians there. He taught what is now called Adoptionist Monarchianism, *i.e.*, a form of unitarianism which denied that Jesus is God incarnate, but held that at His baptism He was made a partial sharer of the divine nature, and thus the adopted son of God. Opinions like those of Paul were held earlier by the Ebionites, and were introduced at Rome *c.* 190. Recent attempts to trace them in Palestine to the apostolic age, or in Rome before 190, rest merely on conjecture or error. Paul's teaching spread among the Syrians. The *Acts of Archelaus*, *c.* 300, represent a Syriac-speaking bishop of Karkhar upholding it against the views of Manes.

The followers of Paul are mentioned by the council of Nicaea and Athanasius (4th century); Innocent I., Augustine, Theodoret (5th century). For a long time they are no more heard of: when they reappear it is as a religious sect in or near Armenia (see *Ency. Brit.*, 9th ed., vol. xviii. p. 433). We learn of it from various Armenian and Greek writers. Among the latter are Photius (*c.* 850) and his contemporary, Peter Siculus, and Georgius Monachus (especially the Madrid MS.): all these use one older document, now lost. About 654 the Armenian "Catholicos" Nerses tried to suppress it; about the same date Constantine Silvanus was born, and preached Paulicianism with success at Cibossa. In 719 the Armenian, John of Otzun, spoke and wrote against it. Evidence contradicts the recent theory that the earliest Armenian church was Paulician, but from the 5th century there was a nationalist anti-Greek Armenian Christianity which opposed the Armenian Church. Out of this tendency Smbat, *c.* 840, organized a strong Paulician sect, named Thonraki from the region of Thonrak, where he laboured. It is hard to determine the exact nature of his teaching. Old writers describe the Paulicians as Manichean. On the other hand, the *Key of Truth*,[1] the only known Paulician book (Armenian) is not Manichean, but Adoptionist. Nevertheless, as the Armenian Paulicians hated infant baptism, perhaps deferred communion till old age, rejected the ministry and ritual of the Church, gave divine honours to their "elect," "anointed ones," or ministers, denied that Christ is God while they worshipped Him, and apparently denied that He took His flesh really of Mary, it is not strange that the Greeks confused them with the Manicheans. According to the *Key*, Jesus Christ "in the season of His maturity . . . received baptism . . . received authority, received the priesthood, received the kingdom and the office of chief shepherd. Moreover, He was then chosen, then He won lordship . . . then He became the chief of beings heavenly and earthly, then He became the light of the world, then He became the way, the truth, and the life." And the fact that their teaching incorporates many Catholic survivals, such as a trine affusion in baptism, and that they made use of the Armenian authorized version of the New Testament and not the older version, shows clearly that their position is a "protestant" one—*i.e.*, that it is a reaction against and a dissension from a developed ecclesiastical system, not a primitive type which has survived side by side with a later development. About 750 Constantine Copronymus, himself probably a Paulician, removed many from Armenia to Thrace as a barrier against the Slavs. Later Byzantine rulers persecuted them. From 845 to 880 they fought desperately, and, joining with the Moslems, plundered Asia Minor. In 874 Tephricé, their stronghold, was taken by the emperor Basil. About 980 many were moved to Thrace by John Zimisces to prevent an alliance between the Paulicians and the Moslems. About 1110 the Thracian Paulicians were harried by Alexius Comnenus for deserting him in war. At the end of the 17th century they lingered in the valleys of Haemus. In 1717 Lady Mary Wortley Montagu found some at Philippopolis. By 1819 the last Thracian Paulicians had become Roman Catholics. That they greatly influenced the Bulgarian Manicheans, known as Bogomils, who arose *c.* 950, and through them the Western movements of the Cathars and the Albigenses, seems to be indicated by the fact that not a few of their beliefs and practices were held in common—*e.g.*, their eucharistic doctrine and the worship offered to their "anointed ones."

In the East they survived later. After the Russo-Turkish war of 1828–29 a body of Thondraketzi (Thonraki), who had left their homes in the Turkish canton of Khnus, settled in the village of Arkhivêli, in the newly-acquired Russian territory between Akhaltzik and Erivan. Here they were before long subjected to persecution by the authorities of the Armenian Church; and in 1837, in the course of the persecution, the *Key* (in which they said "everything was written") was taken from them, having been mutilated previously in order to hide some of the more objectionable tenets, and deposited in the library of the Holy Synod at Etchmiadzin, where Mr Conybeare found it. According to its colophon, it was "written [*i.e.*, it would appear, copied, for the substance of the book must be much earlier] in the province of Taron in the year of the Lord 1782"; and the evidence of five Paulician witnesses tells us that it was "composed" by an Armenian priest Ohannes (John) who had joined the sect, and who subsequently, under pressure from the government, became a Mahommedan. The Paulicians still existed in 1845, since which date they have been unmolested, and have probably died out. Mr H. F. B. Lynch (*Armenia, Travels and Studies*, London, 1901, i. 285) asserts that those who survived have been absorbed by the American Protestant missions in Armenia, but gives no authority for the statement.

For authorities see Professor Bury's edition of Gibbon's *Decline and Fall of the Roman Empire*, vol. vi., appendix 6. But Professor Bury copies the mistake of Mr Conybeare in calling the *Shepherd of Hermas* Adoptionist. See also A. LOMBARD, *Pauliciens, Bulgares, et Bons-Hommes en Orient et en Occident*, Geneva and Basel, 1879. (L. P.; W. E. Co.)

Pauline Epistles.—The familiar grouping of the Pauline Epistles, (1) 1 and 2 Thessalonians, (2) Galatians, 1 and 2 Corinthians, Romans, (3) Colossians, Philemon, Ephesians, Philippians, (4) Pastorals, may help in considering this subject in regard to the later research on (*a*) authenticity, (*b*) date, (*c*) contents.

[1] Edited by F. C. Conybeare (Oxford, 1898). Much of the introduction is seriously marred by the editor's slight acquaintance with Greek theology.

(*a*) Recent attacks upon the generally received second group (the *Hauptbriefe*) are mainly confined to a school of Dutch theologians, as isolated attacks elsewhere can scarcely be credited to a "school" (Holtzmann, *Einleitung*[3], p. 183; Clemen, *Chronologie der Paulinischen Briefe*, p. 30). Van Manen, chief representative of this hypercritical movement, has set forth his views in the *Expository Times*, 1898; *Encycl. Bibl.* iii.; and more especially in the three parts of his *Paulus*. But as he maintains that these Epistles, as well as the rest referred to Paul, are pseudepigrapha dating at least from the close of the 1st century, we cannot be surprised that the positive external evidence of Clement of Rome, *Corinthians*, xlvi. (Salmon, *Introd.*, 36o, and so Schmiedel, *Encycl. Bibl.* ii., "Galatians"), is entirely disregarded, to say nothing of that of other writers, and that Clement is relegated "at any rate to the 2nd century." But if an imposing array of names may fairly be quoted for the *Hauptbriefe*, similar strong testimony accepts 1 Thessalonians (Holsten, only notable exception), Philemon, Philippians, and, with a few interpolations, Colossians (Clemen, *u.s.* p. 37; Weiss, *Einleitung*, p. 149). In group 1, 2 Thessalonians was rejected by advanced critics, until it became almost an axiom to accept 1 Thessalonians and not 2 (see Holtzmann, *Zeitschrift für die neutest. Wissenschaft*, ii., 1901). But Jülicher, if he does not positively accept 2 Thessalonians, regards the doubts raised against it as not insurmountable (*Einleitung*, pp. 34, 40), whilst in England Dr J. Drummond (*International Handbooks*, 1899) accepts it at least provisionally, and in America Bacon (*Introd.* 75; cf. also Moffatt, *Historical N. T.*, p. 144 ff.).

Authenticity.

The chief objection alleged is the representation of the Man of Sin. Not only, however, is it unlikely that a forger would introduce a passage so unlike anything in Paul's writings, but no one has defended the Epistle more acutely than Clemen in maintaining that the Apostle might easily have derived his picture from Jewish sources (so Jülicher), although the Jewish *traditional* element may be pushed too far (cf. Bousset, *Der Antichrist*; Charles, *Ascension of Isaiah*, Introd.; and on the other hand, Askwith, *Introduction to Thessalonians*, 1902).

Of Ephesians and Colossians, Arnold Meyer writes that the recent criticism of Jülicher and Harnack is much more friendly than that of Weizsäcker and others (*Die moderne Forschung über die Geschichte des Urchristentums*, p. 39, 1898), and admits that a much earlier stage of Gnosis is represented than that of the great Gnostic systems, whilst English readers will remember that the specious appeal to advanced Gnosticism was repudiated by Dr Hort in tracing the Colossian heresy to Jewish soil and influences (Hastings, *B. D.*, "Colossians," and for additional influences Ramsay, "Colossæ"). No criticism of any wide acceptance reckons Philemon spurious, although Van Manen would refer it to some unknown writer, A.D. 125–130. But he has no word of explanation as to how the epistle found a place some ten years later in the heretic Marcion's canon. But Philemon carries with it Colossians, and if Colossians is Paul's, "the subtle intricacies of likeness and unlikeness between it and Ephesians are a peculiarly strong kind of evidence for identical authorship" (Hort, *Proleg. to Ephesians*, 168; Robertson, *B. D.*[2] (Smith), "Ephesians"; Harnack, *Chron.* i. 239).

Group 4 Clemen ranks as "doubtless unauthentic" with the majority of advanced critics. But Ramsay, by his searching inquiry into the historical position which the Pastorals presuppose, maintains that their tone is inconsistent with a late date; the undeveloped type of persecution which they represent cannot be referred to the middle of the 2nd century, or to the formulated persecutions of the 1st (*C. R. E.* 246, 345, Weiss, Meyer's *Kommentar*, p. 40, 1894).

Another adverse argument is weakened by the fact that much of the language formerly regarded as characteristic of the 2nd century may be referred to early Jewish sources, *e.g.*, the reference of "endless genealogies" to pseudo-Philo's *Book concerning Biblical Antiquities* (before A.D. 70); Dr James, *N. T. Apocrypha*, Church Congress, 1898; Hort, *Judaistic Christianity*, p. 130. From another point of view such references are of value, because, whilst in our best commentaries it is usual to illustrate freely from contemporary and other Jewish documents, these and similar illustrations mark not only comparisons, but also contrasts (see, *e.g.*, Charles, *Apoc. of Baruch*, Introd.).

A peculiar stumbling-block to the rejection of these Epistles lies in their abundance of personal notices (Zahn, *Einleitung*, ii. 457; Salmon, *Introd.* 409; and Weiss, *Einleitung*[3], p. 304). It is difficult to see why a later writer should introduce these, since he ran the serious risk of making some fatal mistake; but if, as genuine Pauline fragments, they were introduced into letters the avowed aim of which was to secure the healthful development of the Church, it is evident that, as they are not in themselves connected with this aim, they could only have been designedly inserted to palm off the letter in which they occur as the work of Paul. In such case the language of Weiss, *u.s.*, will not seem too strong.

The acceptance of the Pastorals naturally implies a liberation and second imprisonment, as the attempts to fit them into an earlier part of Paul's life have not been successful (Steinmetz, *Die zweite römische Gefangenschaft des Apostels Paulus*, 121, 1897). Mr Vernon Bartlet has lately made an ingenious attempt in this direction (*Apostolic Age*, 198); *e.g.*, he asks us to transfer 2 Timothy iv. 20 to the close of 1 Timothy as a postscript, and to suppose that the reference to Trophimus is connected with the voyage from Miletus to Jerusalem, Acts xx. 21. Trophimus falls sick at the last moment, and could not sail with Paul from Miletus, and Paul refers to this in 1 Timothy—a letter written on board ship to his son in the faith at, or soon after leaving, Miletus. But Trophimus, it would seem, was certainly at Jerusalem very soon after, Acts xxi. 29, and on Mr Bartlet's theory it is difficult to see any sense in such a notice as 1 Timothy iii. 14, which he apparently admits to be from Paul. If Paul, Acts xx. 25, had just told the Ephesian elders that they should see his face no more, upon which Mr Bartlet insists (p. 201), it is difficult to believe that he had no sooner left Miletus than he writes to Timothy at Ephesus (p. 180) that he hopes to come unto him shortly. Moreover, the positive evidence for Paul's release and subsequent labours cannot be calmly ruled out of court. Amongst moderns Spitta and Harnack accept it, and both lay stress upon the fact that in Clem. Rom., *Cor.* v. 7, "the limit of the West" could not be used of Rome by one writing in Rome (cf. Ramsay, *St Paul*, 455; Zahn, *u.s.*, p. 448).

(*b*) With regard to *dates*, Clemen, in accordance with his view of development of Pauline thought, placed 1 and 2 Thessalonians, 47, 48, *before* the Apostolic Council (see below), while Harnack places them 48, 49 (47, 48), and McGiffert, c. 48, in accordance with their early chronology, but *after* the Council. The greatest diversity of opinion gathers round Galatians. McGiffert places it earliest of the Epistles, at Antioch, before the second missionary journey, whilst Rendall, holding with McGiffert the South Galatian theory, maintains that it was written during this journey, at Corinth. Mr V. Bartlet would apparently place it earlier still, either on Paul's way to Jerusalem for the Council or during the dispute at Antioch with the Judaizers before the Council. These writers thus agree in so far that they rank Galatians earliest. In Germany Prof. V. Weber, the fullest advocate of the South Galatian theory and of the identification of Gal. ii. with Acts xi. 30, places Galatians earliest, in 49, during the period Acts xiv. 28; and he is now followed by Belser, *Einleitung*, pp. 170, 436 ff., 1901. Zahn also places it earliest, but in the beginning of 53, and 1, 2 Thessalonians within the first half of the year, these three Epistles thus forming his first group. He too, holding the South Galatian theory for the Epistle, dates it with Rendall from Corinth, and both writers consider vi. 17 a reference to the scourging at Philippi, of which Paul still bore the scars. Ramsay, however,

Date.

gives strong reasons for placing Galatians later in Paul's life, at Antioch, at the close of the second journey. The most remarkable change of opinion in favour of the early date of Galatians is that of Clemen, who, after placing it subsequent to Romans (1897), now considers it the earliest of all, in view of the South Galatian theory, placing it in the second missionary journey before 1 and 2 Thess.; on this cf. *Theol. Rundschau*, 12, 1901.

The inquiry gains additional interest from Mr Askwith's discussion (*Galatians*, 1899) of points at issue between Ramsay and Lightfoot, and his contention that the later date assigned by the latter, during the third missionary journey, need not interfere with maintaining the South Galatian theory. The later date is adopted by Lightfoot chiefly from similarity of style and language between Galatians and Romans, but undoubted resemblance of language between two writings does not of necessity involve any certain inference as to date (Sanday and Headlam, *Romans*, xxxviii.). Sieffert (Meyer's *Kommentar*, 1899) follows most Continental critics, placing Galatians first in the second group, but, as an upholder of the North Galatian theory, in the third journey, at Ephesus, 54–55. There is no reason, he argues, for assigning a later date because of the developed teaching on justification, since the essential features of that doctrine belong so inseparably to the foundations of Paul's Gentile Gospel that they must have been early fixed, and would find at different times a kindred representation. It is not surprising that Harnack should find it impossible to assign any date precisely; see further Hastings, *B. D.*, "Galatians." Halmel (1895) stands almost alone in supporting the view, once widely held, that Galatians was written in Rome, or elsewhere in Italy, because of the terms of Roman law. But Sieffert (p. 24) points out that in the Roman provinces there were numbers of Roman citizens, and the Roman legal rights would be widely known amongst other provincials; and still more strikingly Ramsay maintains that the peculiar legal procedures are applicable to South Galatian cities of the first missionary journey, in which Seleucid and Greek law, not Roman law, prevailed (*Galatians*, p. 370).

In group 3 Philippians is now often placed last (first, by Lightfoot). Ramsay maintains that Paul's trial had begun, and favourably; hence the undercurrent of hope and eagerness for the issue (*St Paul*, 357). From this standpoint Mommsen's interpretation of i. 13 as the supreme imperial court carries weight: before these judges Paul had appeared, his bonds became manifest in Christ, sympathy was awakened, inasmuch as he is no longer regarded as a dangerous seditious leader, a sympathy corroborated perhaps by the greetings, iv. 22.

In i. 7 two legal terms afford confirmatory evidence, ἀπολογία, βεβαίωσις, whilst i. 14 (Job xiii. 6, LXX.) indicates speedy deliverance from imprisonment (Zahn, *Einleitung*, i. 380, although differing from Mommsen; Kennedy, *Expository Times*, 1898; R. R. Smith, *Epistle of the Trial*, 1899; Belser, *Einleitung*, p. 570, 1901).

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(*c*) With regard to the *contents* of these Epistles, recent criticism strengthens the subtle but undesigned coincidences with Acts. In group 1, topics referred to in Thessalonian Epistles may well have given colour to the charge of proclaiming "another Emperor," Acts xvii. 7, in Thessalonica (Findlay, *Paul;* Hastings, *B. D.*, and, further, McGiffert, *Apostolic Age*, 246). In *Commentary on Galatians*, p. 399, Ramsay strikingly enumerates many coincidences between this Epistle and the address at Pisidian Antioch, Acts xiii., and thus affords additional support to the South Galatian theory. The stress laid upon the collection for the saints, so marked in these Epistles of group 2, and the fuller recognition of its importance in creating a deeper sense of Church unity, give fresh vividness to Paley's argument from undesigned coincidences, Acts xxiv. 7, Romans xv. 25 ff.; whilst the tone of apprehension with which Paul regarded his final visit to Jerusalem fitly agrees with the sense of danger, Romans xv. 30, 31 (also emphasized by Paley) (Hort, *Proleg. to Romans*, 42; Ramsay, *u.s.* 459; Rendall, *Expositor*, 1893).

In connexion with the great (circular) Epistle of group 3, Ephesians, Paley remarked that we cannot expect many agreements with Acts, but if Ephesians was addressed to various Churches, a strong tradition makes Ephesus one of them, and resemblances between Paul's address of Miletus and the phraseology of Ephesians may not unfairly help to confirm this tradition (Lock, *Ephesians;* Hastings, *B. D.*).

These writings supply another evidential argument from their corroborative witness to facts and teaching of the Gospels, as also from the knowledge of these facts which they presuppose in their readers (Zahn, *Einleitung*, ii. 158, 166; Uhlhorn, *Das Leben Jesu in seinen neueren Darstellungen*, p. 113; Drescher, *Das Leben Jesu bei Paulus*, 1900; for literature, Findlay, *Paul;* Hastings, *B. D.*).

If we confine ourselves to those Epistles which we claim as authentic, and if we take the earliest, *e.g.*, 1 Thessalonians or Galatians, this testimony is forthcoming—a testimony which can be further traced through each of the four groups—Zahn, *u.s.*; *e.g.*, 1 Thessalonians i. 10; ii. 15, 19; iii. 13; iv. 2, 16; v. 1–5, 23; and especially Zahn, *u.s.*, p. 159; Galatians, i. 1, 4, 17–19; ii. 9, 20; iii. 1, 13; iv. 4, 6; v. 24; vi. 2; and for evidence of probable Johannine tradition, P. Ewald, *Hauptproblem der Evangelienfrage*, pp. 84–94.

The Epistles thus constitute "a fifth Gospel," and it is not surprising that even Pfleiderer acknowledges that the Apostle's work would be a castle in the clouds without some historical data of the personal life of Jesus.

Moreover, Dr Sanday has forcibly urged that the teaching of Paul, a Jewish monotheist, as to our Lord's relation to the Father in 1 and 2 Thessalonians is best explained by believing that behind it lay the knowledge of teaching of Jesus in the Gospels (Hastings, *B. D.*, "Jesus Christ"). But this may also be said of the Galatian Epistle, cf. 1, 2 Corinthians; *e.g.*, Galatians i. 1, 3; ii. 20; iv. 4; 1 Corinthians viii. 6; 2 Corinthians xiii. 14, to say nothing of others. Thus, whilst the doctrine of the divine Person of Christ received in later Epistles its greatest prominence —as, *e.g.*, Colossians i. 18—in answer to the angel-worship of false Jewish teaching, and whilst the language of Hellenism may have enabled Paul to give adequate expression to his thoughts, the doctrine itself "had underlain all his teaching and each earlier Epistle" (Hicks, *Studia Biblica*, iv. 10).

Another point emphasized by recent criticism is the naturalness, the conventionality of these Epistles; *i.e.*, not merely the directness and simplicity with which the writer passes, as in Colossians and Ephesians, from highest doctrinal themes to commonest relationships of life, but the "manner of men" which he adopts in phraseology, salutations, prayers. The instances in Deissmann, *Bibelstudien*, i. 210–216 (cf. *Neue Bibelstudien*, 65, 76–84), afford parallels and illustrations to each of the four groups—*e.g.*, the unceasing mention of Paul's converts in his prayers: 1 Thessalonians i. 2; Romans i. 9; Philemon, v. 1; Ephesians i. 6; 2 Timothy i. 3, has an interesting parallel in an Egyptian letter (172 B.C.), οἱ εν οἴκῳ πάντες σου διαπαντὸς μνείαν ποιούμενοι ("all at home make constant mention of you"), especially as the context mentions constant prayer to the gods. The simplest letters, moreover, took in earliest times the form of conversation between people separated, and hence the possibility of restoring a lost letter, to which we have a reply in some extant epistle, by noting the conversational elements which have been incorporated in the answer. This possibility has been skilfully maintained by Dr Rendel Harris with reference to 1 Thessalonians (*Expositor*, September 1898), with which we may compare Dr Lock's valuable contribution to *Expositor* (July 1897), in which he explains how many passages of St Paul's Epistles—*e.g.*, in 1 and 2 Corinthians—are best understood by supposing that he had before him the actual words, written perhaps, or at least employed, by his opponents in taunt, question, argument, and that the phrase so used is caught up, as it were, by the Apostle in his reply, according to the common custom of letter-writers; cf. a similar suggestion, Ramsay, *Galatians*, p. 462; Findlay, *Expositor* (June 1900). Such traits do not render Paul's letters weak or contemptible, like his presence and speech in the estimation of his foes; rather do they help to confer a power and a charm which make them known and read of all men.[1]

(R. J. K*.)

[1] With regard to attempts to break up 2 Corinthians, it cannot be said that they have proved successful (see Sanday, *Encycl. Bibl.* i., "Corinthians" (1899); Jülicher, *Einleitung*, p. 43 ff., who also pronounces in favour of the integrity of the Epistle, and even against the hypothesis of *Vierkapitel Brief*, x.–xiii. or x. 1–xiii. 10, as a separate letter). Dr J. H. Kennedy's articles (*Expositor*, September, October 1897) and Mr White's reply in favour of the integrity of 2 Corinthians, February 1898, should also be consulted. See further Schmiedel, *Theol. Rundschau*, 12, 1901.

Pavia, capital of the province of the same name, Lombardy, Italy, 18 miles south of Milan by rail. The population remained stationary during the last thirty years of the 19th century, since its increase from 34,614 in December 1871 to 36,107 in December 1899 was due to the inclusion of part of the commune of Mirabello in 1883. In consequence of this change the area, previously less than 700 acres, was increased to nearly 7000 acres. Having in 1872 ceased to be a fortress, the fortifications were ceded to the commune in 1876, and the bastions have been gradually transformed into boulevards and public gardens. Inside the city, changes have been limited to partial straightening of old streets and the construction of some new ones, and to the arrangement of public squares in front of the Castle, the Municipal Palace, and other sites. Among the public buildings may be mentioned the Palazzo Mezzabarba, converted into the Municipal Palace; the Prefecture, enlarged and rebuilt; the covered market, with post, telegraph and telephone offices; the new people's agricultural bank; and the public slaughter-house. The University, founded in 1361, has been increased by the addition of schools of general chemistry, pharmaceutical chemistry, physiology, and by the foundation of chairs of pathological anatomy, histology, legal medicine and hygiene, while in the old University building the geological, palæontological, and mineralogical collections have been enlarged. The number of students in 1899–1900 was 1308, of whom 503 were inscribed in the faculty of medicine. The buildings devoted to secondary education and technical instruction have been enlarged and improved. In 1881 a new cemetery was laid out and the old cemetery of Borgo Ticino suppressed. For the promotion of athletics a rifle club, a gymnastic hall, and several boating clubs have been established. In 1884 a monument was erected to Garibaldi, and in 1900 another monument to the Cairoli family. The communal fine arts museum has been enlarged and reorganized to make room for numismatic, archæological, and natural history departments. The cathedral, begun at the end of 1500, has been crowned with a cupola and the façade begun. The old basilicas of S. Michele Maggiore, S. Pietro in Ciel d'Oro, and S. Teodoro have been restored and isolated. Since 1880 there has been a considerable increase in iron foundries, military engineering works, and electrical production works. In addition, numerous cement factories, factories of antiseptic preparations, and establishments for rearing silk-worms have been founded.

Pavia y Albuquerque, Manuel (1828–1895), Spanish general, was born at Cadiz on 2nd August 1828. He was the son of Admiral Pavia, a naval officer of some note in the early part of the 19th century. He entered the Royal Artillery College at Segovia in 1841; became a lieutenant in 1846, a captain in 1855, and major in 1862. Three years later he joined the staff of Marshal Prim, and was his devoted follower during the last years of Isabella's reign, when Prim was the moving spirit of the Progressist party. Pavia took part in the two unsuccessful revolutionary movements concerted by Prim in 1866, and, after two years of exile, in the successful revolution of 1868. Prim employed him in high commands, in which Pavia showed much vigour against the republican risings in the southern provinces; the governments of King Amadeus of Savoy, from 1871 to 1873, also showed him much favour. After the abdication of that prince, General Pavia was called upon by the short-lived cabinets of the federal republic to lead their armies first against the Carlists and then against the cantonal insurrections of the chief towns of the south, which he quelled with great energy. On three occasions during the eventful year 1873, as captain-general of Madrid, he frankly offered his services to the governments of the day to put an end to the anarchy that was raging in the provinces and to the disorganization prevalent in the Cortes. To all he used the same arguments, namely, that they had to choose between an Alphonsist restoration or a dictatorial, military, and political republic, which would rally round its standard all the most Conservative groups that had made the revolution of 1868. This he hoped to realize with Castelar, but the plan was interrupted by the military *pronunciamiento* for the purpose of dissolving the Cortes of 1873. As soon as the federal Cortes had defeated Castelar, Pavia made his *coup d'état* of 3rd January 1874, for which he had, on his own confession in his memoirs, prepared the garrison of Madrid under his command, with the assent of all the leaders of the army in the provinces. After his *pronunciamiento*, Pavia was absolute master of the situation, and might have played the part of a Cromwell, Prim, or Monk. Having no personal ambition, he sent for Marshal Serrano to form a government with Sagasta, Martos, Ulloa, and other Conservatives and Radicals of the revolution. From that moment Pavia carefully abstained from taking an active part in politics; but he sat in the Cortes of the Restoration several times, and once in a famous retrospective debate he defended himself skilfully against no less an orator than Emilio Castelar, who upbraided him for the part he had played on 3rd January 1874. He died suddenly on 4th January 1895, at the age of sixty-seven. (A. E. H.)

Pavlodar, a town of Asiatic Russia, in the province and 225 miles north-west of the town of Semipalatinsk, 259 miles south-east of Omsk railway station, on the right bank of the Irtysh. It has regular steamer communication with the Ob and Irtysh ports, and is a centre for trade with the Kirghiz, who exchange animals and animal products for grain, flour, and manufactured goods. Population (1897), 7730.

Pavlovo, an industrial town of Russia, in the government and 40 miles south-west of the town of Nijni-Novgorod, on the Oka river. It is the centre of a considerable cutlery, hardware, and locksmith trade, which, carried on in cottages and small workshops, engages, besides Pavlovo itself, no less than 119 villages, and the output of which reaches an annual value of over £200,000. There are also steel works and match factories. Pavlovo is well provided with schools, and has a museum of cutlery models and a library. Population (1897), 12,200.

Pavlovskiy Posad, or Vokhna, a town of Russia, in the government and 42 miles by rail east of the town of Moscow, on the Klyazma river. It is the centre of an important manufacturing district, comprising woollen mills, and dyeing and printing works, turning out goods to the value of £111,300 annually. Population (1897), 10,020.

Pawnbroking.—If we desire to trace with minuteness the history of pawnbroking, we must go back to the earliest ages of the world, since the business of lending money on portable security is one of the most ancient of human occupations. Even in the remote ages when the Old Testament was being written, the practice was already familiar, although it was hardly regarded with a benevolent eye. "If a man be poor, thou shalt not sleep with his pledge," says the Pentateuch; "and if thou at all take his raiment to pledge, thou shalt deliver it to him by that the sun goeth down . . . that he may sleep in his own raiment, and bless thee." No man might take the upper or the nether millstone in pawn, since that was equivalent to taking a man's life in pledge.

History.

Nor might the widow's ox be taken. The Mosaic Law struck at the root of pawnbroking as a profitable business, since it forbade the taking of interest from a poor borrower, while no Jew was to pay another for timely accommodation. And it is curious to reflect that, although the Jew was the almost universal usurer and money-lender upon security of the Middle Ages, it is now very rare in Great Britain to find a Hebrew pawnbroker.

In China, which was venerable before most of the rest of the world had learned the elements of civilization, the pawnshop was probably as familiar two or three thousand years ago as it is to-day, and its conduct is still regulated quite as strictly as in England. The Chinese conditions, too, are decidedly favourable to the borrower. He may, as a rule, take three years to redeem his property, and he cannot be charged a higher rate than 3 per cent. per annum—a regulation which would close every pawnshop in England in a month. Both Rome and Greece were as familiar with the operation of pawning as the modern poor all the world over; indeed, from the Roman jurisprudence most of the contemporary law on the subject is derived. The chief difference between Roman and English law is that under the former certain things, such as wearing apparel, furniture, and instruments of tillage, could not be pledged, whereas there is no such restriction in English legislation. The Emperor Augustus was himself an illustrious pawnbroker. He converted the surplus arising to the State from the confiscated property of criminals into a fund from which sums of money were lent, without interest, to those who could pledge valuables equal to double the amount borrowed. It was, indeed, in Italy, and in more modern times, that the pledge system which is now almost universal on the continent of Europe arose. In its origin that system was purely benevolent, the early *Monts de Piété* established by the authority of the Popes lending money to the poor only, without interest, on the sole condition of the advances being covered by the value of the pledges. This was virtually the Augustan system, but it is obvious that an institution which costs money to manage and derives no income from its operations must either limit its usefulness to the extent of the voluntary support it can command, or must come to a speedy end. This is probably the explanation of the failure of some very early attempts to establish charitable pawnshops. Thus as early as 1198 something of the kind was started at Freising in Bavaria; while in 1350 a similar endeavour was made at Salins in Franche Comté, where interest at the rate of $7\frac{1}{2}$ per cent. was charged. Nor was England backward, for in 1361 Michael Northbury, or de Northborough, bishop of London, bequeathed 1000 silver marks for the establishment of a free pawnshop. These primitive efforts, like the later Italian ones, all failed. The Vatican was therefore constrained to allow the Sacri Monti di Pietà—no satisfactory derivation of the phrase has yet been suggested—to charge sufficient interest to their customers to enable them to defray expenses. Thereupon a learned and tedious controversy arose upon the lawfulness of charging interest. In time it died away, extinguished by its own futility, but about the beginning of the 16th century it was revived, and was only finally set at rest by the issue of a papal bull. By that document Pope Leo X., in the tenth sitting of the Council of the Lateran, declared that the pawnshop was a lawful and valuable institution, and threatened with excommunication those who should presume to express doubts on the subject. The Council of Trent inferentially confirmed this decision, and at a somewhat later date we find St Charles Borromeo counselling the establishment of State or municipal pawnshops.

The pledge system.

Long before this, however, Monti di Pietà charging interest for their loans had become common in Italy. The precise date of their establishment is not clear, but it is certain that it was not later than 1464, when the earliest of which there appears to be any record in that country—it was at Orvieto—was confirmed by Pius II. Three years later another was opened at Perugia by the efforts of two Franciscans, Barnabus Interamnensis and Fortunatus de Copolis. The one had been a physician and the other a lawyer, and both had gone to the cloister late in life. They collected the necessary capital by preaching, and the Perugian pawnshop was opened with such success that there was a substantial balance of profit at the end of the first year. The Dominicans, who were perhaps jealous of the Franciscans, endeavoured to preach down the "lending-house," but without avail, and others were established in rapid succession. Thus Viterbo obtained one in 1469, and Sixtus IV. confirmed another to his native town of Savona in 1479. After the death of Brother Barnabus in 1474, a strong impulse was given to the creation of these establishments by the preaching of another Franciscan, Father Bernandino di Feltre, who was in due course canonized. By his efforts Monti di Pietà were opened at Assisi, Mantua, Parma, Lucca, Piacenza, Padua, Vicenza, Pavia, and a number of places of less importance. At Florence the veiled opposition of the municipality and the open hostility of the Jews prevailed against him, and it was reserved to Savonarola, who was a Dominican, to create the first Florentine pawnshop, after the local theologians had declared that there was "no sin, even venial," in charging interest. The activity of the Church in this matter, and the readiness of the Popes to give permission for pawnshops all over Italy, make it the more remarkable that the papal capital itself possessed nothing of the kind until 1539, and that even then Rome, like so many other cities, owed the convenience to the exertions of a Franciscan. The Naples establishment, opened about the same year, became famous in time as not only the largest in Europe, but as containing a larger accumulation of valuable articles than any other. From Italy the pawnshop spread gradually all over Europe. Augsburg adopted the system in 1591, Nuremberg copied the Augsburg regulations in 1618, and by 1622 it was established at Amsterdam, Brussels, Antwerp, and Ghent. Madrid followed suit in 1705, when a priest opened a charitable pawnshop with a capital of fivepence taken from an alms-box.

Italian Monti di Pietà.

The institution was, however, very slow in obtaining a footing in France. It was adopted at Avignon in 1577, and at Arras in 1624. The doctors of the once powerful Sorbonne could not, despite the action of the Popes, reconcile themselves to the idea of the lawfulness of interest, and when a pawnshop was opened in Paris in 1626, it had to be closed within a year. Then it was that Jean Boucher published his *Défense des Monts de Piété.* Marseilles obtained one in 1695; but it was not until 1777, after the idea had been pressed upon the Government for more than a century, that the first Mont de Piété was founded in Paris by royal patent, to the great satisfaction of M. Necker. The statistics which have been preserved relative to the business done in the first few years of its existence show that it was resorted to by a much better class than that from which most pawnshops now draw their customers. In the twelve years between 1777 and the Revolution, the average value of the pledges was 42 francs 50 centimes, which is double the present average. The interest charged was 10 per cent. per annum, and large profits were made upon the sixteen million livres that were lent every year. The National Assembly, in an evil moment, destroyed the monopoly of the Mont de Piété, but it struggled on until 1795, when the competition of the money-lenders compelled it to close its doors. So great, however, were the extortions of the usurers that the people began to clamour for its reopening, and in July 1797 it recommenced business with a fund of £20,000 found by five private capitalists. At first it charged interest at the rate of 36 per cent. per annum, which was gradually reduced, the gradations being 30, 24, 18, 15, and finally 12 per cent. in 1804. In 1806 it fell to 9 per cent., and in 1887 to its present level of 7 per cent. In 1806 Napoleon I. re-established its monopoly, while Napoleon III., as Prince-President, regulated it by new laws that are still in force. In Paris the pledge-shop is, in effect, a department of the Administration; in the French provinces it is a municipal monopoly; and this remark holds good, with modifications, for most parts of the continent of Europe.

Introduction in France.

In England the pawnbroker, like so many other distinguished personages, "came in with the Conqueror." From that time, indeed, to the famous legislation of Edward I., the Jew money-lender, who as often as not advanced money upon the security of valuable property which passed into his temporary possession pending its redemption, was the only pawnbroker. Yet, despite the valuable services which the class rendered, not infrequently to the Crown itself, it is matter of familiar history that the usurer was treated with studied cruelty—Sir Walter Scott's Isaac of York was no mere creation of fiction. These barbarities, by diminishing the number of Jews in the country, had, long before Edward's decree of banishment, begun to make it worth the while of the Lombard merchants to settle in England. It is now as well established as anything of the kind can be that the three golden balls, which have for so long been the trade sign of the pawnbroker, were the symbol which these Lombard merchants hung up in front of their houses, and not, as has often been suggested, the arms of the Medici family. It has, indeed, been conjectured that the golden balls were originally three flat yellow effigies of byzants, or gold coins, laid heraldically upon a sable field, but that they were presently converted into balls the better to attract attention. That these sharp, and not always very scrupulous, men of business from the South did actually advance money on pledges can hardly be questioned when we remember that in 1338 Edward III.

Great Britain.

pawned his jewels to the Lombards to raise money for his war with France. An equally great king—Henry V.—did much the same in 1415. It has indeed been said, with no great touch of extravagance, that both Creçy and Agincourt owed something to the pawnbroker.

The Lombards were not a popular class, and Henry VII. harried them a good deal. But, whatever parliaments and kings might enact, usury and broking went on clandestinely when the business was too perilous to be conducted openly, and it would appear that the principal City companies were not above acting as pawnbrokers. By the time Bacon wrote his essay on *Usury* a juster estimate of the subject had begun to prevail. "Brokers of pawn" were, however, still regarded as the lineal business descendants of the 14th-century Jew usurers and the unpopular Lombards, and in the very first year of James I. "An Act against Brokers" was passed and remained on the statute-book until Queen Victoria had been thirty-five years on the throne. It was aimed at "counterfeit brokers," of whom there were then many in London. They were described as men of "manual occupations and handicraftsmen," and were denounced for having "set up a trade of buying and selling and taking in pawn of all kinds of wearing apparel, household stuff, and goods of all kinds soever, finding thereby that the same is a more idle and easier kind of trade and living, and that there ariseth and groweth to them a more ready, more great, more profitable, and speedier advantage and gain than by their former manual labours." This type of broker was evidently regarded as a mere receiver of stolen goods, for the Act provided that "no sale or pawn of any stolen jewels, plate, or other goods, to any pawnbroker in London, Westminster, or Southwark, shall alter the property therein," and that "pawnbrokers refusing to produce goods to their owner from whom stolen shall forfeit double the value."

In the time of Charles I. there was another Act which made it quite clear that the pawnbroker was not deemed to be a very respectable or trustworthy person. Nevertheless a plan was mooted for setting that king up in the business. The Civil War was approaching and supplies were badly needed, when a too ingenious Royalist proposed the establishment of a State "pawnhouse." The preamble of the scheme recited how "the intolerable injuries done to the poore subjects by brokers and usurers that take 30, 40, 50, 60, and more in the hundredth, may be remedied and redressed, the poor thereby greatly relieved and eased, and His Majestie much benefited." That the king would have been "much benefited" is obvious, since he was to enjoy two-thirds of the profits, while the working capital of £100,000 was to be found by the City of London. The reform of what Shakespeare calls "broking pawn" was in the air at that time, although nothing ever came of it, and in the early days of the Commonwealth it was proposed to establish a kind of Mont de Piété. The idea was emphasized in a pamphlet of 1651 entitled *Observations manifesting the Conveniency and Commodity of Mount Pieteyes, or Public Bancks for Relief of the Poor or Others in Distress, upon Pawns.* No doubt many a ruined Cavalier would have been glad enough of some such means of raising money, but this radical change in the principles of English pawnbroking was never brought about. It is said that the Bank of England, under its charter, has power to establish pawnshops; and we learn from *A Short History of the Bank of England,* published in its very early days, that it was the intention of the directors, "for the ease of the poor," to institute "a Lombard" "for small pawns at a penny a pound interest per month."

Throughout both the 17th and 18th centuries the general suspicion of the pawnbroker appears to have been only too well founded. It would appear from the references Fielding makes to the subject in *Amelia,* which was written when George II. was on the throne, that, taken in the mass, he was not a very scrupulous tradesman. The householder, whose stolen property had been pledged much below its value, appeals to the justice for some penalty on the pawnbroker, "who plainly appears to have known that these goods were stolen"; and he adds, "The shops of these fellows are, indeed, the fountains of theft." Down to about that time it had been customary for publicans to lend money on pledges that their customers might have the means of drinking, but the practice was at last stopped by Act of Parliament. Nor was respect for the honesty of the business increased by the attempt of "The Charitable Corporation" to conduct pawnbroking on a large scale. Established by charter in 1707, "this nefarious corporation," as Smollett called it, was a swindle on a large scale. Its ostensible object was benevolence—it would lend money at legal interest to the poor upon the smallest pledges. The capital was £30,000, which before long was increased to £600,000. With an office in the City and another at the West End, the undertaking was an almost immediate success for the promoters; but there was no attempt at circumspection in the conduct of the business, and the facilities which it offered for the disposal of stolen goods were far greater than had ever been reproached against the private broker. The directors gambled wildly with the shareholders' money, and in the end the Common Council of the City of London petitioned Parliament for the dissolution of this dishonest concern, on the ground that "the corporation, by affording an easy method of raising money upon valuables, furnishes the thief and pickpocket with a better opportunity of selling their stolen goods, and enables an intending bankrupt to dispose of the goods he buys on credit for ready money, to the defrauding of his creditors." Yet the corporation had managed to keep its doors open for a good many years, and was, as is not unusual with such schemes, officered by persons of the greatest outward respectability. When the concern collapsed in 1731 its cashier was Mr George Robinson, M.P. for Marlow. In company with another principal official he disappeared, less than £30,000 being left of a capital which had once been twenty times as much.

Modern regulations in England.

The pawnbroker's licence dates from 1785, the duty being fixed at £10 in London and £5 in the country; and at the same time the interest chargeable was settled at $\frac{1}{2}$ per cent. per month, the duration of loans being confined to one year. Five years later the interest on advances over £2 and under £10 was raised to 15 per cent. The modern history of legislation affecting pawnbroking begins, however, in 1800, when the Act of 39 and 40 George III. c. 99 was passed, in great measure by the influence of Lord Eldon, who never made any secret of the fact that, when he was a young barrister without briefs, he had often been indebted to the timely aid of the pawnshop. The pawnbrokers were grateful, and for many years after Lord Eldon's death they continued to drink his health at their trade dinners. The measure treated the broker a good deal less like an outcast and a potential criminal than the legislation of the previous two centuries, but it was far from being a liberal enactment. It increased the rate of interest to a halfpenny per half-crown per month, or fourpence in the pound per mensem—that is to say, 20 per cent. per annum. Loans were to be granted for a year, although pledges might be redeemed up to fifteen months, and the first week of the second month was not to count for interest. The Act worked well, on the whole, for three-quarters of a century, but it was thrice found necessary to amend it. Thus in 1815 the licence duties were raised to £15 and £7, 10s. for London and the country respectively; another Act of 1840 abolished the reward to the "common informer" for reporting illegal rates of interest; while in 1860 the pawnbroker was empowered to charge a halfpenny for the pawn-ticket when the loan was under five shillings. As time went on, however, the main provisions of the Act of 1800 were found to be very irksome, and the Pawnbrokers' National Association and the Pawnbrokers' Defence Association worked hard to obtain a liberal revision of the law. It was argued that the usury laws had been abolished for the whole of the community with the single exception of the pawnbroker who advanced less than £10. The limitations of the Act of 1800 interfered so considerably with the pawnbrokers' profits that, it was argued, they could not afford to lend money on bulky articles requiring extensive storage room. So many books and documents and official forms had to be filled up that an undue amount of clerical assistance was required, and the profit upon short pledges was so small that he was only able to keep his shutters down by what he could make on those for longer terms. Yet, however seriously the old law may have checked the prosperity of the lender, it was evidently no deterrent to borrowers. In 1870 the House of Commons appointed a Select Committee on Pawnbrokers, and it was stated in evidence before that body that in the previous year 207,780,000 pledges were lodged, of which between thirty and forty millions were lodged in London. The average value of pledges appeared to be about 4s., and the proportion of articles pawned dishonestly was found to be only 1 in 14,000. More recent official statistics show that of the forfeited pledges sold in London less than 20 per million are claimed by the police. Another interesting fact brought out in the inquiry of 1870 was that, contrary to the popular belief, the profits of the pawnbroker were small, rarely indeed exceeding 6 per cent.

The result of the Select Committee was the Pawnbrokers Act of 1872, which repealed, altered, and consolidated all previous legislation on the subject, and is still the measure which regulates the relations between the public and the "brokers of pawn." Based mainly upon the Irish law passed by the Union Parliament, it put an end to the old irritating restrictions, and reduced the annual tax in London from £15 to the £7, 10s. paid in the provinces. By the provisions of the Act (which does not affect loans above £10), a pledge is redeemable within one year, and seven days of grace added to the year. Pledges pawned for 10s. or under and not redeemed in time become the property of the pawnbroker, but pledges above 10s. are redeemable until sale, which must be by public auction. In addition to one halfpenny for the pawn-ticket—which is sometimes not charged for very small pawns—the pawnbroker is entitled to charge as interest one halfpenny per month on every 2s. or part of 2s. lent where the loan is under 40s., and on every 2s. 6d. where the loan is above 40s. "Special contracts" may be made where the loan is above 40s., at a rate of interest agreed upon between lender and borrower. Unlawful pawning of goods not the property of the pawner, and taking in pawn any article from a person under the age of twelve, or intoxicated, or any linen, or apparel, or unfinished goods or materials entrusted to wash, make up, &c., are (*inter alia*) made offences punishable by summary conviction. A new pawnbroker must produce a magistrate's certificate before he can receive a licence; but the permit cannot be refused if the applicant gives sufficient evidence that he is a person of good character. The word "Pawnbroker" must always be inscribed in large letters over the door of the shop. Elaborate provisions are made to safeguard the interests of borrowers whose unredeemed pledges are sold under the Act. Thus the sales by auction may take place only on the first Monday of January, April, July, and October, and on the following days should one not be sufficient. This legislation was, no doubt, favourable to the pawnbroker rather than to the borrower. The annual interest on loans of 2s. had been increased by successive Acts of Parliament from the 6 per cent. at which it stood in 1784 to 25 per cent. in 1800, and to 27 in 1860—a rate which was continued by the measure of 1872. The annual interest upon a loan of half-a-crown is now 260 per cent., as compared with 173 in 1860 and 86 in 1784; while the extreme point is reached in the case of a loan of 1s. for three days, in which case the interest is at the rate of 1014 per cent. per annum. It must be remembered, however, that it has always been contended by the pawnbrokers that under the old arrangement there was no profit at all upon the small transactions, in which the bulk of their business consists. The foreign Mont de Piété often disposes of this difficulty in a manner not possible to the English trader, by refusing to advance very small sums. It thus retains the profitable work, while rejecting that which is unremunerative. An English Mont de Piété was once projected by the Salvation Army, and in 1894 the London County Council considered the practicability of municipal effort on similar lines; but in neither case was anything done.

Scotland and Ireland.

The growth of pawnbroking in Scotland, where the law as to pledge agrees generally with that of England, is remarkable. Early in the 19th century there was only one pawnbroker in that country, and in 1833 the number reached only 52. Even in 1865 there were no more than 312. It is probable that at the present moment Glasgow and Edinburgh together contain nearly as many as that total. There was a time, however, when the second city of the Empire supported an enormous number of illegitimate pawnbrokers. Thus in 1840 there were known to be some 700 "leaving shops," advancing money chiefly upon objects of exceedingly small value, and charging, as usual with such contraband places—which are still numerous in great towns, and especially in the poor districts of London—interest at the rate of 400 or 500 per cent. per annum. In Ireland the rates for loans are practically identical with those charged in England, but a penny instead of a halfpenny is paid for the ticket. Articles pledged for less than £1 must be redeemed within six months, but nine months are allowed when the amount is between 30s. and £2. For sums over £2 the period is a year, as in England. In Ireland, too, a fraction of a month is calculated as a full month for purposes of interest, whereas in England, after the first month, fortnights are recognized. In 1838 there was an endeavour to establish Monts de Piété in Ireland, but the mistake was made of opening establishments in small towns and ignoring large ones, and the scheme was so unsuccessful that in 1841 the eight charitable pawnshops that had been opened had a total adverse balance of £5340. By 1847 only three were left, and eventually they collapsed likewise.

United States.

The pawnbroker in the United States is, generally speaking, controlled very stringently. There are no federal laws on the subject, each state having its own regulations, but those of New York and Massachusetts may be taken as fairly representative. "Brokers of pawn" are usually licensed by the mayors, or by the mayors and aldermen, but in Boston the police commissioners are the licensing authority. In the state of New York permits are renewable annually on payment of $500, and the pawnbroker must file a bond with the mayor, executed by himself and two responsible sureties, in the sum of $10,000. The business is conducted on much the same lines as in England, and the rate of interest is 3 per cent. per month for the first six months, and 2 per cent. monthly afterwards. Where, however, the loan exceeds 100 dollars, the rates are 2 and 1 per cent. respectively. To exact higher rates is a misdemeanour. Unredeemed pledges may be sold at the end of a year. Pawnbrokers are not allowed to engage in any kind of second-hand business. New York contains one pawnshop to every 12,000 inhabitants, and most of the pawnbrokers are Jews. In the state of Massachusetts unredeemed pledges may be sold four months after the date of deposit. The licensing authority may fix the rate of interest, which may vary for different amounts, and in Boston every pawnbroker is bound to furnish to the police daily a list of the pledges taken in during the preceding twenty-four hours, specifying the hour of each transaction and the amount lent.

Municipal pawnshops.

The fact that on the continent of Europe Monts de Piété are almost invariably either a State or a municipal monopoly necessarily places them upon an entirely different footing from the British pawnshop, which, as we have seen, any respectable person is at liberty to open. It has often been argued that the foreign system might be introduced into England with advantage. Indeed, unsuccessful attempts have been made to introduce it; but, compared with the English system, it is very elaborate and rather cumbersome. Moreover, in addition to being slow in its operation, it is, generally speaking, based upon the supposition that the borrower carries in his pocket "papers" testifying to his identity. On the other hand, it is argued that the English borrower of more than £2 is at the mercy of the pawnbroker in the matter of interest, that sum being the highest for which a legal limit of interest is fixed. The rate of interest upon a "special contract" may be, and often is, high. For the matter of that, indeed, this system of obtaining loans is always expensive, either in actual interest or in collateral disadvantages, whether the lender be a pawnbroker intent upon profit, or the official of a Mont de Piété. In Paris the rate charged is 7 per cent., and even then the business is conducted at a loss except in regard to long and valuable pledges. Some of the French provincial rates are as high as 12 per cent., but in almost every case they are less than they were prior to the legislation of 1851 and 1852. The French establishments can only be created by decree of the President of the Republic, with the consent of the local Conseil Communal. In Paris the prefect of the Seine presides over the business; in the provinces the mayor is the president. The administrative council is drawn one-third each from the Conseil Communal, the governors of charitable societies, and the townspeople. A large proportion of the capital required for conducting the institutions has to be raised by loan, while some part of the property they possess is the product of gifts and legacies. The profits of the Paris Mont de Piété are paid over to the "Assistance Publique," the comprehensive term used by France to indicate the body of charitable foundations. Originally this was the rule throughout France, but now many of them are entirely independent of the charitable institutions. Counting the head office, the branches, and the auxiliary shops, the Paris establishment has its doors open in some fifty or sixty districts; but the volume of its annual business is infinitely smaller than that transacted by the London pawnbrokers. This may be the result of the system, or it may be explained by the thriftier character of the French people—while something must of course be allowed for smaller population. The amount to be advanced by a municipal pawnshop is fixed by an official called the *commissaire-priseur*, who is compelled to load the scales against the borrower, since, should the pledge remain unredeemed, and be sold for less than was lent upon it, he has to make good the difference. This official is paid at the rate of ½ per cent. upon loans and renewals, and 3 per cent. on the amount obtained by the sales of forfeited pledges. This is obviously the weakest part of the French system. The Paris Mont de Piété undertakes to lend four-fifths of the intrinsic value of articles made from the precious metals, and two-thirds of that of other articles. The maximum and minimum that may be advanced are also fixed. The latter varies in different parts of the country from one to three francs, and the former from a very small sum to the 10,000 francs which is the rule in Paris. Loans are granted for twelve months with right of renewal, and unredeemed pledges may then be sold by auction, but the proceeds may be claimed by the borrower at any time within three years. Pledges may be redeemed by instalments.

Somewhere between forty and fifty French towns possess municipal pawnshops, a few of which, like those of Grenoble and Montpellier, having been endowed, charge no interest. Elsewhere the rate varies from *nil* in some towns, for very small pledges, to 10 per cent. The constant tendency throughout France has been to reduce the rate. The great establishment in Paris obtains part of its working capital—reserves and surplus forming the balance—by borrowing money at a rate varying from 2 to 3 per cent. according to the length of time for which the loan is made. Under a law passed in 1891 the Paris Mont de Piété makes advances upon securities at 6 per cent., plus a duty of 5 centimes upon every hundred francs. The maximum that can be lent in this way is £20. Up to 80 per cent. is lent on the face value of Government stock and on its own bonds, and 75 per cent. upon other securities; but 60 per cent. only may be advanced on railway shares. These advances are made for six months. Persons wishing to borrow a larger sum than sixteen francs from the Paris Mont de Piété have to produce their papers of identity. In every case a numbered metal check is given to the customer, and a duplicate is attached to the article itself. The appraising clerks decide upon the sum that can be lent, and the amount is called out with the number. If the borrower is dissatisfied he can take away his property, but if he accepts the offer he has to give full particulars of his name, address, and occupation. The experts calculate that every transaction involving less than twenty-two francs results in a loss to the Paris Mont de Piété, while it is only those exceeding eighty-five francs which can be counted upon to be invariably profitable. The average loan is under thirty francs.

Holland and Belgium.

The borrowing of money on the security of goods deposited has been the subject of minute regulations in the Low Countries from an early date. So far back as the year 1600 the "Archdukes" Albert and Isabella, Governors of the Spanish Netherlands under Philip III., reduced the lawful rate of interest from 32½ to 21⅔ per cent.; but since extortion continued, they introduced the Mont de Piété in 1618, and, as we have already seen, in the course of a dozen years the institution was established in all the populous Belgian towns, with one or two exceptions. The interest chargeable to borrowers was fixed originally at 15 per cent., but was shortly afterwards reduced, to be again increased to nearly the old level. The early history of these offices was chequered; the interest on the stock which had been created to provide working capital could not always be paid, and many changes in management were necessary before a stable equilibrium could be established. Meanwhile various towns possessed charitable funds for gratuitous loans, apart from the official institutions. Shortly after the Mont de Piété was introduced in the Spanish provinces, the prince-bishop of Liége (Ferdinand of Bavaria) followed the example set by the archdukes. He ordained that the net profits were to accumulate, and the interest upon the fund to be used in reduction of the charges. The original rate was 15 per cent., when the Lombard money-lenders had been charging 43; but the prince-bishop's Monts de Piété were so successful that for many years their rate of interest did not exceed 5 per cent.—it was, indeed, not until 1788 that it was increased by one-half. These flourishing institutions, along with those in Belgium proper, were ruined by the French Revolution. They were, however, re-established under French dominion, and for many years the laws governing them were constantly altered by the French, Dutch, and Belgian Governments in turn. The whole subject is now regulated by a law of 1848, supplemented by a new constitution for the Brussels Mont de Piété dating from 1891.

The working capital of these official pawnshops is furnished by charitable institutions or the municipalities, but the Brussels one possesses a certain capital of its own in addition. The rate of interest charged in various parts of the country varies from 4 to 16 per cent., but in Brussels it is usually less than half the maximum. The management is very similar to that of the French Monts de Piété, but the arrangements are much more favourable to the borrower. The ordinary limit of loans is £120. In Antwerp there is an "anonymous" pawnshop, where the customer need not give his name or any other particulars. In Holland private pawnbrokers flourish side by side with the municipal "Banken van Leening," nor are there any limitations upon the interest that may be charged. The rules of the official institutions are very similar to those of the Monts de Piété in the Latin countries, and unredeemed pledges are sold publicly fifteen months after being pawned. A large proportion of the advances are made upon gold and diamonds; workmen's tools are not taken in pledge, and the amount lent varies from 8d. upwards. On condition of finding such sum of money as may be required for working capital over and above loans from public institutions, and the "caution money" deposited by the city officials, the municipality receives the profits.

Pawnbroking in Germany is conducted at once by the State, by the municipalities, and by private enterprise; but of all these institutions the State loan office in Berlin is the most interesting. It dates from 1834, and the working capital was found, and still continues to be in part provided, by the Prussian State Bank. The profits are invested, and the interest devoted to charitable purposes. The maximum and minimum rates of interest are fixed, but the rate varies, and often stands at about 12 per cent. Two-thirds of the estimated value is the usual extent of a loan; four-fifths is advanced on silver, and five-sixths on fine gold. State and municipal bonds may be pledged up to a maximum of £150, the advance being 80 per cent. of the value, and a fixed interest of 6 per cent. is charged upon these securities. The values are fixed by professional valuers, who are liable to make good any loss that may result from over-estimation. The bulk of the loans are under £5, and the State office is used less by the poor than by the middle classes. Loans run for six months, but a further six months' grace is allowed for redemption before the article pledged can be sold by auction. The net annual profit usually amounts to little more than 1 per cent. upon the capital employed. The pawnbroking laws of Austria-Hungary are very similar to those which prevail in England. Free trade exists, and the private trader, who does most of the business, has to obtain a Government concession, and deposit caution-money varying in amount from £80 to £800, according to the size of the town. He has, however, to compete with the Monts de Piété or Versatzaemter, which are sometimes municipal and sometimes State institutions. The chief of these is the imperial pawn office of Vienna, which was founded with charitable objects by the Emperor Joseph I. in 1707, and one-half of the annual surplus has still to be paid over to the Vienna poor fund. Here, as in Berlin, the profits are relatively small. Interest is charged at the uniform rate of 10 per cent., which is calculated in fortnightly periods, however speedily redemption may follow upon pawning. For small loans varying from two to three kronen, 5 per cent. only is charged. Many of the poorest clients of the "Lombard merchants" resort to the private pawnbroker, partly because of the high rates of the State office, and partly because it is open only from eight in the morning until two in the afternoon. There is the usual Mont de Piété arrangement of official values. The Hungarian State and municipal institutions appear, on the whole, to compete somewhat more successfully with the private firms than is the case in Vienna.

Germany and Austria.

In Italy, the "country of origin" of the Mont de Piété, the institution still flourishes. It is, as a rule, managed by a committee or commission, and the regulations follow pretty closely the lines of the one in Rome, which never lends less than 10d. or more than £40. Four-fifths of the value is lent upon gold, silver, and jewels, and two-thirds upon other articles. The interest, which is reckoned monthly, varies with the amount of the loan from 5 to 7 per cent., but no interest is chargeable upon loans up to 5 lire. A loan runs for six months, and may be renewed for similar periods up to a maximum of five years. If the renewal does not take place within a fortnight of the expiration of the ticket, the pledge is sold, any surplus there may be being paid to the pawner. When more than 10 lire is lent there is a charge of 1 per cent. for the ticket. Agencies of the Mont de Piété are scattered about Rome, and carry on their business under the same rules as the central office, with the disadvantage to the borrower that he has to pay an "agent's fee" of 2 per cent., which is deducted from the loan. Private pawnshops also exist in Italy, under police authority; but they charge very high interest—sometimes as much as 60 per cent.—and those who conduct them, by buying pawn-tickets, speculate upon the proceeds of the sale of the pledges.

Italy.

The Monts de Piété in Spain have for a generation past been inseparably connected with the savings banks. We have already seen that the institution owes its origin in that country to the charitable exertions of a priest who charged no interest, and the system grew until in 1840, a century after his death, the Mont de Piété began to receive the sums deposited in the savings bank, which had just been established, for which it paid 5 per cent. interest. In 1869 the two institutions were united. This official pawnshop charges 6 per cent. upon advances which run for periods varying from four to twelve months, according to the nature of the article pledged, and a further month's grace is allowed before the pledges are sold by auction. The system has been very successful, and the Mont de Piété has increased its capital without any assistance from public authorities, while enabling the poor to borrow at a reasonable rate. Private pawnbrokers are also very numerous, especially in Madrid; but their usual charges amount to about 60 per cent. per annum. They appear, however, to derive advantage from making larger advances than their official rivals, and from doing business during more convenient hours. In Portugal the Monte Pio is an amalgamation of bank, benefit society, and pawnshop. Its business consists chiefly in lending money upon marketable securities, but it also makes advances upon plate, jewellery, and precious stones, and it employs officially-licensed valuers. The rate of interest varies with the bank rate, which it slightly exceeds, and the amount advanced upon each article is about three-fourths of its certified value. There is in Portugal a second class of loan establishment answering exactly to the English pawnshop. The pawnbroker is licensed and strictly controlled, but this class of business is practically limited to the larger towns. When he starts in business he is compelled to deposit a sum, in acceptable securities, equal to the capital he proposes to embark, and the register of his transactions must be submitted quarterly to the chief of the police for examination. As regards small transactions, there appears to be no legal limit to the rate of interest. The sale of unredeemed pledges is governed by the law affecting the "Monte Pio Geral."

Spain and Portugal.

In Russia the State maintains two pawnbroking establishments, one at St Petersburg and the other at Moscow, but only articles of gold and silver, precious stones, and ingots of the precious metals are accepted by them. Advances are made upon such securities at 6 per cent. per annum, and the amounts of the loans are officially limited. Loans run for twelve months, with a month's grace before unredeemed pledges are put up to auction. The bulk of this class of business in Russia is, however, conducted by private companies, which advance money upon all descriptions of movable property except stocks and shares. The interest charged is not allowed to exceed 1 per cent. per month, but there is an additional charge of ½ per cent. per month for "insurance and safe keeping." The loan runs for a year, with two months' grace for redemption before sale. There are also a certain number of pawnshops conducted by individuals, who find it very difficult to compete with the companies. These shops can only be opened by a police permit, which runs for five years, and security, varying from £100 to £700, has to be deposited. Two per cent. per month is the limit of interest fixed, and two months' grace is allowed for redemption after the period for which an article is pledged.

Russia.

Pawnbroking in Denmark dates from 1753, when the Royal Naval Hospital was granted the monopoly of advancing money on pledges and of charging higher interest than the law permitted. The duration of a loan is three months, renewals being allowed. The old law was extended in 1867, and now all pawnbrokers have to be licensed by the municipalities and to pay a small annual licence fee. The rate of interest varies from 6 to 12 per cent., according to the amount of the loan, which must not be less than 7d., and unredeemed pledges must be sold by auction. In Sweden there are no special statutes affecting pawnbroking, with the exception of a proclamation by the governor of Stockholm prohibiting the lending of money upon articles which may be suspected of having been stolen. Individuals still carry on the business on a small scale, but the bulk of it is now conducted by companies, which give general satisfaction. The change from private pawnbrokers to the companies was caused by the extortionate interest formerly charged, which often amounted to 60 per cent. per annum. For many years there was in Stockholm a municipal establishment charging 10 per cent. for loans paid out of the city funds. The cost of administration was, however, so great that there was an annual loss upon its working, and the opportunity was taken to abolish it when, in 1880, a private company was formed called the "Pant Aktie Bank," to lend money on furniture and wearing apparel at the rate of 3 öre per krona a month, and 2 öre per krona a month on gold, silver, and other valuables: a krona, which equals 1s. 1½d., contains 100 öre. Some years later an opposition was started which charged only half these rates, with the result that the original enterprise reduced its interest to the same level, charging, however, 2 öre per krona per mensem for bulky articles—a figure which is now usual for pledges of that description. The money is lent for three months, and at the end of five months the pledge, if unredeemed, is sold by auction under very carefully prescribed conditions. In Norway a police licence is required for lending money on pawn where the amount advanced does not exceed £4, 10s. Beyond that sum no licence is necessary, but the interest charged must not exceed such a rate as the king may decide.

Denmark and Norway.

The fate of pawnbroking in Switzerland appears to be not very dissimilar from that of the Jew who is fabled to have once started in business at Aberdeen. Nevertheless the cantons of Bern and Zürich have elaborate laws for the regulation of the business. In Zürich the broker must be licensed by the cantonal government, and the permit can be refused only when the applicant is "known to be a person undeserving of confidence." Regular books have to be kept, which must be at all times open to the inspection of the police, and not more than 1 per cent. interest per month must be charged. A loan runs for six months, and unredeemed pledges may be sold by auction a month after the expiration of the fixed period, and then the sale must take place in the parish in which the article was pledged. No more than two persons at a time have ever been licensed under this law, the business being unprofitable owing to the low rate of interest. In the canton of Bern there were once two pawnbrokers. One died and the other put up his shutters. The Zürich cantonal bank, however, conducts a pawnbroking department, which lends nothing under 4s. or over £40 without the special sanction of the bank commission. Loans must not exceed two-thirds of the trade value of the pledge, but 80 per cent. may be lent upon the intrinsic value of gold and silver articles. The establishment makes practically no profit. The Swiss disinclination to go to the pawnshop is, perhaps, accounted for in some measure by the growing number of dealers in second-hand articles, to whom persons in want of ready money sell outright such things as are usually pledged, in the hope of subsequently buying them back. Since, however, the dealer is at liberty to ask his own price for re-purchase, the expectation is often illusory, and can usually be fulfilled only upon ruinous terms. (J. G. J. P.-B.)

Switzerland.

Pawtucket, a city of Providence county, Rhode Island, U.S.A., on the Pawtucket river, four miles north of Providence, and on the New York, New Haven, and Hartford Railroad, in the north-eastern part of the state, at an altitude of 76 feet. The plan of the city is irregular, it is divided into five wards, has a water-supply from works owned by the city, and good sewerage. It has fine water-power in the river, which has been utilized in extensive manufactures, mainly cotton goods, in which industry this city was the pioneer in America. In 1900 the total number of manufacturing establishments was 534, with a total capital of $22,399,187. They employed 12,776 hands, and the product was valued at $24,080,328. Of this, $4,935,309 consisted of cotton goods, while $1,600,916 was the value of dyed and finished textiles. Worsted goods were manufactured to the value of $3,733,219. The product of foundries and machine shops was valued at $1,833,379. The assessed valuation of real and personal property was, in 1900, $33,570,000, the net debt $4,251,106, and the rate of taxation $16.50 per $1000. Population (1890), 27,633; (1900), 39,231, of whom 13,087 were foreign-born and 173 negroes.

Payn, James (1830–1898), English novelist, was born at Cheltenham, 28th February 1830, his father being clerk to the Thames Commissioners and treasurer to the county of Berks. He was educated at Eton, and afterwards entered the Military Academy at Woolwich; but his health was not equal to the demands of a military career, and he proceeded to Trinity College, Cambridge. He was not an assiduous "reading man," but was among the most popular men of his time, and served as president of the Union. Before going to Cambridge he had published some verses in Leigh Hunt's *Journal*, and while still an undergraduate put forth a volume of *Stories from Boccaccio* in 1851, and another collection of *Poems* in 1853. In the same year he left Cambridge, and shortly afterwards married Miss Louisa Adelaide Edlin, sister of Sir Peter Edlin. He then settled down to a literary career, contributed to *Household Words* and *Chambers's Journal*, and was in 1858 appointed editor of the latter periodical, conducting it with much success for sixteen years. In its pages he published in 1864 his most popular story, *Lost Sir Massingberd*, a serial which attracted so much attention that its appearance in *Chambers's* is said to have increased the circulation by 20,000 copies. From this time he was always engaged in novel-writing, among the most popular of his productions being *Married Beneath Him* (1865), *Carlyon's Year* (1868), *By Proxy* (1878), and *The Talk of the Town* (1885). In 1882 he succeeded Mr Leslie Stephen as editor of the *Cornhill Magazine*, and continued in the post until the breakdown of his health in 1896. He was also literary adviser to Messrs Smith, Elder and Company, and may be described as one of the last of the old-fashioned school of "readers"—a school which did much to foster literary talent, and to surround the individual firm with a loyal and competent body of men of letters. Payn was the means of introducing many promising writers to the public, and his advice and tact were in harmony with the highest traditions of the literary profession. As a novelist he was entertaining rather than profound. He told a good story easily and naturally; he possessed some dramatic force, and was skilful in the arrangement of incidents. He was not without a Dickensian sense of character, but his female figures are ingenuous and simple rather than subtly interesting. In other departments of the literary life he was a prolific writer. He published a *Handbook to the English Lakes* (1859), and various volumes of occasional essays, such as *Maxims by a Man of the World* (1869), *Some Private Views* (1881), *Literary Recollections* (1884), and a posthumous work, *The Backwater of Life*, revealed much of his own personality in a mood of kindly, sensible reflection upon familiar topics. For years he contributed a weekly column of literary and social gossip to the *Illustrated London News*. He died in London, 25th March 1898. (A. W.)

Paysandu, a city of Uruguay and capital of the department of the same name, situated on the Rio Uruguay, 131 miles above Montevideo. It is the third city of the republic in importance, with fine public buildings, good streets, and tramways. In 1898 the imports were valued at $750,892, and exports at $3,964,548. In other words, it has about 3 per cent. of the total import trade of the republic, and over 12 per cent. of the export trade. In 1900 the imports were valued at $626,214 (gold), and the exports at $2,720,870 (gold). In 1898 the entries were 787 steamers of 460,492 tons and 461 sailing ships of 23,177 tons. Population, 14,000.

Paz Soldan, Mariano Felipe (1821–1886), Peruvian historian and geographer, was born at Arequipa, 22nd August 1821. He studied law, and after holding some minor judicial offices, was minister to Colombia in 1853. After his return he occupied himself with plans for the establishment of a model penitentiary at Lima, which he was enabled to accomplish through the support of General Castilla, the most eminent of the rulers of Peru. In 1860 Castilla made him director of public works, in which capacity he superintended the erection of the Lima statue of Bolivar, the finest work of sculpture in South America. He was also concerned in the reform of the currency by the withdrawal of the debased Bolivian coins, which had long circulated at the same nominal value as the Peruvian. In 1861 he published his great atlas of the republic of Peru, and in 1868 the first volume of his history of Peru after the acquisition of her independence. A second volume followed, and a third, bringing the history down to 1839, was published after his death by his son. In 1870 he was minister of justice and worship under President Balta, but shortly afterwards retired from public life to devote himself to his great geographical dictionary of Peru, which was published in 1877. During the disastrous war with Chile he sought refuge at Buenos Aires, where he was received with distinguished hospitality and made professor in the National College, and where he wrote and published the history of his country's misfortunes. He died on 31st December 1886.

Peabody, a town of Essex county, Massachusetts, U.S.A., containing an area of 17 square miles of level country, dotted over with glacial hills, situated in the north-eastern part of the state, adjoining Salem on the west. The principal village bears the same name as the town, is laid out very irregularly, and is on a line of the Boston and Maine Railroad. Its chief industry is the manufacture of leather, for which there are several establishments. Population (1890), 10,158; (1900), 11,523, of whom 2870 were foreign-born.

Peace Conference, the official name of the International Conference, held at the instance of the emperor of Russia in 1899, at The Hague, "with the object of seeking the most efficacious means of assuring to all peoples the blessings of real and lasting peace, and, above all, in order to put a stop to the progressive development of the present armaments." The subject matter proposed for discussion embraced the following elements:—

1. An understanding not to increase for a fixed period the present effective of the armed military and naval forces, and at the same time not to increase the budgets pertaining thereto; and a preliminary examination of the means by which a reduction might even be effected in future.

2. To prohibit the use in the armies and fleets of any new kinds of firearms whatever, and of new explosives or any powder more powerful than those now in use either for rifles or cannon.

3. To restrict the use in military warfare of the formidable explosives already existing, and to prohibit the throwing of projectiles or explosives of any kind from balloons or by any similar means.

4. To prohibit the use in naval warfare of submarine torpedo-boats or plungers, or other similar engines of destruction; to give an undertaking not to construct vessels with rams in future.

5. To apply to naval warfare the stipulations of the Geneva Convention of 1864 on the basis of the Additional Articles of 1868.

6. To neutralize ships and boats employed in saving those overboard during or after an engagement.

7. To revise the Declaration concerning the laws and customs of war, elaborated in 1874, by the Conference of Brussels, which remained unratified.

8. To accept in principle the employment of good offices of mediation and facultative arbitration in cases lending themselves thereto, with the object of preventing armed conflicts between nations; to come to an understanding with respect to the mode of applying these good offices, and to establish a uniform practice in using them.

In accepting the invitation to attend the Conference, Lord Salisbury, referring to the 8th point, specially mentioned Great Britain's "earnest desire to promote by all possible means the principle of recourse to mediation and arbitration for the prevention of war."

The delegates appointed by the respective governments met at The Hague on 20th May 1899. The work, set out as above in the Russian scheme, was divided up among three committees, appointed: the first, to deal with points 1, 2, 3, and 4; the second with points 5, 6, and 7; and the third with point 8. The work of the third committee, which resulted in an "International Convention for the Pacific Settlement of International Disputes," has already been summarized in the article on ARBITRATION (INTERNATIONAL).[1] The work of the second committee was embodied in declarations to which Great Britain was not a party, and that of the third in two International Conventions—the one completing and adopting the work prepared by the Brussels Conference in 1874 on "the laws and customs of war by land," and the other "adapting to maritime warfare the principles of the Geneva Convention of 22nd August 1864." These two Conventions will be dealt with in the article on WAR. The question of restriction of armaments, which was placed at the head of the Russian proposal and referred to the first committee, was abandoned as impracticable. All three Conventions are dated 29th July 1899. (T. BA.)

[1] The United States representatives signed it subject to the recording alongside of it of the following declaration:—

"Nothing contained in this Convention is to be interpreted as obliging the United States of America to depart from their traditional policy, in accordance with which they abstain from intervening, meddling, or mixing in the political questions, policy, or internal administration of a foreign State. It is also understood that nothing in the Convention is to be construed as implying that the United States of America abandon their traditional attitude with respect to purely American questions."

Peace River. See MACKENZIE.

Peacock, Sir Barnes (1810–1890), English judge, was born in 1810, and was the son of Lewis Peacock, a solicitor. After practising as a special pleader, he was called to the bar in 1836, and in 1844 obtained great reputation by pointing out the flaw which invalidated the conviction of Daniel O'Connell and his fellow-defendants. In 1852 he went to India as legal member of the Governor-General's Council. He here displayed great activity as a law reformer, but sometimes, in his laudable anxiety to extirpate abuses, manifested too little consideration for native susceptibilities, and too imperfect a recognition of the limited extent of his own acquaintance with the country. The Legislative Council was established soon after his arrival, and although no orator, he was so frequent a speaker that legislation enjoining councillors to deliver their speeches sitting was said to have been devised with the sole object of restraining him. As a member of Lord Dalhousie's council he supported the annexation of Oudh, and he stood by Lord Canning all through the Mutiny. In 1859 he became chief justice of the Supreme Court, and presided over it with great industry and efficiency, although upon one important occasion, a case involving the rights of landholders, he found himself in a minority of one. He returned to England in 1870, and in 1872 was placed upon the judicial committee of the Privy Council, where his Indian experience rendered him invaluable. He laboured there for the rest of his life with unremitting energy, having sat only three days before his decease on 3rd December 1890.

Pearsall, Robert Lucas de (1795–1856), English composer, was born, 14th March 1795, at Clifton, educated for the bar, and practised till 1825, when he left England for Germany. He studied composition under Panny of Mainz; and with the exception of three comparatively short visits to England, during one of which he made the acquaintance of the English school of madrigals, he lived abroad for the remainder of his life, selling his family property of Willsbridge and settling in the castle of Wartensee, on the Lake of Constance, where he emulated the style of the grandees of the Middle Ages, and devoted himself to the arts, with special preference for music. Notwithstanding the diffusion of his gifts and the circumstances of his career, he produced many works of lasting beauty, nearly all of them for voices in combination: from his part songs, such as "Oh, who will o'er the downs," to his elaborate and scholarly madrigals, such as the admirable eight-part compositions, "Great God of Love" and "Lay a Garland," or the beautiful "Light of my Soul," his genius ranged over a wide field. He combined great technical knowledge of the various styles he employed with a spontaneity of invention that gives his works a peculiar beauty. His reception into the Roman Church in his later years may have suggested the composition of some beautiful sacred music, among other things a "Salve Regina" that will not soon be forgotten. He wrote many valuable treatises on music, and edited a Catholic hymn-book of considerable merit. He died 5th August 1856.

Pearson, Charles Henry (1830–1894), British historian and colonial statesman, was born in London on 7th September 1830. After receiving his early education at Rugby and King's College, London, he went up to Oxford, where he was generally regarded as the most brilliant of an exceptionally able set, and in 1854 obtained a fellowship at Oriel College. His constitutional weakness and bad eyesight forced him to abandon his chosen profession of medicine, and in 1855 he returned to King's College as lecturer in English language and literature, a post which he almost immediately quitted for the professorship of modern history. From his undergraduate days he had been a keen student of foreign countries and literatures. Of his numerous journeys abroad the most important were his visit to Russia in 1858, his account of which was published anonymously in 1859 under the title of *Russia, by a Recent Traveller*; an adventurous journey through Poland during the insurrection of 1863, of which he gave a sympathetic and much-praised account in the *Spectator*; and a visit to the United States in 1868, where he gathered materials for his subsequent discussion of the negro problem in his *National Life and Character*. In the meantime, besides contributing regularly, first to the *Saturday Review* and then to the *Spectator*, and editing the *National Review*, he wrote the first volume of *The Early and Middle Ages of England* (1861). The work was bitterly attacked by Freeman, whose "extravagant Saxonism" Pearson had been unable to adopt. It appeared in 1868 in a revised form with the title of *History of England during the Early and Middle Ages*, accompanied by a second volume which met with general recognition. Still better was the reception of his admirable *Maps of England in the First Thirteen Centuries* (1870). But as the result of these labours he was threatened with total blindness; and, disappointed of receiving a professorship at Oxford, the goal of his ambition, he threw up the lectureship of modern history at Trinity College, Cambridge, which he had held for a short time, and in 1871 emigrated to Australia, which he had already visited on a voyage undertaken for his health's sake. Here he married and settled down to the life of a sheep-farmer; but finding his health and eyesight greatly improved, he came to Melbourne as lecturer on history at the University. Soon afterwards he became headmaster of the Presbyterian Ladies' College, and in this position practically organized the whole system of higher education for women in Victoria. In 1877 he was appointed by the Liberal Government to inquire into the state of education in the colony. His report, issued in the following year, was recognized as a classic, and many of its suggestions were adopted both in Europe and in the other Australian colonies. He had for some time been an influential contributor to the great Liberal organ, *The Age*, and on his election in 1878 to the Legislative Assembly definitely adopted politics as his career. His views on the land question and secular education aroused the bitter hostility of the rich squatters and the clergy; but his singular nobility of character, no less than his powers of mind, at once made him one of the most influential men in the Assembly. He was minister without portfolio in the Berry cabinet (1880–81), and when the ministry was on the eve of quitting office, was offered the post of Agent-General, but felt that in the circumstances he could not honourably accept it. As minister of education in the coalition government of 1886 to 1890, he was able to pass into law many of the recommendations of his report. His reforms, which entirely remodelled state education in Victoria, included the establishment of a system of state scholarships, the reorganization of industrial schools and of the teaching of art, and the improvement of the position of teachers. He obtained the appointment of a commission on technical education, as chairman of which he drew up a valuable report. During the intervals of his public work he prepared an edition of Juvenal in collaboration with Professor Strong (1887). In 1892 a fresh attack of illness decided him to return to England. Here he published in 1893 the one of his works which attracted most general notice, *National Life and Character*. It is an attempt to show that the white man can flourish only in the temperate zones, that the yellow and black races must increase out of all proportion to the white, and must in time by their industrial competition crush out his civilization, both material and intellectual. He died in London on 29th May 1894. A volume of his *Reviews and Critical Essays* was published in 1896, and was followed in 1900 by his autobiography, completed by his friends, a work of great interest. (H. SY.)

Pearson, John Loughborough (1817–1897), English architect, son of William Pearson, etcher, of Durham, was born in Brussels on 5th July 1817. He was articled at the age of fourteen to Ignatius Bonomi, architect, of Durham, but soon removed to London, and worked under the elder Hardwicke. Durham Cathedral and the churches and abbeys of Yorkshire seem to have influenced his studies. He revived and practised largely the art of vaulting, and acquired in it a proficiency unrivalled in his generation. He was, however, by no means a Gothic purist, and was also fond of Renascence and thoroughly grounded in classical architecture. From the erection of his first church of Ellerker, in Yorkshire, in 1843, to that of St Peter's, Vauxhall, in 1864, his buildings are Geometrical in manner and exhibit a close adherence to precedent, but elegance of proportion and refinement of detail lift them out of the commonplace of mere imitation. Holy Trinity, Westminster (1848), and St Mary's, Dalton Holme (1858), are notable examples of this phase. St Peter's, Vauxhall (1864), his first groined church, was also the first of a series of buildings which brought Pearson to the forefront among his contemporaries. In these he applied the Early English style to modern needs and modern economy with unrivalled success. St Augustine's, Kilburn (1871), St John's, Red Lion Square, London (1874), St Alban's, Birmingham (1880), St Michael's, Croydon (1880), St John's, Norwood (1881), St Stephen's, Bournemouth (1889), and All Saints', Hove (1889), are characteristic examples of his matured work. He is best known by Truro Cathedral (1880), which has a special interest in its apt incorporation of the south aisle of the ancient church. Pearson's conservative spirit fitted him for the reparation of ancient edifices, and among cathedrals and other historical buildings placed under his care were Lincoln, Chichester, Peterborough, Bristol, and Exeter Cathedrals, St George's Chapel, Windsor, Westminster Hall, and Westminster Abbey, in the surveyorship of which last he succeeded Sir G. G. Scott. Except as to the porches, the work of Scott, he re-faced the north transept of Westminster Abbey, and also designed the vigorous organ cases. In his handling of ancient buildings he was repeatedly opposed by the ultra anti-restorers (as in the case of the west front of Peterborough Cathedral in 1896), but he generally proved the soundness of his judgment by his executed work. Pearson's practice was not confined to church building. Treberfydd House (1850), Quar Wood (1858), Lechlade Manor, an Elizabethan house (1873), Westwood House, Sydenham, in the French Renaissance style (1880), the Astor estate offices (1892) upon the Victoria Embankment, London, the remodelling of the interiors of Clieveden House (1893) and No. 18 Carlton House Terrace (1894), with many parsonages, show his aptitude for domestic architecture. Pearson's church plans possess great variety and interest. The management of choir and sanctuary evidences much individuality, and the side chapel is frequently treated so as to give additional scale to the rest of the building. In general design he first aimed at form, embracing both proportion and contour; and his work may be recognized by accurate scholarship coupled with harmonious detail. Its keynotes are cautiousness and refinement rather than boldness. After a continuous progress up to the last days of his long career, he died on the 11th of December 1897, and was buried in the nave of Westminster Abbey, where his grave is marked by the appropriate motto *Sustinuit et abstinuit.* He was elected A.R.A. in 1874, R.A. in 1880, was a fellow of the Society of Antiquaries, and a fellow and member of the Council of the Royal Institute of British Architects.

The following are some of Pearson's more important works, not already named :—Ferriby Church, 1846 ; Stow, Lincolnshire (restoration), 1850 ; Weybridge, St James's, 1853 ; Freeland Church, Parsonage, and Schools, 1866 ; Kilburn, St Peter's Home, 1868 ; Wentworth Church, 1872 ; Horsforth Church, 1874 ; Cullercoats, St George's, 1882 ; Chiswick, St Michael's (restoration), 1882 ; Great Yarmouth Church (restoration), 1883 ; Liverpool, St Agnes', 1883 ; Woking Convalescent Home, 1884 ; Headingley Church, 1884 ; Torquay, All Saints', 1884 ; Maidstone, All Saints' (restoration), 1885 ; Shrewsbury Abbey, 1886 ; Ayr, Holy Trinity, 1886 ; Hythe Church (restoration), 1887 ; Oxford, New College, Reredos (completion), 1889 ; Cambridge University Library (additions), 1889 ; Friern Barnet, St John's, 1890 ; Cambridge, Sidney Sussex College (additions), 1890 ; Middlesex Hospital Chapel, 1890 ; Bishopsgate, St Helen's (restoration), 1891 ; Maida Hill (Irvingite) Church, 1891 ; Barking, All Hallows' (restoration), 1893 ; Cambridge, Emmanuel College (additions), 1893 ; Ledbury, St Michael's (restoration), 1894 ; Malta, Memorial Church, 1894 ; Port Talbot Church, 1895. (W. D. C.)

Pécs (German, *Fünfkirchen*), a municipal town, capital of the province of Baránya, Hungary. It has an upper *real*-school, a commercial academy, an orphanage, and a foundling hospital. In the 14th century it possessed also a university, which existed until the disaster of Mohács. Its industry and commerce are thriving. It is famous for its porcelain, organs, and sparkling wine. There are in the vicinity extensive coal-mines, which produce yearly five million tons of good coal. Population (1890), 34,100 ; (1900), 43,982.

Pedro II. (1825–1891), EMPEROR OF BRAZIL, came to the throne in childhood, having been born on 2nd December 1825, and proclaimed emperor in April 1831, upon the abdication of his father. He was declared of full age in 1840, and, after some troubles had been overcome, found himself reigning peacefully over a united people. For a long period few thrones appeared more secure, and his prosperous and beneficent rule might have endured throughout his life, but for his want of energy and inattention to the signs of the times. The rising generation had become honeycombed with republicanism, the prospects of the imperial succession were justly regarded as unsatisfactory, the higher classes had been estranged by the emancipation of the slaves, and all these causes of discontent found expression in a military revolt, which in November 1889 overthrew the seemingly solid edifice of the Brazilian empire in a few hours. Dom Pedro retired to Europe, and died in Paris on the 5th of December 1891. The chief events of his long reign had been the emancipation of the slaves already adverted to, and the sanguinary and costly, though ultimately successful, war with Paraguay in 1864–1870. Dom Pedro was a model constitutional sovereign, and, like Prospero, carried study to such an extent as to undermine his authority by impairing his efficiency as a ruler. He was a munificent patron of science and letters, travelled in the United States (1876), and thrice visited Europe (1871–72, 1876–77, 1886–89).

Peebles, a midland county of Scotland, bounded on the N. and N.E. by Midlothian, on the E. and S.E. by Selkirk, on the S. by Dumfries, and on the W. by Lanark.

Area and Population.—In 1891 the boundaries between Peebles and Selkirk were rearranged, the parishes of Innerleithen and Peebles being placed wholly in Peeblesshire, and a detached portion of the Peebles parish of Lyne and Megget transferred to the Selkirk parish of Yarrow; the boundary was also rearranged between Peebles and Lanark shires in the parish of Coulter, which was placed wholly in the latter county, its Peebles portion being transferred to the Peebles parish of Broughton. The area of the county is 223,295 acres, or about 349 square miles. The population was, in 1881, 13,822; in 1891, 14,761; in 1891 on the above area 14,750; and in 1901, 15,066, of whom 7129 were males and 7937 females. On the old area, taking land only (226,899 acres, or 354·5 square miles), the number of persons to the square mile in 1891 was 42, and the number of acres to the person 15·4. In the registration county the increase of population between 1881 and 1891 was 6·9. Between 1881 and 1891 the excess of births over deaths was 1902, and the increase of the resident population 950. The following table gives particulars of births, deaths, and marriages in 1880, 1890, and 1899:—

Year.	Deaths.	Marriages.	Births.	Percentage of Illegitimate.
1880	194	71	423	10·4
1890	198	78	302	5·63
1899	209	74	363	4·7

The following table gives the birth-rate, death-rate, and marriage-rate per thousand of the population for a series of years:—

	1880.	1881–90.	1890.	1891–98.	1899.
Birth-rate . .	31·17	27·45	20·73	23·91	23·41
Death-rate . .	14·29	14·02	13·58	14·41	13·48
Marriage-rate .	5·23	5·20	5·35	6·14	4·77

In 1891 there were 68 Gaelic-speaking persons in the county, and 15 foreigners. Valuation in 1889–90, £144,036; 1899–1900, £144,066.

Administration.—The county unites with Selkirkshire in sending a member to Parliament. Peebles (5266) is the only royal burgh, and its constituency is merged in that of the county. There are 14 civil parishes, of which four are not assessed for poor. The number of paupers and dependants in September 1899 was 214, and there is a combination poorhouse at Peebles. Peebles forms a sheriffdom with the Lothians, and a sheriff-substitute sits in the county town.

Education.—Fourteen school boards manage 20 schools, with an average attendance of 1995 in 1898–99, and three other schools (one Episcopal) had an average attendance of 80 in the same year. Peebles has a high school, and another school in the county earned grants in 1898 for giving secondary education. Most of the "residue" grant is spent by the county council in subsidizing science and art, and technical classes and evening classes in Peebles, Innerleithen, and elsewhere.

Agriculture.—In 1898, 21·5 per cent. of the acreage was under cultivation. The following table gives the principal acreages for the years specified:—

Year.	Area under Crops.	Corn Crops.	Green Crops.	Clover.	Permanent Pasture.	Fallow.
1880	42,010	10,382	6245	13,995	11,297	91
1885	42,514	9,600	5441	11,301	16,168	4
1890	42,731	8,988	5500	13,372	14,824	41
1895	46,814	8,782	5237	17,938	14,846	6
1899	48,607	8,648	5018	18,254	16,669	5

The following table gives particulars of the live stock for the same years:—

Year.	Total Horses.	Total Cattle.	Cows or Heifers in Milk or Calf.	Sheep.	Pigs.
1880	1184	5934	1991	199,512	719
1885	1164	6530	2128	192,367	1043
1890	1046	6843	1929	188,033	876
1895	1176	6789	2112	186,221	707
1899	1098	7498	2204	201,538	618

In 1891, 1407 men and 108 women in the county were engaged in agriculture. There were 9490 acres under wood in 1895. Of the 300 holdings in the county in the same year, the average size was 156 acres; 8 per cent. were under 5 acres, 27 per cent. between 5 and 50 acres, and 65 per cent. over 50. There were 29 farms between 50 and 100 acres, 115 between 100 and 300, 42 between 300 and 500, and 9 over 500. A normal farm is about 200 acres arable, with pasturage for 600 or 800 sheep.

Industry.—The minerals—coal, limestone, and iron ore—scarcely repay working. Of 3686 persons registered in 1891 as being connected with industrial pursuits, 1008 men and 1082 women were employed about textiles.

AUTHORITIES.—*Guide to Peeblesshire.* Peebles, 1881.—ROBERT RENWICK. *Historical Notes on Peeblesshire Localities.* Peebles, 1897; *Aisle and Monastery.* Glasgow, 1897; *Gleanings from Peebles Burgh Records.* Peebles, 1892.—ALEXANDER WILLIAMSON. *Glimpses of Peebles.* Selkirk, 1895.—Dr C. B. GUNN. *The Three Tales of the Three Priests of Peebles.* Selkirk, 1894; *Innerleithen and Traquair.* Innerleithen, 1867.—Sir GEORGE REID. *The River Tweed from its Source to the Sea* (text by Professor VEITCH). Edinburgh, 1884.—Professor VEITCH. *Border Essays.* Edinburgh, 1896; *History and Poetry of the Scottish Border.* Edinburgh, 1893.—WILLIAM CHAMBERS. *History of Peeblesshire.* Edinburgh, 1864; *Reminiscences of Innerleithen.* Innerleithen, 1898.—JAMES GROSART. *Chronicles of Peebles Briggate.* Peebles, 1899.

(W. WA.)

Peebles, a royal burgh and the county town of Peeblesshire, at the junction of the Eddlestone water with the Tweed, 23 miles south of Edinburgh by road. The town grows in favour as a health resort. Tweed bridge has been widened, and an Established church has been erected. Population (1881), 3495; (1901), 5266.

Peekskill, a village of Westchester county, New York, U.S.A., on the east bank of the Hudson river and on the New York Central and Hudson River Railroad, 43 miles above New York, in the south-eastern part of the state. Its site is hilly and its street plan irregular. It has a good water-supply and sewerage system, and contains a number of private schools for boys and girls. Its manufactures are varied, and include iron-works, flour-mills, and cigar factories. It is the site of the annual camp of the State National Guard. Population (1890), 9676; (1900), 10,358, of whom 1341 were foreign-born and 243 negroes.

Peel, Arthur Wellesley Peel, 1st VISCOUNT (1829– ——), youngest son of the eminent statesman, Sir Robert Peel, was born on 3rd August 1829, and was educated at Eton and Balliol College, Oxford. Destined for a political career, he unsuccessfully contested Coventry in 1863; but two years later he was elected in the Liberal interest for Warwick, for which he sat until his elevation to the peerage. Soon after his entrance into the House of Commons, he evinced great business capacity and wide knowledge of constitutional forms, and in December 1868 was appointed parliamentary secretary to the Poor Law Board. This office he filled until 1871, when he became secretary to the Board of Trade, an appointment which he held for two years. In 1873–74 he was patronage secretary to the Treasury, and when the Liberals again returned to power in 1880 he became under-secretary for the Home Department. On the retirement of Mr Brand (afterwards Viscount Hampden) in 1884, Mr Peel was elected Speaker, and his speech on accepting the office was one of marked dignity. He was thrice re-elected to the post, twice in 1886, and again in 1892. Throughout his career as Speaker he exhibited the greatest impartiality, combined with a perfect knowledge of the traditions, usages, and forms of the House, soundness of judgment, and readiness of decision upon all occasions. On 8th April 1895, in a very full gathering of the House of Commons, Speaker Peel announced that in consequence of failing health he was compelled to retire from the chair. The farewell ceremony was of a most impressive character, and warm tributes were paid from all parts of the House. The dignity of a viscount was subsequently conferred upon him, and he was granted by statute a pension of £4000 for life. Lord Peel received the honorary degree of D.C.L. from Oxford University in 1887, and he was presented with the freedom of the City of London in a gold casket in July 1895. A Royal Commission was appointed in April 1896 to inquire into the operation and administration of the licensing laws. The Commission was of a most comprehensive and representative character, and Viscount

Peel was appointed chairman. It held 123 sittings and examined 260 persons. The taking of evidence was concluded in July 1898, when the commissioners adjourned, and Lord Peel drew up a draft report for discussion, in five parts, dealing with England, Wales, Scotland, Ireland, Clubs, and the Reduction of Licences, Compensation, Local Option or Prohibition, and Municipal Management. Some differences of opinion arose in connexion with the report, and at a meeting of the commissioners on 12th April 1899, when part 5 of the draft report was to be considered, a proposal was made to substitute an alternative draft for Lord Peel's, and also a series of alternative drafts for the four sections already discussed. Lord Peel declined to put these proposals, and left the room. Sir Algernon West was elected to the chair, and ultimately two main reports were presented, one section agreeing with Lord Peel, and the other—including the majority of the commissioners—presenting a report which differed from his in several important respects. The Peel Report recommended that a large reduction in the number of licensed houses should be immediately effected, and that no compensation should be paid from the public rates or taxes, the money for this purpose being raised by an annual licence-rental levied on the rateable value of the licensed premises. Lord Peel's Report at once became a valuable weapon in the hands of temperance reformers.

Peesemsky, Alexey Feofilactovich (1820–1881), a well-known Russian novelist of an extremely sceptical and pessimistic character, was born on his father's estate, in the province of Kostroma, 10th/22nd March 1820. In his autobiography he describes his family as belonging to the ancient Russian nobility, one of his ancestors having been sent as ambassador to London by Ivan the Terrible to see a niece of Queen Elizabeth, whom the Tsar wished to marry, and another having been canonized after death as a saint. His more immediate progenitors, however, were all very poor, and quite unable to read or write. His grandfather ploughed the fields as a simple peasant, and his father, as Peesemsky himself said, was washed and clothed by a rich relative, and placed as a soldier in the army, from which he retired, after thirty years' service, with the rank of major. Peesemsky's first teachers were a village curate, and a priest expelled from the Church for drunkenness. During childhood he read eagerly the translated works of Walter Scott and Victor Hugo, and later those of Shakespeare, Schiller, Goethe, Rousseau, Voltaire, and George Sand. From the gymnasium of Kostroma, where he exhibited some talent for acting, he passed through Moscow University, and in 1884 entered the Government service as a clerk in the office of the Crown Domains in his native province. Between 1854 and 1872, when he finally quitted the civil service, he occupied similar posts in St Petersburg and Moscow. His early works exhibit a profound disbelief in the higher qualities of humanity, and one of his singular traits was a disdain for the other sex, although he appears to have been attached to a particularly devoted and sensible wife. His first novel, *Boyarstchina*, was forbidden for its unflattering description of the Russian nobility. His principal novels are *Tufak* ("A Muff"), 1850; *Teesicha Doush* ("A Thousand Souls"), 1862, which is considered his best work of the kind; and *Vzbalomoucheneoe More* ("A Troubled Sea"), giving a picture of the excited state of Russian society about the year 1862. He also produced a comedy, *Gorkaya Soudbina* ("A Bitter Fate"), depicting the dark sides of the Russian peasantry, and resembling Zola's *La Terre*, which obtained for him the Ouvaroff prize of the Russian Academy. In 1856 he was sent, together with other literary men, to report on the ethnographical and commercial condition of the Russian interior, his particular field of inquiry having been Astrakhan and the region of the Caspian Sea. His scepticism in regard to the liberal reforms of the 'sixties made him very unpopular among the more progressive writers of that time. His death occurred at Moscow on the 2nd February 1881 (21st January, Russian style). (G. D.)

Pegu, a division of Lower Burma comprising the districts of Rangoon town, Hanthawaddy, Pegu, Tharrawaddy, and Prome, with a total area of 13,083 square miles and a population in 1891 of 1,522,511, and of 1,818,845 in 1901. In 1898–99 it paid a revenue of Rs.74,14,902. PEGU district is the largest in the division, and has an area of 4276 square miles, with a population in 1891 of 237,594, and in 1901 of 339,942, with 782 villages paying a revenue in 1898–99 of Rs.17,61,123. Of the population in 1891, 218,889 were Buddhists and Jains, 7777 were Hindus, 2407 Mahommedans, 2939 aborigines (mostly Karens), and 5582 Christians, 5387 of whom were natives, chiefly Karens. Of a total acreage of 2,736,640, there were 612,968 acres cultivated in 1898–99, 741,618 remained uncultivable, and 481,168 acres apart from fallow were cultivable. The rainfall in 1898–99 was 114·42 inches, taken at Pegu town. The vast bulk of the cultivation is rice. The chief town, PEGU, has increased greatly in prosperity since the opening of the railway. It had a population of 5891 in 1881, and in 1891 of 10,762. It has a municipal committee of twelve elective and four *ex officio* members.

Peine, a town of Prussia, province of Hanover, 16 miles by rail west-north-west of Brunswick. It has ironworks, breweries, manufactures of starch and artificial manure, brickworks, and distilleries. There are also large horse and cattle markets. Population (1885), 7868; (1900), 15,427.

Pekin, a city of Illinois, U.S.A., capital of Tazewell county, is on the Illinois river, at the intersection of six large railways, north-west of the centre of the state. It has a level site, and its street plan is regular. It is in a rich agricultural region and in the Illinois coalfield, and is a shipping point and grain market of great importance. Its manufactures are varied, including agricultural implements, lumber, brick and tiles, &c. Population (1890), 6347; (1900), 8420, of whom 1366 were foreign-born.

Peking, the capital of the Chinese empire, on a sandy alluvial plain on the Peiho and its tributary the Hunho, nearly equidistant from both, 36 miles south-east of the Great Wall, at the head of the Great Canal. Not being open to foreign trade, there is no general right of residence for foreign merchants at Peking, and consequently it has not shared in the industrial growth and progress that have benefited so many other Chinese cities. The only foreign commercial institution which has so far succeeded in gaining a foothold within the walls is the Hong Kong and Shanghai Bank, a branch of which has been established there for several years. A branch of the Russo-Chinese Bank has also been opened. With these exceptions the foreign residents are either the diplomatic representatives, or employés of the Chinese Government, or missionaries. The most important fact to be noted is the opening of the railway between Tientsin and Peking in 1897. This was only accomplished after great opposition from the ultra-Conservatives, but once accomplished the facilities were gladly accepted by all classes, and the traffic both in goods and passengers is already enormous. Out of deference to the scruples of the ultra-Conservatives, the terminus was fixed at a place called Lu-Ko-chiao, some four miles outside the walls, but this distance has since been covered by an electric tramway. The trunk line constructed by the Franco-Belgian syndicate will connect Lu-Ko-chiao, the original terminus, with Hankow—hence the name Lu-Han by which this trunk line is generally spoken of, Lu being short for Lu-Ko-chiao and Han for Hankow. Since the first advent of foreigners in Peking in 1860 nothing whatever had been done until 1900 to improve the streets or the drainage. The streets as originally laid out were wide and spacious, but being unpaved and undrained they were no better than mud tracks diversified by piles of garbage and foul-smelling stagnant pools. Such drainage as had at one time existed was allowed to get choked up, giving rise to typhoid fever of a virulent type. Some attempt has been made to improve matters by macadamizing one of the principal thoroughfares, but it will be the labour of a Hercules to cleanse this vast city from the accumulated filth of ages of neglect. Fortunately the space inside the walls is so great that the houses are not crowded together, and there is a great number of large enclosures, mostly garden ground, the residence of one or other of the Manchu princes and nobility. One of such enclosures constitutes the British legation, and most of the other foreign legations are similarly, though not so sumptuously, lodged. The exact population of Peking is not known even to the Chinese themselves. In the ninth edition of this work it was stated to be about one million, and this figure is probably the highest at which it can yet be put. Many estimates make it considerably less. Peking suffered severely during the Boxer movement and the siege of the legations in the summer of 1900. Not only were most of the foreign buildings destroyed, but also a large number of important Chinese buildings in the vicinity of the foreign quarter, including the ancient Hanlin, the Boards of War, of Rites, &c. Almost the whole of the business quarter, the wealthiest part of the Chinese city, was laid in ashes. (For a fuller account of the siege, see CHINA: *History*.)

Pelew Islands. See MICRONESIA.

Pelloux, Luigi (1839-——), Italian general and politician, was born, on 1st March 1839, at La Roche, in Savoy, of parents who retained their Italian nationality when Savoy was annexed to France. Entering the army as lieutenant of artillery in 1857, he gained the medal for military valour at the battle of Custozza in 1866, and in 1870 commanded the brigade of artillery which battered the breach in the wall of Rome at Porta Pia. Manifesting aptitude for a political career, he was elected deputy in 1880, and, after having been secretary-general of the War Office, became minister of war in the Rudini and Giolitti Cabinets of 1891–93. In July 1896 he resumed the portfolio of war in the Rudini Cabinet, and was appointed senator. In May 1897 he secured the adoption of the Army Reform Bill, fixing Italian military expenditure at a maximum of £9,560,000 a year, but in December of that year he was defeated in the Chamber on a technical issue. Resigning office, he was in May 1898 sent as royal commissioner to Bari, where, without recourse to martial law, he succeeded in restoring public order. Upon the fall of Rudini, in June 1898, General Pelloux was entrusted by King Humbert with the formation of a Cabinet. An excellent administrator but an indifferent politician, he accomplished little in the legislative field, and turned his attention chiefly to the maintenance of order and to sound management of public affairs. The Public Safety Bill for the reform of the police laws, taken over by him from the Rudini Cabinet, and eventually promulgated by royal decree, was fiercely obstructed by the Socialist party, which, with the help of the other groups of the Left and Extreme Left, succeeded in forcing General Pelloux to dissolve the Chamber in May 1900, and to resign office shortly after the general election in the following June. In the autumn of 1901 he was appointed to the command of the Turin army corps.

Pembroke, a maritime county of South Wales, bounded on the E. by Carmarthen, on the N.E. by Cardigan, on the S.E. and S. by the Bristol Channel, and on the W. and N.W. by St George's Channel.

Area and Population.—The area of the ancient county is 395,151 acres, or 617 square miles, with a population in 1881 of 91,824; in 1891 of 89,133, of whom 41,685 were males and 47,448 females; in 1901 of 88,749, the number of persons per square mile being 144, and of acres to a person 4·4. The area of the administrative county is 392,710 acres, with a population in 1891 of 80,296. The registration county comprises 357,118 acres, with a population in 1891 of 82,003. Within this area the decrease of population between 1881 and 1891 was 2·00 per cent. The excess of births over deaths between 1881 and 1891 was 9914, but the resident population nevertheless decreased by 1674. The following table gives the numbers of marriages, births, and deaths, with the number and percentage of illegitimate births, for 1880, 1890, and 1898:—

Year.	Marriages.	Births.	Deaths.	Illegitimate Births.	
				No.	Per cent.
1880	563	2604	1540	163	6·3
1890	574	2305	1566	153	6·5
1898	564	2222	1448	115	5·2

In 1891 there were in the county 342 natives of Scotland, 784 natives of Ireland, and 127 foreigners, while 51,959 persons could speak English, 13,673 Welsh, and 10,804 English and Welsh.

Constitution and Government.—The county returns one member to Parliament, and it also includes the Pembroke and Haverfordwest district of parliamentary boroughs (consisting of Fishguard, Haverfordwest, Milford, Narberth, Pembroke, Tenby, and Weston), returning one member. There are three municipal boroughs: Haverfordwest (6007), Pembroke (15,853), and Tenby (4400). Haverfordwest is a county in itself and has its own lord-lieutenant. There is only one urban district, Milford Haven (5101). Pembrokeshire is in the South Wales and Chester circuit, and assizes are held at Haverfordwest. The boroughs of Haverfordwest, Pembroke, and Tenby have separate commissions of the peace, and Haverfordwest has also a separate court of quarter sessions. The ancient county, which is entirely in the diocese of St Davids, contains 114 entire ecclesiastical parishes and districts and parts of 5 others.

Education.—The total number of elementary schools on 31st August 1899 was 127, of which 57 were board and 70 voluntary schools, the latter including 58 National Church of England schools, 1 Wesleyan, and 11 "British and other." The average attendance at board schools was 6413, and at voluntary schools 5790. The total school board receipts for the year ended 29th September 1899 were over £22,198. The income under the Agricultural Rates Act was over £1424.

Agriculture.—About four-fifths of the total area of the county is under cultivation, and of this about two-thirds is in permanent pasture. Only about 33,000 acres are in hill pasture, and less than 10,000 acres are under woods. Of the corn crops oats are the principal, occupying considerably more than half the acreage, while barley occupies about three-eighths, and wheat not much more than a fourteenth. The acreage under green crops is not large, but about seven-twelfths is occupied by turnips, cattle being largely kept both for feeding and milking. Only about one-fifth of the green crop acreage is occupied by potatoes, and about one-fifth also is under mangold, cabbage, &c. The following table gives the larger main divisions of the cultivated area at intervals from 1880:—

Year.	Total Area under Cultivation.	Corn Crops.	Green Crops.	Clover.	Permanent Pasture.	Fallow.
1880	302,780	57,573	12,471	28,789	199,913	4034
1885	306,783	52,250	13,633	31,214	207,808	1878
1890	309,293	52,455	13,455	42,365	199,507	1503
1895	315,303	49,689	13,222	41,655	209,661	1041
1900	313,346	49,929	12,191	39,998	210,485	716

The table on the next page gives particulars regarding the principal live stock for the same years.

Year.	Total Horses.	Total Cattle.	Cows or Heifers in Milk or in Calf.	Sheep.	Pigs.
1880	14,376	85,138	31,817	99,030	21,537
1885	14,667	90,250	33,567	102,655	20,318
1890	14,682	88,266	33,186	115,334	31,095
1895	16,131	87,543	32,280	119,817	32,278
1900	15,984	93,744	32,998	138,199	29,482

Industries and Trade.—According to the report for 1898 of the chief inspector of factories (1900), the total number of persons employed in factories and workshops in 1897 was 4654, as compared with 4217 in 1896. Of the 3370 persons employed in non-textile factories, 2736 were employed in the manufacture of machines, appliances, conveyances, and tools, mostly in connexion with the shipbuilding yards at the different ports. Only 1133 persons were employed in workshops. The number of persons employed in connexion with mines and quarries in 1899 was 946. In the same year 246,330 tons of igneous rocks were raised, and 22,998 tons of limestone. Lead mining has practically ceased, and little or no iron ore is obtained. The coal production (wholly anthracite) is rather fluctuating, 52,642 tons valued at £13,160 being obtained in 1885, 71,908 tons valued at £35,954 in 1890, 82,384 tons valued at £45,311 in 1898, and 59,419 tons valued at £32,680 in 1899. The fisheries are of considerable importance. At Tenby, Newland, and Milford (almost entirely the last two) 448,449 cwt. of fish valued at £381,610 was landed in 1899.

See *A Historical Tour through Pembrokeshire.* London, 1811. —TOMBS. *Concerning Pembrokeshire.* Haverfordwest, 1863.—The guide-books to South Wales. (T. F. H.)

Pembroke, a municipal and contributory parliamentary borough of Pembrokeshire, Wales, in the Pembroke and Haverfordwest district of boroughs, 272 miles west of London by rail. The dock has a length of 404 feet, with a depth on sill, at high water ordinary spring tides, of 25 feet. Population (1881), 14,156; (1891), 14,978; (1901), 15,853.

Pembroke, a town of Ontario, Canada, capital of Renfrew county, 74 miles west-north-west of Ottawa by rail, on the south shore of Allumette Lake, and on the Canadian Pacific and Canada Atlantic railways. It is the seat of a Roman Catholic bishop, and contains saw, grist, and woollen mills, axe factory, &c. The Muskrat river, which flows through the town, affords excellent water-power. Population (1881), 2820; (1891), 4401; (1901), 5156.

Penang. See PRINCE OF WALES ISLAND.

Penarth, a seaport, urban district (1894), and railway station in the Southern parliamentary division of Glamorganshire, Wales, on the river Taff, opposite Cardiff. The town is rapidly spreading. Gardens have been laid out along the cliff, numerous villas built in the western district, and a promenade and landing-pier opened, with a length of 630 feet. The chief buildings of modern erection are an Established church (1891) and an intermediate and technical school (1894). Three miles to the west is Dinas Powis Castle. Penarth dock, which cost £775,000 and comprised 17½ acres, was extended in 1884 at a cost of £250,000, and now covers 23 acres. It is 2900 feet in length, has a minimum depth of 26 feet, and is furnished with every convenience for facilitating the export of coal, of which from 20,000 to 30,000 tons can be stored in the sidings near by. The trade of the dock in one year totalled a tonnage of 3,454,964, and a still further extension is contemplated. Penarth harbour (55 acres) and basin (3 acres) have a minimum depth of 20 feet. A considerable import trade is carried on at the Penarth-Ely tidal harbour, mainly through coasting vessels. Commodious store-houses have been erected there; also tanks to hold about 6000 tons of oil. Population (1881), 6228; (1891), 12,424; (1901), 14,227.

Pender, Sir John (1816–1896), was born in the Vale of Leven, Scotland, on 10th September 1816, and, after attending school in Glasgow, entered on a successful business career in that city and in Manchester. His name is chiefly known in connexion with submarine cables. He was one of the 345 contributors who each risked a thousand pounds in the transatlantic cable in 1857, and when, after many disappointments, the Atlantic Cable Company was ruined by the loss of the 1865 cable, he did not lose faith in submarine telegraphy, but formed the Anglo-American Telegraph Company to continue the work. His faith, however, was not generally shared, and it was not till he had given his personal guarantee for payment to the amount of a quarter of a million that the makers would undertake the manufacture of a new cable. But in the end he was justified, and telegraphic communication with America became a commercial success. Subsequently he fostered cable enterprise in all parts of the world—to the Mediterranean, India and China, Australia and Africa—with the result that at the time of his death, which occurred in London on 7th July 1896, he controlled companies having a capital of 15 millions sterling and owning 73,640 nautical miles of cable.

Pennsylvania, a central eastern state of the American Union. The area is 45,215 square miles (44,985 land and 230 water), with a mean elevation of 1100 feet. The distribution of this area in altitude is as follows:—

Elevation.	Area.
0 to 100 feet	600 square miles
100 to 500 ,,	5,550 ,,
500 to 1000 ,,	12,700 ,,
1000 to 1500 ,,	15,900 ,,
1500 to 2000 ,,	8,215 ,,
2000 to 3000 ,,	2,300 ,,

The first two elevations are in the south-eastern end of the state, and represent Philadelphia and the adjacent region. The third, largest in the western end of the state, is a continuation of the southern Ohio plain, and includes Pittsburg. The third and fourth are two coal tracts. The fifth is a central plateau, whose population, the largest at this elevation of any state but Colorado, is drawn thither by the oil wells. The sixth is a mountain region. The state is also rudely divided between the Delaware valley, 11,000 square miles, the Susquehanna, 24,000 square miles, and the Monongahela and Allegheny, 18,000 square miles. The census of 1890 showed a total population of 5,258,014, of whom 2,666,331 were males and 2,591,683 females; 4,412,294 were native-born, and 845,720 were foreign-born. The negroes numbered 107,596. Of the male population over 16 years of age 1,602,153, or 89·95 per cent., and of the female population 311,296, or 14·88 per cent., were engaged in different occupations. Owing to legislation requiring school attendance and forbidding employment under twelve, a decided decrease occurred between 1880 and 1890 in the number of children employed. The families were 1,061,626, and dwellings 999,364; 5·26 persons to a dwelling and 4·95 to a family. The number of persons to a family has fallen, from 1850 to 1890, from 5·66 to 4·95, and the persons to a dwelling from 5·99 to 5·26. The decrease in persons to a family is apparently still in progress with accelerated rapidity. While the general population increased, from 1880 to 1890, 22·77 per cent., the number of children under five in 1880 was 552,174, and in 1890, 477,591, a decrease of 74,583, or 13·48 per cent. According to the census of 1900, the population of the state was 6,302,115, an increase for the decade of 1,044,101, or 19·9 per cent. The average number to the square mile had increased to 140·1, as compared with 116·9 in 1890. The males numbered 3,204,541, the females, 3,097,574; the native-born, 5,316,865; the foreign-born, 985,250; the negroes, 156,845. The proportion of foreign-born has for a long period varied within narrow limits, having been 13·12 per cent. in 1850, 16·08 per cent. in 1890, and 15·6 in 1900. The foreign-born take the place of an equal number of native-born who have moved west. The proportion of Germans has always been large, being estimated at one-half in 1750.

State and Local Government.—To the executive, legislature, and judiciary provided by the constitution of 1874, legislation has added commissioners of insurance (1872), banking (1891), a department of agriculture (1876), a factory inspector (1893) and mine inspectors (1891–93); a board of health (1885), board of charities, with a lunacy committee (1883), fishery commission (1873), and game commission (1895); also boards and other lesser commissions to manage the lands, parks, soldier and orphan asylums, public buildings, and other state properties. Each commission has its body of special statutes, and collectively they constitute an important part of the development of state administration. A superior court between the common pleas and supreme court has been added (1897). The exercise of suffrage, conferred on male citizens over twenty-one years old, has been regulated by the adoption of the Australian ballot (1893–97), and by a series of laws (1881, 1883, 1897) imposing penalties for false voting and providing for the judicial determination of nominations by party organizations. The two leading parties have, under these laws, become strongly organized, with clearly-defined membership, rules, and elections, whose choice is usually decisive of the final result for the state and most of the counties in it. Stringent provisions forbid special legislation, particularly legislation for corporate or municipal purposes. The constitution, by prohibiting special municipal legislation, made necessary the adoption of general charters for the cities of the state. For charter purposes these are divided into first-class cities (over 600,000: Philadelphia alone), second-class (over 100,000 and less than 600,000: first Pittsburg, and later Allegheny and Scranton), and third-class (all below 100,000, comprising all the cities of the state but the four named). The three classes of charters are substantially the same. They provide for a mayor, elected, with wide executive powers, who appoints and removes the heads of city police, public works and charities, and lower officers, such appointments being subject, except in the case of lower officials, to the confirmation of the upper branch of the municipal legislature. The city legislature, which consists of two branches elected by districts, levies all taxes, votes all appropriations, and through standing committees exercises a close supervision over public works. In 1901 the Legislature placed the government of Pittsburg and Scranton temporarily in the hands of officers appointed by the governor. Education and the parks in first-class cities are in the hands of a separate body, appointed by judges, which submits estimates to and receives appropriations from the city council. In second and third class cities the schools are in the hands of an appointed board. Any local population over 300, not within a city, can, on application to a court of quarter sessions, receive a charter as a borough, electing a chief burgess, a council of five, and two poor trustees. Such a body can, by taxation, supply drainage, water, and light within its area, and can provide for its police and poor, but in small boroughs little use is made of these powers. The remainder of the area is divided into townships, whose officers have lesser power, collecting taxes for roads, the poor, &c., but cannot issue bonds. The right to issue bonded indebtedness for municipalities and boroughs is limited to 7 per cent. of the assessed valuation in the former and 1 per cent. in the latter. Bonds to the amount of 2 per cent. of the assessed valuation can be issued by the officers of a municipality. A larger amount must be authorized at a regular election, and this authorization must be repeated when such issue has been redeemed by the sinking fund required by law. The total local debt of the state was reduced under this plan from $93,318,474 in 1880 to $66,973,065 in 1890.

The population of the state has been distributed at each census under these five forms of local government:—

	1880.	1890.	1900.
Cities, first-class	847,170	1,046,964	1,293,697
,, second-class	156,389	343,904	553,538
,, third-class	430,792	522,095	700,540
Boroughs over 4000 population	224,172	444,744	670,462
Townships and smaller boroughs	2,624,368	2,900,307	3,083,878
Total	4,282,891	5,258,014	6,302,115

Finances.—The receipts and expenditures in the whole state, including state, county, municipal, and local governments, were in 1890: receipts, $49,859,913, and expenditures, $45,589,937. Of these receipts, $36,111,124 was derived from the direct taxation of real and personal property. The true valuation for the state, as determined by the census of 1890, in gross and per capita of this property, has been as follows, the figures being corrected and differing from the assessment of county officials:—

	1870.	1880.	1890.
Total	$3,806,340,112	$4,942,000,000	$6,190,746,550
Per caput	1,081	1,154	1,177

The assessed valuation amounted in 1890 to $2,659,796,909, of which $2,042,016,599 was realty and $617,780,310 personalty. In 1899 the aggregate was $3,027,649,299; in 1850, $492,898,829. The census returns of this assessed valuation in realty have been:—

	1870.	1880.	1890.
Total	$1,071,680,934	$1,540,007,957	$2,042,016,599
Per caput	373.38	427.93	494.29

Philadelphia raises two-thirds of its income from direct taxation, lesser cities a larger proportion. The state receives one-tenth of its income from this source, the rest from the taxation of corporations. Of the gross expenditures for public purposes in 1890, $5,512,128 was disbursed by the state. Of the remainder, amounting to $40,077,809, over one-third or $15,430,983 was expended by five cities of 50,000 or more in population. For school education $12,828,645 was dispensed. The per capita expenditure for all purposes was $8.67 through the state, but this was made up of a per capita expenditure of $13.90 in five cities and of $6.54 in the remainder of the state. The aggregate receipts of state and all local taxation in 1899 were: state, $15,158,462; local, $55,808,585—a total of $70,967,047. Nearly one-third of this aggregate, or $21,733,586, was raised by Philadelphia. In the decade state revenue had more than doubled, and local taxation increased 32 per cent. The local expenditures have grown by tolerably steady increments from the settlement of the state, the best example being in Philadelphia. The expenditures of the state government are the creation of the 19th century. Cut off by the Federal Government from customs revenue and by its own system of local finance from a direct land or property tax, the state government was forced to create a source of revenue for itself, and this did not develop to a point which met its necessities until the growth of corporations had provided a field of taxation independent of customs on the one side and realty or personal taxation on the other. Of the total state revenue in 1899, viz., $15,158,462, $8,617,343 was derived from taxes on corporations, $2,764,258 from taxes on personal property, and the remainder from a great variety of small taxes. Of the state expenditures in 1899, $15,063,467, over one-half, or $8,301,562, was returned to local agencies for disbursement, of which $5,871,984 was for schools, $2,360,308 from the personal tax was for the use of counties, and $69,270 from fire insurance taxes was for fire departments. With one-half of its taxation the state government therefore supports the executive, legislature, numerous commissions, penitentiaries ($122,907), insane asylums ($882,478), and various charitable corporations, which in 1899 received grants amounting to $1,278,594. The other half aids local government, the grant for education meeting all the expenses of the public schools in many rural districts.

History.—In 1882 and in 1892 the continuous election of Republican candidates as governor was broken by the election of Robert E. Pattison, his majority being due in one case to the presence of two Republican candidates, and in the other to a wide change of votes from the Republican to the Democratic party. Both elections were part of a continuous protest by a small but energetic body, variously designated, in favour of administrative reform, and against the increasing control of party and political action by individuals—a control due in great measure to the growth through custom and law of a stricter and more systematic organization. Industrial disputes, both as to the rate of wages and the recognition of a union, led, on 6th July 1892, to the Homestead steel strike over the employment of non-union workers by Carnegie and Company, in which several persons on both sides were killed, and the riot was only suppressed by the presence of state militia on 1st October. A coal strike, on 10th September 1897, led to a collision between deputy-sheriffs and a mob at Lattimer, in which twenty persons were killed. Another and still more serious strike, with riots, occurred in the coal-mining region in the summer of 1902. The Johnstown flood, 31st May 1889, in the Conemaugh valley, swept away the town and 3500 lives, though only 1440 bodies were recovered. No estimate of the property loss was possible. The fund disbursed by the relief fund commission was $2,899,727.

Education.—The legal system of public tax-supported education has remained unchanged since 1880, but its development only became possible when the constitution of 1874 changed the varying appropriations of the legislature in aid of local grants into a mandatory appropriation of at least $1,000,000 annually.

		Schools.	Teachers.	Students.
Common	1872	15,999	18,368	975,753
	1898	14,666	28,080	1,173,082
Normal	1872	11	140	2,191
	1898	15	359	10,656
Secondary	1872	44	272	5,015
	1898	292	1,022	27,082
High schools	1872	...	...	...
	1898	427	1,878	35,700
Colleges	1872	22	293	1,625
	1898	30	544	6,203
Law schools	1872	3	3	62
	1898	3	36	488
Medical schools	1872	5	50	942
	1898	6	227	2,415
Dental schools	1872	2	13	63
	1898	5	91	1,387
Pharmacy schools	1872	1	3	239
	1898	2	13	501

This sum has been as high as $5,500,000, though reduced in 1899 to $5,000,000. The amount levied by local taxation for educational purposes in 1880 was $5,634,072. In 1899–1900 this amount was $14,700,512. The state had therefore increased its appropriation 450 per cent., and local taxation 168 per cent., during a period in which the children in attendance had increased from 937,310 to 1,151,880, or 22·89 per cent., and the average attendance from 601,627 to 854,640, or 40·37 per cent. The estimated growth of population in the same period, taking the growth in previous decades, was 42·82. The best comparative view of the educational progress of the state is offered by the reports of the U.S. Bureau of Education, from which the foregoing table is compiled. The common schools, of which the high schools are a part, are wholly supported by taxation; the normal schools are partly dependent on state grants and partly on fees; the remaining schools are all conducted by private bodies, though appropriations are made from time to time by the state in aid of higher education. Illiterates, unable to read and write, have for thirty years been almost an unchanged fraction of the population, an indication that the education offered by the state and by private enterprise had reached all but that fraction which could be educated only under a compulsory system. Provision for a yearly count of school children and fines for non-attendance were first arranged for in 1897, and enforced only in the largest cities. Another decade will be needed to decide whether this measure and policy can deal with what has hitherto been a proportion whose reduction has been slow. Illiterates were in 1870, 8·5 per cent. of those over ten years of age; in 1880, 7·12; in 1890, 6·78; and in 1900, 6·1. Of this illiterate population one-half was in each census of foreign birth, the illiterate proportion of the foreign population, over ten years of age, 191,706, or 19·9 per cent., being ninefold, and of the small coloured population 20,298, or 15·3 per cent., fourteenfold that of the illiterate proportion of native white population, 87,372, or 2·3 per cent. The problem of complete elementary education turns on reaching this fraction. As this can be done only by a compulsory system, the great increase in expenditure has been attended by no increase in relative attendance. In 1900 the male illiterates of 21 years of age and over numbered 139,982. Of these 41,324 were native-born and 98,658 were foreign-born.

Crime and Charity.—From 1880 to 1898, 93 persons were executed for murder in the first degree. The prison population in 1898 was 7603, as compared with 4623 in 1880. The proportion of convicts had risen from 1 to 1555 inhabitants to 1 to 1272. Two juvenile reformatories had 835 inmates in 1881, and 1567 in 1898, an increase about twice that of the population. Insane patients in 1898 were 10,565, of whom 672 were in private institutions. In 1886 the same institutions had 5923. County almshouses had in 1881, 8566 inmates, including pauper insane, and in 1898, 11,722. In addition, in 1898, 22,187 persons received outdoor relief. Four deaf and dumb institutions held in 1898, 815 inmates; two for the blind, 266; and two for the feeble-minded, 1487. Hospitals had 6477 inmates, and "homes," for the most part for children and the aged, 16,080. These institutions receive yearly appropriations from the state aggregating about $1,500,000.

Communications.—The general railway system, complete as to main lines in 1880, consists of the Pennsylvania, whose trunk line occupies the middle of the state and crosses it by repeated branches, and the Reading, which reticulates the anthracite coal region, while the trunk lines of other states cross portions of the state. A railway mileage of 5500 in 1880 in the state had increased to 10,330 in 1900. The capital shares and debt, funded and floating, of railways in whole or in part in the state had risen within these years from $1,030,683,638 to $2,310,968,116, divided nearly equally between capital shares and debt. Gross receipts rose from $133,945,771 to $377,825,660, and expenses from $75,815,377 to $334,570,957, reducing the balance from $58,130,394 to $43,254,703, though the capital had doubled and the tonnage advanced from 111,348,416 to 400,548,087. While the Pennsylvania, with 3385 miles in the state, with an east and west traffic, and with an ownership of profitable lines outside of the state amounting to 6644 miles, has maintained a credit and prosperity unequalled, the Reading, 961 miles in and 39 out of the state, has thrice been in the hands of receivers. The street car lines of the state have a mileage of 1493, and a total capitalization of $242,628,019. Their present cost, all having been re-equipped with electric power since 1885, is $197,161,214, principally represented by the capital of operating companies, $147,570,893, $103,122,319 shares and $31,309,425 bonds. The remaining sum in the total capital represents for the most part the franchises of corporations formerly working the lines by horse-power. These lines have 5864 cars, employ 12,680 persons, and in 1899 carried 473,313,258 passengers. About 80 telephone companies operate telephone lines in the state. Telegraph facilities are furnished by inter-state lines, of which the Western Union is the largest. Three canal companies manage canals, now almost unused, 293 miles long.

Forestry.—The territory composing the state began with an exceptional wealth of forest, the conifers of the north and the deciduous trees of the south meeting within its limits. They contain 35 genera, and over 80 species of indigenous trees, of which

78 have economic value, or nearly as many as the entire continent of Europe, whose number Asa Gray estimates as 33 genera and 85 species. Nearly one-third of the state's area in 1896, 9,099,817 acres out of 28,937,600, was returned by assessors as woodland—much being scrub-oak and brush, but all abandoned to wood growth or but partly cleared. There has probably never been a time when nearly one-third of its area was not so overgrown with trees, large or small, as not to be open to cultivation, though the share of this in timber is not over a quarter of the area of the state. In its original condition, a yield of hemlock (spruce) of 30,000 feet board measure to the acre, or of white pine of 50,000 feet board measure, was usual. The Delaware, Allegheny, and Susquehanna were successively lumber centres. In 1880 the lumber product was $22,457,359, only exceeded by Michigan ($52,449,928). In 1890 this product was $27,772,834, and that of Michigan $73,484,306. Local statistics of the yield were not preserved, but at Williamsport, the last great lumbering centre, in the seven years 1873–80 the pine yield was 7,395,455 logs and 1,266,608,045 feet board measure. The yield of the four Delaware river counties was estimated, prior to exhaustion, at 12,000,000,000 feet board measure of pine. In 1897 the state forester, Dr J. T. Rothrock, reported white pine at 500,000,000 feet; spruce, 70,000,000; and hemlock, 5,000,000,000. By the close of the ninth decade of the 19th century exhaustion was seen to be near. In the eastern fifth of the state only 12 per cent. of the area was under timber; in the elevated west, 28 per cent.; and in the valleys of the east and west, 24 per cent. Over a sixth of the area of the state is at an elevation of 1500 to 2000 feet, and a broad belt 2000 to 3000 feet high is economically unfit for any cultivation but forestry, having a mean annual temperature of 40° to 45° F., a climate similar to that of northern New England. Forest fires yearly sweep broad areas of this region, which would otherwise reforest. In 1880, 685,738 acres were burned, with a loss of $3,043,723. During the decade ending with 1890 the annual loss was estimated at $1,000,000. In 1896 it was $557,056, in 1897, $394,327, and in 1898, $53,345. This reduction is believed to be due to legislation for reforesting the state. Penn, in his regulations, provided that one acre in four of woodland should be preserved. This wise provision was altogether neglected, and desultory statutes in regard to fires, the first in 1735, were the only legislation for the preservation of timber. In 1860, 1870, and 1879 statutes more stringent were formed to prevent fires. In 1887 a yearly bounty of 45 cents an acre was offered for timber; in 1893 a state forestry commission was established; and in 1897 Acts were passed for fire-wardens, providing means for detecting forest fires, for forest reserves, and for the state purchase of waste land sold for taxes, of which about 2300 square miles are yearly sold, usually land from which the timber has been stripped. Forest reserves of 40,000 acres each have been (1900) bought on the head-waters of the Delaware in Pike and Monroe counties, in Clinton, Cameron, and Center counties on the Susquehanna, and on the Allegheny.

Agriculture.—Of the total area of the state, only one-half has ever been reduced to cultivation in improved farm lands. This reached its maximum in 1880 in 213,542 farms of 19,791,341 acres, 13,423,007 improved and 6,368,334 unimproved. In 1900 the farms were 224,248, of 19,371,015 acres, 13,209,183 acres improved and 6,161,832 unimproved, employing 331,119 persons, 30,007 more than in 1880. The change measures the increase of lands used as woodland for collieries, and for industrial purposes. Tanneries in 1892 held 749,017 acres of bark lands, valued at $11,383,920. The growth of paper and other industries constantly turns farm lands near the margin of cultivation to other purposes. The valuation of farm lands was in 1870, $1,119,786,853 (gold at 15 per cent. premium); in 1890 it was $1,062,939,846; and in 1900 was $1,051,629,173. From 1870 to 1900 the selling value of farm lands in the eastern and centre parts of the state fell about one-third, many failing under foreclosure to reach their mortgage value. In the decade 1880–90 the farms cultivated by owners fell from 168,220 to 162,219, but rose again in 1900 to 165,982. Of the area under cultivation, one-third, 4,738,194 acres, in 1899 was under cereals and 3,269,441 acres under hay, producing 4,020,388 tons. Over one-half the farm area is devoted to these crops, whose yield has been stationary since 1880 (the increase from 1850 to 1899 keeping pace with acreage) and in 1899 the crop was: Indian corn, 51,869,780 bushels; wheat, 20,632,680; and oats, 37,242,810. The great change in the agriculture of the state is in sheep—1,749,301 in 1870 and 959,483 in 1900. Milch cows have in part taken their place—706,437 in 1870; 943,773 in 1900. Tobacco is the largest special crop—in 1899, 27,760 acres, 41,502,620 ℔.

Manufactures.—Pre-eminence in iron and steel industries made Pennsylvania the leading manufacturing state up to 1890. The relative increase of textiles and lesser industries has advanced other states, but in 1890, with 39,339 establishments, a capital of $991,243,115, and an output of $1,331,794,901, one-third in iron, and 620,562 persons employed, Pennsylvania was exceeded only by New York. In 1900 it still ranked as the second manufacturing state, having 52,185 establishments, with $1,551,548,712 of capital, employing 733,834 hands, and with a product valued at $1,834,790,860. The percentage of increase in the value of the product for the preceding decade was 37·8. In 1850 Pennsylvania had approximately one-sixth of the manufacturing capital and product of the country, and in 1900 over one-seventh of each, so that its relative position has been fairly maintained.

The following table shows the leading industries and the value of the product in 1890 and 1900:—

Industry.	1890.	1900.
Iron and steel . . .	$264,571,624	$434,445,200
Foundry and machine-shop products	67,587,025	127,292,440
Leather	49,931,716	55,615,009
Cars and repairs by railway companies . . .	28,769,728	43,065,171
Flouring and grist mill products	39,478,076	36,639,423
Printing and publishing .	34,408,493	36,455,629
Sugar and molasses refining .	46,599,754	36,163,817
Lumber products . . .	29,087,920	35,749,965
Petroleum refining . .	18,498,777	34,977,706
Liquors	22,698,423	34,520,358
Tobacco	23,387,910	33,355,932
Silk and silk goods . .	19,357,546	31,072,926
Cotton goods . . .	18,431,773	25,447,697
Woollen goods . . .	29,878,010	25,389,344
Slaughtering and meat-packing	21,991,604	25,238,772

Other important industries were men's clothing, newspapers and periodicals, carpets and rugs, worsted goods, coke, glass, and hosiery and knitted goods.

Mineral Products.—The petroleum, coal, coke, and iron deposits of the state, after standing almost alone to 1880, entered during the following 20 years on a competition whose results were apparent in labour disturbances and a reduction of profits on previously invested capital. In 1880 the production of petroleum, 26,027,631 barrels, was practically that of the country. In 1898 the Pennsylvania field yielded 15,948,464 barrels, 28·83 per cent. of the entire yield of 55,364,233 barrels. In natural gas the state yield in 1895, valued at $4,500,000, was nearly that of the whole country. In 1898 the Pennsylvania product was valued at $6,806,742, or 44·12 per cent. of all the states. In 1880 the bituminous coal mined in the state, 26,229,031 short tons, was 61·28 per cent. of the total. In 1898 a yield of 65,165,133 tons was but 39·49 per cent. of the entire product. The anthracite coal, which nearly doubled from 1870 to 1880 (1870, 15,596,257 tons; 1880, 28,612,575), under this competition made but about the same advance in the next 18 years, reaching, in 1898, 53,382,644 tons. The coke yield, 1880, 2,821,384 tons, 84·72 per cent. of the total, rose to 10,715,302 tons in 1898, but sank to 66·97 per cent. of the whole American yield. Iron ore in 1880, 1,820,561 long tons, was 20·59 per cent. of the total product, and in 1898, 1,773,082 tons, 3·98 per cent. of the entire ore output of the United States. Cheap fuel and high skill, however, maintained the iron supremacy of the state. In 1870 the state yield of pig iron, 1,836,808 tons, was 50·32 per cent. of the total for the country, and in 1899 it was 6,558,878 tons, or 48·23 per cent., never having been less than 46 per cent. in the interval, coke taking the place of anthracite and Lake Superior of local ores. Bessemer steel, 1899, 4,473,493 tons, was 54·42 per cent., a slightly larger proportion than a decade before. Rolled steel and iron in all forms in 1873, 835,584 tons, was 42·63 per cent., in 1898, 4,622,770 tons, 54·32 per cent. of all rolled in the United States. In 1901 the pig iron produced in the state was 7,343,257 tons; the bituminous coal, 80,914,236 tons; and the anthracite coal, 59,905,951 tons. In stone, the state's product in 1880 was $1,944,208, 10·62 per cent. of the total, and in 1898, $5,993,616, or 15·60 per cent. This was due to the increase in slate, $2,421,756, 1898, 64·29 per cent. of the total, the state product having trebled since 1880, when it raised 56·83 per cent. of all. Clay products, 1898, $9,642,098, were 13·47 per cent. of the total. The Portland cement yield, 221,000 barrels, then 65·91 per cent. of the total, increased to, 1898, 2,095,114 barrels, but sank to 26·30 per cent. of all produced. (T. W*.)

Pennsylvania, University of.—The University of Pennsylvania, situated at Philadelphia, Pa., had its beginning in 1740, and was incorporated under its present name in 1791. In 1850 it had 22 instructors and 586 students; in 1880, 97 instructors and 972 students; in 1890, 180 instructors and 1579 students; in 1900 it had 260 instructors and 2673 students. The student body represented 41 states of the Union and 30 foreign countries. The university property consisted (1901) of 57 acres, on which are 32 buildings. Of these only 4 existed prior to 1880, and 20 were erected between 1890 and 1900. The buildings and equipments were valued at $6,455,218, of which $4,965,261 had been expended since 1890. For the year 1901 the expenditure for educational purposes was $716,380. The undergraduate (college) courses are in arts, sciences, finance and economy, and music. There are graduate (philosophy) courses; schools of law, medicine, dentistry, veterinary medicine, hygiene; hospitals of medicine and surgery, and of veterinary surgery; a school for nurses; a general museum of science and art, especially archæological; a special institute of anatomy and biology; an astronomical observatory; a general and some special libraries. Athletics and physical education are under careful official supervision, and a large athletic field is provided. There are a students' club house, a dining hall, and a system of dormitory houses of the latest hygienic construction, and several substantial fraternity houses. (See also EDUCATION and UNIVERSITIES.) (C. C. H*.)

Penn Yan, a village of New York, U.S.A., capital of Yates county, at the foot of Keuka Lake, on the Northern Central and the Fall Brook railways, west of the central part of the state, at an altitude of 750 feet. It is in the grape-growing region of central New York, for which it serves as a shipping point. Population (1880), 3475; (1890), 4254; (1900), 4650, of whom 449 were foreign-born and 67 negroes.

Penryn, a municipal borough (since 1216), parliamentary borough, and market town, in the Truro parliamentary division of Cornwall, England, situated on an arm of Falmouth harbour, 2 miles north-west of Falmouth, on the Great Western Railway. The borough returned two members to Parliament until 1885, when the number was reduced to one. A Wesleyan chapel was built in 1891. Granite, which is extensively quarried in the county, is dressed and polished here; chemical and bone manure is also manufactured, and there are engineering works and an iron foundry. Population (1881), 3466; (1891), 3256; (1901), 3190.

Pensacola, a city and seaport of Florida, U.S.A., capital of Escambia county, on Pensacola Bay, in the western part of the state. The harbour is excellent, with 24 feet of water at the entrance, and the city has an extensive export commerce, consisting largely of lumber, fruit, vegetables, and cotton. It has two railways, the Louisville and Nashville, and the Pensacola, Alabama, and Tennessee. Its street plan is regular, it has a good water-supply and sewer system, and varied manufactures. Population (1890), 11,750; (1900), 17,747, of whom 1105 were foreign-born and 8561 negroes.

Pensions (*United States*).—The American "Pension Fund" is so singular a feature of the national budget, that it is desirable to give here an account of the different classes of allowances which are granted.

Old war pensions.

In the United States allowances for services in wars prior to 4th March 1861 are called "old war" pensions, and may be divided into three classes, viz., (1) invalid pensions, based upon wounds or injuries received, or disease contracted in the course of duty, (2) "service" pensions, and (3) land bounties, both granted for service irrespective of injuries.

The first provision made by Congress for pensions was a resolution passed 26th August 1776, promising invalid pensions to officers and men of the army or navy who lost a limb or were otherwise disabled in the Revolutionary war, at a rate equal to half of their monthly pay as officers or soldiers during life or continuance of the disability, those not totally disabled to receive an adequate monthly pension not to exceed half of their pay. Then followed various Acts of Congress enlarging the provisions for invalid pensions and extending them to those who had been in the war of 1812, and to the widows and children of those who died in the war or from wounds received in the war. The Act of 3rd May 1846 provided for the prosecution of the war with Mexico and for pensioning those volunteers wounded or otherwise disabled in service. Other Acts were subsequently passed making further provision for pension on account of service in the Mexican war. The first general law granting "service" pensions was not passed until 18th March 1818, thirty-five years after the termination of the war of the American Revolution. Its beneficiaries were required to be in indigent circumstances and in need of assistance from their country. Two years later Congress became alarmed by reason of the large number of claims filed (about 8000), and enacted what was known as the "Alarm Act," requiring each applicant for pension and each pensioner on the rolls to furnish a schedule of his whole estate and income, clothing and bedding excepted. Many pensioners were dropped who were possessed of as much as $150 worth of property. Numerous Acts were, however, passed from time to time liberalizing the law or dealing more generously with the survivors of the Revolution. Service pensions were not granted to widows of the soldiers of this war until 1836, and then only for a period of five years and on condition that the marriage of the soldier was prior to his last service, and that the soldier's service was not less than six months. In 1853, seventy years after the close of the war, the limitation as to the time of marriage was removed. The rolls in 1901 contained nine pensions based upon service in the Revolutionary war. The first law granting service pensions on account of the war of 1812 was passed in 1871, fifty-six years after the close of the war. This Act required sixty days' service. Widows were not pensionable unless the marriage to the soldier had taken place prior to the treaty of peace of 15th February 1815. On 9th March 1878, sixty-three years after the war, an Act was passed reducing the requisite period of service to fourteen days and removing the limitations as to date of marriage. In 1901 the pension rolls contained the names of one survivor and 1527 widows of this war. Service pensions were provided for those who served in the Black Hawk war, Creek war, Cherokee disturbances, and the Seminole war (1832 to 1842), on 27th July 1892, fifty years after the period embraced in the Act: they were granted to those who had served for thirty days and were honourably discharged, and to their widows. In 1901 there were 1086 survivors and 3479 widows pensioned under this Act. Service pensions were granted to the survivors of the war with Mexico by an Act passed 29th January 1887, thirty-nine years after the Guadeloupe-Hidalgo treaty. The pensions were granted to those who were honourably discharged, and to their widows, for service of sixty days, if sixty-two years of age, or disabled or dependent. This law was liberalized by the Acts of 5th January 1893 and 23rd April 1900, increasing from $8 to $12 per month the pension to survivors who are totally disabled and destitute. In 1901 the pension rolls contained the names of 7568 survivors and 8109 widows on account of service in the Mexican war. To give title to bounty land, service must have been for at least fourteen days or in a battle prior to 3rd March 1855; and if in the navy or regular army, must have been in some war in which the United States was engaged. Bounty land warrants are issued for 160 acres, and over 70,000,000 acres have been granted under the different Bounty Land Acts.

Civil War pensions.

For services rendered in the War of the Rebellion (1861–65) in the army or navy of the United States, or in their various branches, the law provided two distinct systems of pensioning—(1) the general laws, granting pensions for wounds or injuries received, or disease contracted in service in the line of duty, the pensions ranging from $6 to $100 per month; and (2) the so-called Dependent Pension Act, granting pensions for permanent disabilities regardless of the time and manner of their origin, provided they were not the result of vicious habits, the pensions ranging from $6 to $12 per month. What is known as the general law for disabilities incurred in service and in the course of duty was constituted in the Act of 14th July 1862 as amended by the Act of 3rd March 1873. Under its provisions the following classes of persons are entitled to benefit, viz., any officer of the army, including regulars, volunteers, and militia, or any officer in the navy or marine corps, or any enlisted man, however employed, in the military or naval service of the United States, or in its marine corps, whether regularly mustered or not; any master serving on a gunboat, or any pilot, engineer, sailor, or other person not regularly mustered, serving upon any gunboat or war-vessel of the United States; any acting assistant or contract surgeon; any provost-marshal, deputy provost-marshal, or enrolling officer; subject to the several conditions in each particular case prescribed in the law. This law also embraces in its provisions the following classes, each class being subject to certain specified conditions, viz., widows, children under sixteen years of age, dependent parents, and brothers and sisters. This Act has been the subject of numerous amendments along more liberal lines. As an illustration a case may be cited where a soldier lost both hands in the service in the course of duty, and was discharged in 1862. He is entitled to a pension of $8 per month from the date of his discharge. Under subsequent Acts he is entitled to $25 per month from 4th July 1864; $31.25 from 4th June 1872; $50 from 4th June 1874; $72 from 17th June 1878, and $100 from 12th February 1889.

Under the general law a widow or dependent relative cannot be pensioned unless the cause of the soldier's death originated in service in the line of duty; if it is so shown, a widow may be pensioned whether she is rich or poor. Upon the death or remarriage of the widow the minor children of the soldier under the age of sixteen years are entitled to pension. If the soldier died of causes due to his service, and left no widow or minor children, his other relatives become entitled, if dependent, in the following order, viz.: First, the mother; secondly, the father; thirdly, orphan sisters and brothers under sixteen years of age, who shall be pensioned jointly. In 1901 the number of invalids pensioned under the general law was 301,230, and the number of widows and dependent relatives was 90,851.

The so-called Dependent Pension Act is based upon an Act of Congress approved 27th June 1890, which was amended on 9th May 1900. Properly speaking, it may be called "dependent" only as regards widows and parents. The main conditions as to the soldier or sailor are, ninety days' service, an honourable discharge, and a permanent disability from disease or otherwise, not the result of his own vicious habits, to such an extent as to render him unable to maintain himself by manual labour. The rates of pension under this Act are $6, $8, $10, and $12 per month. Widows become entitled under this law if they married the soldier or sailor prior to 27th June 1890, provided they are without means of support other than their daily labour, and an actual net income not exceeding $250 per year, and have not remarried. Claims of children under sixteen years of age are governed by the same conditions as apply to claims of widows, except that their dependence is presumed, and need not be shown by evidence. If a minor child is insane, idiotic, or otherwise physically or mentally helpless, the pension continues during the life of said child or during the period of disability. In 1901 there were 438,114 invalids on the rolls, and 145,111 widows and dependents. All women employed by competent authority as nurses during the War of the Rebellion for six months or more, who are unable to earn a support, are granted a pension of $12 per month by an Act of 5th August 1892. In 1901 the pension rolls contained the names of 650 pensioners under this Act.

Other benefits.

In addition to pensions, the United States Government grants the following gratuities:—*First:* If a soldier lost a limb in the service, or as a result of his service in line of duty, he is furnished with an artificial limb free of cost every three years, or commutation therefor, and transportation to and from a place where he shall select the artificial limb. *Second:* An honourably discharged soldier or sailor is given preference for appointment to places of trust and profit, and preference for retention in all civil service positions. *Third:* There are nine National Soldiers' Homes situated at convenient and healthy points in different parts of the country, where comfortable quarters, clothing, medical attendance, library, and amusements of different kinds are provided free of all expense; Government providing the soldiers free transportation to the home, continuing payments of pension while they are members of the home, and increasing the same as disabilities increase. *Fourth:* There are twenty-nine homes maintained by the different states, which are similar in their purpose to the National Homes, the sum of $100 per year being paid by the general Government for each inmate. Many of these state homes also provide for the wives and children of the inmates, so that they need not be separated while they are members of such home. *Fifth:* Schools are established by the different states for the maintenance and education of soldiers' orphans until they attain the age of sixteen years.

Amount paid for pensions.

From the close of the Civil War in 1865 to 1901 the Government of the United States paid to its pensioners the sum of $2,666,904,589. The payments for the fiscal year ended 30th June 1901 were $138,531,483. Over $17,000,000 has been paid to surgeons for making medical examinations of pensioners and applicants for pensions. The amount paid to pensioners under the so-called Dependent Pensions Act is over $600,000,000. The total amount paid for pensions from 1st July 1790 to 30th June 1865 was $96,445,444, making a total disbursement for pensions from 1790 to 1901 of $2,763,350,033. No other nation or government in all time has dealt so liberally with its defenders.

The appropriations for the support of the National Homes for 1900 amounted to $3,783,450, and appropriation for artificial limbs to $549,275. The money appropriated by Congress for the payment of pensions is disbursed by eighteen pension agents established in different parts of the country. Pensions are paid quarterly, and the agencies are divided into three classes, one of which pays on the 4th of every month. (H. C. E.)

Penza, a government of east central Russia, south of Nijni-Novgorod, with an area of 14,997 square miles. Population (1881), 1,356,600; (1897), 1,491,215, of whom 767,391 were women, and 137,560 lived in towns. It is divided into ten districts, the chief towns of which are Penza, Gorodische (3973), Insar (4264), Kerensk (4006), Krasnoslobodsk (7378), Mokshany (10,072), Narovchat (4695), Nijni Lomoff (9984), Saransk (13,743), Chembar (5335). The schools, chiefly owing to the efforts of the *zemstvo* (provincial council), are comparatively good; school farms and gardens have increased. More than one-sixth of the area is still under forests (1,661,900 acres in 1898, as against 2,564,400 acres in 1869). More than one-half (4,955,000 acres) is owned by the village communities, while 3,482,000 acres are in the hands of private owners. No less than 3,381,100 acres were under cereals in 1900, and 263,700 acres under roots, flax, tobacco, &c. The annual average yield of the crops in 1895–99 was: rye, 11,263,000 cwt.; wheat, 484,000; oats, 4,007,000. Total crop of cereals, 17,811,000 cwt.; potatoes, 5,676,000 cwt. Grain and flour are considerable exports. The local authorities have established depots for the sale of improved agricultural machinery, the use of which is rapidly spreading among the peasants. There are also several agricultural and horticultural schools, and two model dairy-farms. Cattle-breeding and especially horse-breeding are comparatively flourishing, there being (1896) 352,500 horses, 270,130 horned cattle, 945,500 sheep, and 200,900 pigs in the government. The peasants are relatively well provided with cattle, there being 112 horses, 86 horned cattle, and 255 sheep to every 100 households. Bees are kept in large numbers. Factories afford employment to only about 14,000 persons (annual returns about £1,000,000). Spirits, oils, matches, paper, and timber are the principal manufactures.

Penza, the capital of the above province, 440 miles by rail south-east of Moscow. It has four lyceums for boys and girls, one *real-schule*, several technical schools (railway, gardening, and drawing, the last with a fine art gallery), five public libraries, a museum of antiquities, a theatre, and ten hospitals. There is a considerable trade in grain, spirits, and timber. Population (1897), 61,851.

Penzance, a municipal borough, seaport, and market town in the St Ives parliamentary division of Cornwall, England, at the head of Mounts Bay, 26 miles west-south-west of Truro by rail. The spacious new dock was completed in 1887. The harbour has a total area of 24 acres, with 12 to 16 feet depth of water; and there are a floating dock and a graving dock. Modern erections are public baths, swimming baths, mining and science schools, a free library, and a convalescent home. The West Cornwall Infirmary has been extended. Penzance became a meteorological station in 1893. In 1900 the registered shipping totalled 53 vessels of 6615 tons. In the same year the port was entered by 1476 vessels of 229,608 tons and cleared by 1424 vessels of 220,877 tons. The whole value of the trade was £71,205, about three-fourths of this being for imports. Area, 472 acres. Population (1881), 12,409; (1891), 12,432; (1901), 13,123.

Peoria, a city of Illinois, U.S.A., capital of Peoria county, on the Illinois river, north-west of the centre of the state, at an altitude of 459 feet. Most of the city is built on a terrace above the river, whence it spreads to the bluff at the back, on which is a fine residential quarter. Its street plan is regular, and it is divided into seven wards. Its water-works are owned by the city, and it has a good sewerage system. Its streets are well paved, mainly with brick. Peoria is in a fertile agricultural region, and is one of the great grain markets of the Mississippi valley. It is the centre of no fewer than thirteen railways, which, with the river, here navigable, give it a large commerce. In 1900 it contained 871 manufacturing establishments, with a total capital of $27,971,613, employing 8022 hands. The products were valued at $48,871,596. These were extremely varied, but over one-half, or $26,792,354, were distilled liquors. The city contains, moreover, several large grain elevators. The assessed valuation of real and personal property was in 1900 placed at the extremely low estimate of $9,353,906, the net debt of the city was $779,685, and the rate of taxation was $89.10 per $1000. Population (1890), 41,024; (1900), 56,100, of whom 8945 were foreign-born and 1402 negroes.

Pepper, William (1843–1898), American physician, was born in Philadelphia, 21st August 1843. He was educated at the University of Pennsylvania, graduating from the academic department in 1862 and from the medical department in 1864. In 1868 he became lecturer on morbid anatomy in the same institution, and in 1870 lecturer on clinical medicine. From 1876 to 1887 he was professor of clinical medicine, and in 1887 succeeded Dr Stillé as professor of theory and practice of medicine. He was elected provost of the university in 1881, resigning that position in 1894. For his services as medical director of the Centennial Exposition in 1876 he received the decoration of knight commander of the order of St Olaf from the king of Sweden. He founded the *Medical Times*, and was editor of that journal in 1870–71. Among the members of his profession he was known particularly for his contributions to the literature on the subject of the theory and practice of medicine, and the *System of Medicine* which he edited in 1885–86 became one of the standard text-books in America. He contributed to the medical and scientific journals of the day, including "Trephining in Cerebral Disease," 1871; "Local Treatment in Pulmonary Cavities," 1874; "Catarrhal Irrigation," 1881; "Epilepsy," 1883; and "Higher Medical Education: the True Interest of the Public and the Profession." He died 28th July 1898. (E. H. W.)

Pêrak. See MALAY STATES (FEDERATED).

Pereda, José María de (1834-——), one of the most distinguished of Spanish novelists, was born at Polanco near Santander in 1834. He was educated at Santander grammar school, whence he went to Madrid, where he studied engineering with the vague purpose of entering the artillery corps. Abandoning this design after three years' trial, he returned home and began his literary career by contributing articles to a local journal, *La Abeja Montañesa* in 1859. He also wrote much in a weekly paper, *El Tío Cayetán*, and in 1864 he collected his sketches under the title of *Escenas Montañesas*. These studies of local life and manners gained Pereda a considerable reputation in his province, but they failed to please the general public. Their originality, their total lack of sentimentalism, and their powerful realism were unacceptable novelties, and a popular novelist of the period, Antonio de Trueba, rebuked the author for his pessimistic view of life. Pereda fought against the revolution of 1868 in *El Tío Cayetán*, writing the newspaper almost single-handed. His articles against the revolutionists were more widely read than his *Ensayos dramáticos* (1869), and in 1871 he was elected as the Carlist deputy for Cabórniga. In this same year he published a second series of *Escenas Montañesas;* and in 1876 appeared *Bocetos al temple*, three tales, in one of which the author describes his disenchanting political experiences. The *Tipos trashumantes* belongs to the year 1877, as does *El Buey suelto*, which is intended as a reply to the thesis of Balzac's work, *Les petites misères de la vie conjugale.* More and more pessimistic as to the political future of his country, Pereda takes occasion in *Don González de la Gonzalera* (1878) to ridicule the revolution as he had seen it at work, and to pour scorn upon the *nouveaux riches* who exploited Liberalism for their personal ends. Two novels by his friend Pérez Galdós, *Doña Perfecta* and *Gloria*, drew from Pereda a reply, *De tal palo tal astilla* (1879), in which he endeavours to show that tolerance in religious matters is disastrous alike to nations and to individuals. The *Esbozos y Rasguños* (1881) is of lighter material, and is less attractive than *El Sabor de la Tierruca* (1882), a striking piece of landscape which won immediate appreciation. New ground was broken in *Pedro Sánchez* (1883), where Pereda leaves his native province to portray the disillusion of a sincere enthusiast who has plunged into the political life of the capital. The book was a dangerous experiment, upon which Pereda ventured with much hesitation; but the result has justified his boldness, for, though *Pedro Sánchez* is not actually his best work, it would suffice to make the reputation of any writer. Pereda's masterpiece is *Sotileza* (1884), a vigorous rendering of marine life by an artist who perceives and admires the daily heroisms of his fisher-folk. It has often been alleged against the author that he confines himself to provincial life, to lowly personages and to unrefined subjects, and no doubt an anxiety to clear himself from this absurd reproach led him to attempt a description of society at the capital in *La Montálvez* (1888). If not an absolute failure, *La Montálvez* is certainly the least interesting of his performances. In *La Puchera* (1889) he returned to the marine subjects which he knows and loves best. Again, in *Peñas arriba* (1895), the love of country life is manifested in the masterly contrast between the healthy, moral labour of the fields and the corrupt, squalid life of cities. Pereda belongs to the native realistic school of Spain, which, founded by the unknown author of *Lazarillo de Tormes*, was continued by Mateo Alemán, by Cervantes, by Quevedo, by Castillo Solórzano, and many others. With the single exception of Cervantes, however, the picaresque writers are almost entirely wanting in the spirit of generous sympathy and tenderness which constitutes a great part of Pereda's charm. His realism is purely Spanish, as remote from M. Zola's moroseness as it is remote from the graceful sentimentality of Pierre Loti. Few writers in any country possess the virile temperament of Pereda, and, with the single exception of Tolstoi, none keeps a moral end more steadily in view. This didactic tendency unquestionably injures his effects. Moreover, his grim satire occasionally degenerates into somewhat truculent caricature, and the excessive use of dialect and technical terms (which has caused the author to supply *Sotileza* with a brief vocabulary) is a grave artistic blemish. But he sees, knows, understands character; he creates not only types, but living personages, such as Andrés, Cleto, and Muergo in *Sotileza*, as Pedro Juan and Pilara in *La Puchera;* and he personifies the tumult and calm of the sea with more power than Victor Hugo displayed in *Les Travailleurs de la Mer*. His descriptive powers are of the highest order, and his style, pure of all affectations and embellishments, is of singular force and suppleness. The statutes of the Spanish Academy, which require members to reside in Madrid, were specially suspended in his favour. The compliment was no more than Pereda deserved, for, with all his limitations, he is as original a genius as Spain has produced during the 19th century.

Pérez Galdós, Benito (1845-——), was born at Las Palmas, in the Canary Islands, in 1845. In 1863 he was sent to Madrid to study law, drifted into literature, and was speedily recognized as one of the most promising recruits on the Liberal side. Shortly after the revolution of 1868 he abandoned journalism, and employed fiction as the vehicle for propagating advanced opinions. His first novel, *La Fontana de Oro*, was printed in 1871, and later in the same year appeared *El Audaz;* from the very beginning Pérez Galdós was copious. The reception given to these early essays encouraged the writer to adopt novel-writing as a profession. He had already determined upon his scheme—and he proceeded with incredible labour to prepare himself for the task before him—of producing in the "Episodios Nacionales" a series which might compare with the "Comédie Humaine." Old charters, old letters, old newspapers were collected by him with the minuteness of a German archivist; no novelist was ever more thoroughly equipped as regards the details of his period. *Trafalgar*, the first volume of the "Episodios Nacionales," appeared in 1879; the remaining books of this first series are entitled *La Cort de Carlos IV.*, *El 19 de Marzo y el 2 de Mayo*, *Bailén*, *Napoleón en Chamartín*, *Zaragoza*, *Gerona*, *Cádiz*, *Juan Martín el Empecinado*, and *La Batalla de Arpiles*. As the names suffice to show, the author's aim is to write the national epic of the 19th century in prose; and he so greatly succeeded that, long before the first series ended in 1881, he took rank among the foremost novelists of his time. A second series of "Episodios Nacionales," beginning with *El Equipaje del Rey José* and ending with a tenth volume, *Un Faccioso más y Algunas Frailes Menos*, was brought to a close in 1883, and is, like its predecessor, a monument of industry and exact knowledge, of realism and romantic conception. A third series of "Episodios Nacionales" now in progress will raise the total to thirty volumes. In fecundity and in the power of creating characters, Pérez Galdós vies with Balzac. Parallel with this immense achievement in historical fiction, Pérez Galdós has published a collection of romances dealing with contemporary life, its social problems and religious difficulties. Of these the best known, and perhaps the best, are *Doña Perfecta* (1876); *Gloria* (1877); *La Familia de Leon Roch* (1878); *Marianela* (1878); *Fortunata y Jacinta* (1887); and *Ángel Guerra* (1891). Nor does this exhaust his prodigious activity. Besides adapting several of his novels for stage purposes, he has written original dramas such as *La Loca de la Casa* (1893), and *San Quintín* (1894). As experiments these plays are peculiarly interesting; but the very diffuse, exuberant genius of Pérez Galdós can scarcely accommodate itself to the narrow convention of the theatrical form, and his incessant preoccupation with politico-social theories is a very serious blemish upon his art. This defect, though present, is less obvious in his novels; yet the rapidity with which these are produced—four yearly—naturally affects their style. Still, when all allowances are made, it must be admitted that in Pérez Galdós Spain possesses a genuinely national novelist of extraordinary talent, a fertile inventor of types, and a most happy humorist, who in his eccentrics and oddities is scarcely inferior to Dickens. He is a member of the Spanish Academy and is a deputy in the Cortes; but it is solely as the romancer that his name is familiar wherever Spanish is spoken.

Périgueux, chief town of the department of Dordogne, France, 297 miles south-south-west of Paris, on the railway from Bordeaux to Lyons and the river Isle, on the left bank of which is the suburb of Barris. The large seminary, rebuilt 1887–89, is one of the finest in France. Périgueux is said to be the most important market in France for young pigs. Excellent building stone is quarried. Population (1881), 22,331; (1901), 28,875.

Periodicals.—The history of the origin and development of periodicals (apart from newspapers) in all languages down to 1884 is traced in the article on the subject in vol. xviii. of this Encyclopædia (ninth edition). Since that date the number of periodicals in every country, especially in Great Britain and the United States, has increased enormously, and the tendency has been to specialize in every direction. All professions and trades have not only their general class-periodicals, but every section has its special review or magazine. There were 7 cycling periodicals published in Great Britain in 1884; in 1902 there were 16, besides 5 for motors and motoring. There were 15 insurance and 18 medical periodicals in 1884; in 1902 they numbered 33 and 47. Cheap periodicals appealing to a class of readers hitherto unprovided for, such as *Tit-Bits* (1881) and *Answers* (1888), and profusely illustrated magazines like the *Strand* (1891) and *Pearson's* (1896), which owe much to process-printing from photographs, have multiplied. Most of these publications do not preserve literary matter of permanent value, but the high-class reviews and the archæological, artistic, and scientific magazines contain a great mass of valuable facts, so that general and special indexes have become necessary to all literary workers. The *Edinburgh* and *Quarterly Reviews*, the *Revue des Deux Mondes*, the *Revue Historique*, *Deutsche Rundschau*, and others issue from time to time general indexes of their contents, while the periodical literature of special departments of study and research are noted in the various *Jahresberichte* published in Germany, and indexed monthly in such English and American magazines as the *Engineering Magazine*, the *Geographical Journal*, *English Historical Review*, *American Historical Review*, *Economic Journal* (for political economy), *Library Journal* and *Library Association Record* (for bibliography), and the *Educational Review.* There are also annual indexes, such as those in the *Zoological Record* and the *Annales de Géographie.*

The most complete collection of periodicals in all languages ever brought together is that preserved in the British Museum, and the excerpt from the printed catalogue of the library, entitled *Periodical Publications* (London, 1899–1900, 6 parts folio, with index), includes journals, reviews, magazines, and other works issued periodically, with the exception of transactions and proceedings of learned societies and of British and colonial newspapers later than 1700. The titles of these periodicals, which number about 23,000, are arranged under the town or place of their publication. The collection is very complete as regards Great Britain and Ireland, less perfect as regards the British colonies and the United States, and it includes the leading periodicals belonging to every other country in the world. An examination of the catalogue shows that about 3840 were published since 1880, many, of course, being of an ephemeral nature. Arranged geographically, these fall into the following divisions:—UNITED KINGDOM: England (1956), Wales (26), Scotland (106), Ireland (30); total, 2118. BRITISH COLONIES AND POSSESSIONS: Europe (22), Asia, including India (120), Africa, including Cape Colony (81), America (11), Canada (37), Australia (63), New Zealand (20); total, 354. EUROPE: Austria (72), Belgium (37), Bulgaria (5), Denmark (23), France (312), Germany (258), Greece (9), Holland (32), Italy (133), Portugal (15), Russia (39), Spain (37), Sweden and Norway (21), Switzerland (30), Turkey (2); total, 1025. ASIA: China (16), Japan (6), other countries (21); total, 43. AFRICA: Egypt (6), other countries (5): total, 11. NORTH AMERICA: United States (260), other countries (4); total, 264. SOUTH AMERICA: Argentine (6), Brazil (4), other countries (15); total, 25.

The magazines published in the United Kingdom number 2486 (Mitchell's *Newspaper Press Directory,* 1902). In 1884 the London monthlies were 699, and the quarterlies 129. In 1902 they numbered 1010 and 215 (May's *British and Irish Press Guide,* 1884, and Willing's *Press Guide,* 1902).

It is difficult sometimes to define a magazine or review as distinguished from a newspaper or a trade or professional journal, but the following is a representative list, omitting publications of societies, of existing British, American, French, German, Italian, and Spanish periodicals founded since 1880:—

BRITISH.—*Ancestor* (1902); *Anglican Church Magazine* (1886); *Anglo-Catholic* (1899); *Anglo-Saxon Review* (1899); *Annals of Botany* (1887); *Annals of Surgery* (1885); *Answers* (1888); *Antiquary* (1888); *Architects' Magazine* (1900); *Architectural Review* (1896); *Archives of Surgery* (1889); *Artist* (1880); *Author* (1890); *Babylonian and Oriental Record* (1887); *Baconiana* (1886); *Badminton Magazine* (1895); *Bankers' Journal* (1889); *Beekeepers' Record* (1883); *Bill Poster* (1887); *Bimetallist* (1895); *Black and White* (1891); *Board of Trade Journal* (1886); *Bookman* (1891); *Book-Prices Current* (1887); *Books of To-Day and Books of To-Morrow* (1894); *British Dental Journal* (1898); *British Empire Review* (1899); *British Gynæcological Journal* (1885); *British Journal of Dermatology* (1888); *Broadway* (1899); *Builders' Journal* (1895); *Cabinet Maker* (1880); *Camera Magazine* (1901); *Canadian Gazette* (1883); *Candid Friend* (1901); *Caxton Magazine* (1901); *Century Guild Hobby Horse* (1893); *Chamber of Commerce Journal* (1882); *Chimes* (1896); *Classical Review* (1887); *Connoisseur* (1901); *Cosmopolitan* (1886); *Country Life* (1894); *Economic Journal* (1891); *Economic Review* (1891); *Educational Review* (1890); *Engineering Magazine* (1881); *English Historical Review* (1886); *English Illustrated Magazine* (1883); *Feilden's Magazine* (1898); *Folklore* (1888); *Gardener* (1892); *Genealogical Magazine* (1897); *Geographical Journal* (1893); *Harmsworth Magazine* (1898); *Harper's Magazine,* English edition (1880); *Hibernia* (1897); *Home Counties Magazine* (1895); *Idler* (1892); *Imperial and Asiatic Quarterly Review* (1886); *Index of Archæological Papers* (1891); *Index to the Periodical Literature of the World* (1890); *International Journal of Ethics* (1889); *Investors' Review* (1889); *Jewish Quarterly Review* (1888); *Journal of Balneology and Climatology* (1897); *Journal of Hellenic Studies* (1881); *Journal of Hygiene* (1901); *Journal of Indian Art* (1886); *Journal of Laryngology* (1887); *Journal of Malacology* (1892); *Journal of Obstetrics* (1902); *Journal of Pathology* (1892); *Journal of Physical Therapeutics* (1900); *Journal of State Medicine* (1892); *Journal of the Board of Agriculture* (1896); *King* (1899); *Lady's Magazine* (1901); *Lady's Realm* (1896); *Laryngoscope* (1893); *Law Notes* (1882); *Law Quarterly Review* (1885); *Legal Literature* (1899); *Library* (1889); *Library Assistant* (1898); *Library Association Record* (1899); *Library World* (1898); *Literary Gazette* (1898); *Literature* (1897; combined with *Academy,* 1901); *Longman's Magazine* (1882); *M'Clure's Magazine,* English edition (1894); *Medical Magazine* (1892); *Medical World* (1896); *Metaphysical Magazine* (1896); *Modern Language Quarterly* (1897); *Monthly Magazine of Fiction* (1885); *Monthly Review* (1900); *Moring's Quarterly* (1896); *Motor Car World* (1899); *Munsey's Magazine* (1900); *Museums Journal* (1901); *Musical News* (1891); *National Review* (1883); *Nature Notes* (1890); *New Ireland Review* (1894); *New Liberal Review* (1901); *Onlooker* (1900); *Open Court* (1887); *Ophthalmic Review* (1881); *Optician* (1891); *Outlook* (1898); *Page's Magazine* (1901); *Pall Mall Magazine* (1893); *Patents* (1895); *Pearson's Magazine* (1896); *Pearson's Weekly* (1890); *Philatelic Journal* (1901); *Physical Review* (1893); *Pick-me-up* (1888); *Pilot* (1900); *Playgoer* (1901); *Positivist Review* (1895); *Quarterly Medical Index* (1900); *Quarterly Medical Journal* (1890); *Railway Engineer* (1880); *Reporters' Magazine* (1880); *Review of Reviews* (1890); *Royal Magazine* (1898); *St George* (1898); *St Martin's-le-Grand* (1890); *Sandow's Magazine* (1898); *Scandinavian* (1881); *Science Abstracts* (1898); *Science Siftings* (1891); *Scientific Roll* (1880); *Scribner's Magazine,* English edition (1887); *Secretary's Journal* (1893); *Sketch* (1893); *Smart Set,* English edition (1901); *Something to Read* (1881); *Speaker* (1890); *Sphere* (1900); *Stage* (1880); *Strand Magazine* (1891); *Studio* (1893); *Sunday Strand* (1899); *Tatler* (1901); *Temple Magazine* (1896); *Tit-Bits* (1881); *To-Day* (1893); *Travel* (1896); *Twentieth Century* (1900); *Universal Magazine* (1900); *Wide World Magazine* (1898); *Windsor Magazine* (1895); *Young Man* (1887); *Young Woman* (1892); *Zoophilist* (1881).

AMERICAN.—*Alienist and Neurologist* (1880); *American Amateur Photographer* (1888); *American Book Lore* (1898); *American Geologist* (1888); *American Engineer* (1893; commenced as *Railroad and Engineering Journal,* 1887); *American Journal of Archæology* (1885); *American Jewish Year Book* (1899); *American Journal of Philology* (1880); *American Journal of Psychology* (1887); *American Journal of Semitic Languages* (1893; commenced as *Hebraica,* 1884); *American Journal of Sociology; Annual of the Universal Medical Sciences* (1888); *Annual Literary Index* (1892); *Arena* (1889); *Astrophysical Journal* (1895; commenced as *Sidereal Messenger,* 1882); *Biblical World; Bibliographer* (1902); *Book Chat* (1886); *Bookman* (1895); *Book Lover; British American* (1887); *Cassier's Magazine* (1891); *Chapbook* (1894); *Chatauquan* (1880); *Christian Science Journal* (1896); *Churchman* (1893); *Collector* (1887); *Cosmopolitan* (1886); *Critic* (1881); *Educational Review* (1891); *Electricity* (1891); *Engineering and Mining Journal* (1893); *Esoteric* (1888); *Forum* (1886); *Gunton's Magazine of American Economics* (1896; commenced as *Social Economist,* 1891); *Federal Reporter* (1880); *Harvard Law Review* (1894); *Humanitarian* (1892); *Intelligence* (1897; commenced as *Metaphysical Magazine,* 1895); *Journal of Morphology* (1887); *Journal of Political Economy* (1892); *Journal of Practical Metaphysics* (1896); *Journal of U.S. Artillery* (1891); *Kipling Note Book* (1899); *Ladies' Home Journal* (1882); *Library Notes* (1886); *Literary News* (1880); *McClure's Magazine* (1893); *Mazama* (1897); *Medico-Legal Journal* (1882); *Modern Language Notes* (1886); *Monist* (1890); *Municipal Affairs* (1897); *Nautilus* (1889); *New Church Review* (1894); *New Science Review* (1894); *New York Genealogical and Biographical Record; New World* (1892); *Notes on New Books* (1890); *Open Court* (1887); *Pediatrics* (1896); *Philosophical Review* (1892); *Photo American Review* (1891); *Poet Lore* (1889); *Popular Astronomy* (1893); *Præco Latinus; Presbyterian and Reformed Review* (1890); *Psychological Review* (1894); *Quarterly Journal of Economics; Records of the Past; Ring Record* (1896); *Science* (1883); *Scribner's Magazine* (1887); *Select Notes* (1895); *Sewanee Review* (1892); *Statistician and Economist* (1893; commenced as *McCarty's Annual Statistician,* 1884); *Street Railway Gazette* (1886); *Terrestrial Magnetism* (1896); *Virginia Magazine; West American Scientist* (1885); *Woman's Journal; Yale Review* (1892).

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Peripatus.—Peripatus is a genus of animals belonging to the air-breathing division of the phylum Arthropoda. It differs, however, from all other Arthropoda in such important respects that a special class, equivalent in rank to the old-established Arthropod classes, has been created for its sole occupancy. This class has been named the Prototracheata or Onychophora, and may be most appropriately placed in the system in the neighbourhood of the Myriapoda, though it must not be forgotten that it differs from the Myriapoda more than the Myriapoda differ from other Arthropoda, and that in some respects it presents features which recall the segmented worms (Annelida). The genus has a wide distribution (see later), but it has not been found in Europe or in North America. There is but little variety of structure in the genus, and the species are limited in number. They live beneath the bark of trees, in the crevices of rock and of rotten stumps of trees, and beneath stones. They require a moist atmosphere, and are exceedingly susceptible to drought. They avoid light, and are therefore rarely seen. They move slowly, picking their course by means of their antennæ. When irritated they eject with considerable force the contents of their slime reservoirs by means of the sudden contraction of the muscular body-wall. The slime, which appears to be harmless, is extremely sticky, but it easily comes away from the skin of the animal itself. Locomotion is effected by means of the legs, with the body fully extended. Hutton describes his specimens as sucking the juices of flies, which they had stuck down with their slime, and they have been observed in captivity to devour the entrails which have been removed from their fellows, and to eat raw sheep's liver. They move their mouths in a suctorial manner, tearing the food with their jaws. They have the power of extruding their jaws from the mouth, and of working them alternately backwards and forwards. They are viviparous; the young are fully formed at birth, and differ from the adult only in size and colour. The mother does not appear to pay any special attention to her offspring, which wander away and get their own living. It has lately been stated that some of the Australian species are normally oviparous, but this has not been fully proved. Sexual differences are not strongly marked, and are sometimes absent. There does not appear to be any true copulation. In some species the male deposits small oval spermatophores indiscriminately on any part of the body of the female. It seems probable that in such cases the spermatozoa make their way from the adherent spermatophore through the body-wall into the body, and so by traversing the tissues reach the ovary. In other species which possess *receptacula seminis* it is probable that fertilization is effected once only in early life before any ova pass into the uterus.

External Features.—The anterior part of the body may be called the head, though it is not sharply marked off from the rest of the body (Fig. 1). The head carries three pairs of appendages, a pair of simple eyes, and a ventrally-placed mouth. The body is elongated and vermiform; it bears a number of paired appendages, each terminating in a pair of claws, and all very much alike. The number varies in the different species. The anus is always at the posterior end of the body, and the generative opening is on the ventral surface, just in front of the anus; it may be between the legs of the penultimate pair, or between the legs of the last pair, or it may be subterminal. The colour varies considerably in the different species, and even in different individuals of the same species. The skin has a velvety appearance, and is thrown into a number of transverse ridges, along which

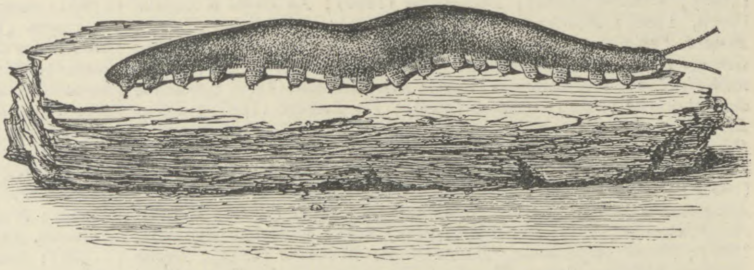

FIG. 1.—*Peripatus capensis*, drawn from life. Life size. (*After Sedgwick.*)

wart-like papillæ are placed. These papillæ, which are found everywhere, are the *primary* papillæ; they are covered with small, scale-like projections called *secondary* papillæ, and are specially developed on the dorsal surface, less so on the ventral. Each papilla carries at its extremity a well-marked spine. Among the primary papillæ smaller *accessory* papillæ are sometimes present.

The appendages of the head are the antennæ, the jaws, and the oral papillæ. The mouth is at the hinder end of a depression called the buccal cavity, and is surrounded by an annular tumid lip, raised into papilliform ridges and bearing a few spines (Fig. 2). Within the buccal cavity are the two jaws. They are short, stump-like, muscular structures, armed at their free extremities by a pair of cutting blades or claws, and are placed one on each side of the mouth. In the median line of the buccal cavity in front is placed a thick muscular protuberance, which may be called the tongue, though attached to the dorsal instead of to the ventral wall of the mouth (Fig. 2). The tongue bears a row of small, chitinous teeth. The jaw-claws (Figs. 3 and 4), which resemble in all essential points the claws borne by the feet, and, like these, are thickenings of the cuticle, are sickle-shaped. They have their convex edge directed forwards, and their concave, or cutting edge, turned backwards. The inner cutting plate (Fig. 3) usually bears a number of cutting teeth. The oral papillæ are placed at the sides of the head (Fig. 2). The ducts of the slime-glands open at their free end. They possess two main rings of projecting tissue,

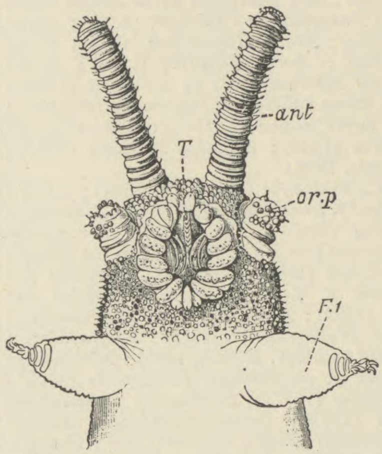

FIG. 2.—Ventral view of the head of *P. capensis*. (*After Sedgwick.*) *ant*, antennæ; *or.p*, oral papillæ; *F.1*, first leg; *T*, tongue.

FIG. 3.—Inner jaw-claw of *P. capensis*. (*After Balfour.*)

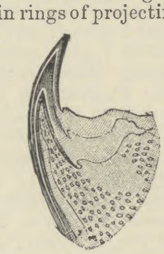

FIG. 4.—Outer jaw-claw of *P. capensis*. (*After Balfour.*)

and their extremities bear papillæ irregularly arranged. The ambulatory appendages vary in number. There are seventeen pairs in *P. capensis* and eighteen in *P. Balfouri*, while in *P. jamaicensis* the number varies from twenty-nine to forty-three. They consist of two main divisions, which we may call the leg and the foot (Fig. 5). The leg (*l*) has the form of a truncated cone, the broad end of which is attached to the ventro-lateral wall of the body, of which it is a prolongation. It is marked by a number of rings of papillæ placed transversely to its long axis, the dorsal of which are pigmented like the dorsal surface of the body, and the ventral like the ventral surface. At the narrow distal end of the leg there are on the ventral surface three or four (rarely five) spiniferous pads, each of which is continued dorsally into a row of papillæ. The foot is attached to the distal end of the leg. It is slightly narrower at its attached extremity than at its free end. It bears two sickle-shaped claws, and at its distal end three (rarely four) papillæ. The part of the foot which carries the claws is especially retractile, and is generally found more or less telescoped into the proximal part. The legs of the fourth and fifth pairs differ from the others in the fact that the third pad (counting from the distal end of the leg) carries the opening of the enlarged nephridia of these segments. In some species certain of the legs bear on their ventral sides furrows with tumid lips and lined by smooth non-tuberculate epithelium; they are called coxal organs, and it appears that they can be everted. The males are generally rather smaller and less numerous than the females. In those species in which the number of legs varies the male has a smaller number of legs than the female.

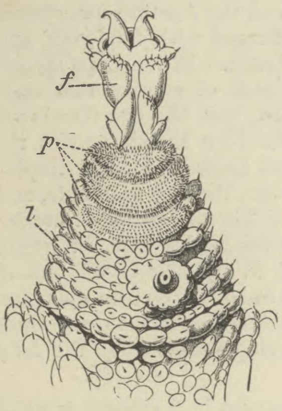

FIG. 5.—Ventral view of last leg of a male *P. capensis*. (*After Sedgwick.*) *f*, foot; *l*, leg; *p*, spiniferous pads. The white papilla on the proximal part of this leg is characteristic of the male of this species.

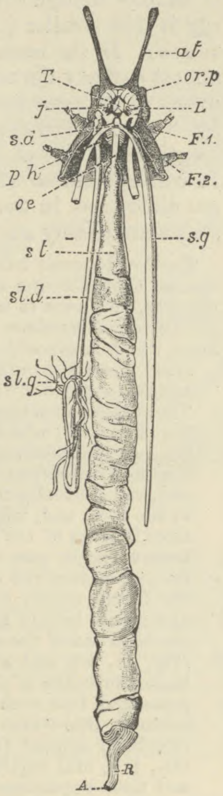

FIG. 6.—*Peripatus capensis* dissected so as to show the alimentary canal, slime glands, and salivary glands. (*After Balfour.*) The dissection is viewed from the ventral side, and the lips (*L*) have been cut through in the middle line behind and pulled outwards so as to expose the jaws (*j*), which have been turned outwards, and the tongue (*T*) bearing a median row of chitinous teeth, which branches behind into two. The muscular pharynx, extending back into the space between the first and second pairs of legs, is followed by a short tubular œsophagus. The latter opens into the large stomach with plicated walls, extending almost to the hind end of the animal. The stomach at its point of junction with the rectum presents an S-shaped ventro-dorsal curve. *A*, Anus; *at*, antenna; *F.1*, *F.2*, first and second feet; *j*, jaws; *L*, lips; *oe*, œsophagus; *or.p*, oral papilla; *ph*, pharynx; *R*, rectum; *s.d*, salivary duct; *s.g*, salivary gland; *sl.d*, slime reservoir; *sl.g*, portion of tubules of slime gland; *st*, stomach; *T*, tongue in roof of mouth.

Breeding.—As already stated, *Peripatus* is viviparous. The Australasian species come nearest to laying eggs, inasmuch as the eggs are large, full of yolk, and enclosed in a shell; but development normally takes place in the uterus, though, abnormally, incompletely developed eggs are extruded. The uterus always contains several young, which are usually at different stages of development and are born at different times of the year. In most of the African species, however, the embryos of the uterus are almost of the same age and are born at a definite season. The young of *P. capensis* are born in April and May. They are almost colourless at birth, excepting the antennæ, which are green, and their length is 10 to 15 mm. A large female will produce thirty to forty young in one year. The period of gestation is thirteen months, that is to say, the ova pass into the oviducts about one month before the young of the preceding year are born.

Anatomy.—The alimentary canal (Fig. 6). The buccal cavity, as explained above, is a secondary formation around the true mouth, which is at its dorsal posterior end. It contains the tongue and the jaws, which have already been described, and into the hind end of it there open ventrally by a median opening the salivary glands. The mouth leads into a muscular pharynx, which is connected by a short œsophagus with the stomach. The stomach forms by far the largest part of the alimentary canal. It is a dilated soft-walled tube, and leads behind into the short narrow rectum, which opens at the anus. There are no glands opening into the alimentary canal. The central nervous system, the anterior part of which is shown in Fig. 7, is described in the ninth edition of this work (see vol. xvii. p. 116).

The cuticle is a thin layer, of which the spines, jaws, and claws are special developments. Its surface is not, however, smooth, but is everywhere, with the exception of the perioral region, raised into minute secondary papillæ, which in most instances bear at their free extremity a somewhat prominent spine. The epidermis, placed immediately within the cuticle, is composed of a single row of cells. The pigment which gives the characteristic colour to the skin is deposited in the protoplasm of the outer ends of the cells in the form of small granules. Beneath the epidermis is a thin cutis, which is followed by the muscular layers (external circular and internal longitudinal). The muscular fibres of the jaws are transversely striated, the other muscles are unstriated.

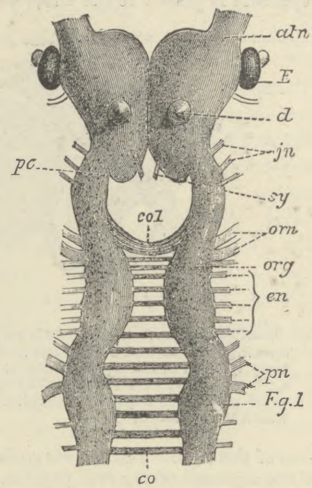

FIG. 7.—Brain and anterior part of the ventral nerve-cords of *Peripatus capensis* enlarged and viewed from the ventral surface. (*After Balfour.*) *atn*, antennary nerves; *co*, commissures between ventral cords; *d*, ventral appendages of brain; *E*, eye; *en*, nerves passing outwards from ventral cord; *F.g.*1, ganglionic enlargements from which nerves to feet pass off; *jn*, nerves to jaws; *org*, ganglionic enlargement from which nerves to oral papillæ pass off; *orn*, nerves to oral papillæ; *pc*, posterior lobe of brain; *pn*, nerves to feet; *sy*, sympathetic nerves.

The apertures of the tracheal system are placed in the depressions between the papillæ or ridges of the skin. Each of them leads into a tube, which may be called the tracheal pit (Fig. 8); the walls of this are formed of epithelial cells, bounded towards the lumen of the pit by a very delicate cuticular membrane continuous with the cuticle covering the surface of the body. Internally it expands in the transverse plane, and from the expanded portion the tracheal tubes arise in diverging bundles. The tracheæ are minute tubes exhibiting a faint transverse striation which is probably the indication of a spiral fibre. They appear to branch, but only exceptionally. The tracheal apertures are diffused over the surface of the body, but are especially developed in certain regions.

FIG. 8.—Section through a tracheal pit and diverging bundles of tracheal tubes taken transversely to the long axis of the body. (*After Balfour.*) *tr*, tracheæ, showing rudimentary spiral fibre; *tr.c*, cells resembling those lining the tracheal pits, which occur at intervals along the course of the tracheæ; *tr.o*, tracheal stigma; *tr.p*, tracheal pit.

The vascular system consists of a dorsal tubular heart with paired ostia leading into it from the pericardium, of the pericardium, and the various other divisions of the perivisceral cavity (Fig. 12, D). As in all Arthropoda, the perivisceral cavity is a hæmocœle; *i.e.*, contains blood, and forms part of the vascular system. It is divided by septa into chambers (Fig. 12, D), of which the most important are the central chamber containing the alimentary canal and the dorsal chamber or pericardium. Nephridia are present in all the legs. In all of them (except the first three) the following parts may be recognized (Fig. 9): (1) a vesicular portion (*s*) opening to the exterior on the ventral surface of the legs by a narrow passage (*s.d*); (2) a coiled portion, which is again subdivided into several sections (*s.c*); (3) a section with closely-packed nuclei ending by a somewhat enlarged opening (*p.f*); (4) the terminal portion, which consists of a thin-walled vesicle. The nephridia of the first three pairs of legs are smaller than the rest, consisting only of a vesicle and duct. The fourth and fifth pairs are larger than those behind, and are in other respects peculiar; for instance, they open on the third pad (counting from the distal end of the leg), and the external vesicular portion is not dilated. The external opening of the other nephridia is placed at the outer end of a transverse groove at the

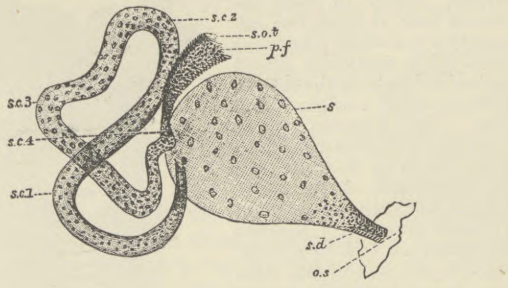

FIG. 9.—Nephridium from the ninth pair of legs of *P. capensis*. *o.s*, external opening of segmental organ; *p.f*, internal opening of nephridium into the body cavity (lateral compartment); *s*, vesicle of segmental organ; *s.c.*1, *s.c.*2, *s.c.*3, *s.c.*4, successive regions of coiled portion of nephridium; *s.o.t*, third portion of nephridium broken off at *p.f* from the internal vesicle, which is not shown.

base of the legs. The salivary glands are the modified nephridia of the segment of the oral papillæ.

The male generative organs (Fig. 10) consist of a pair of testes (*te*), a pair of seminal vesicles (*v*), vasa deferentia (*v.d*), and acces-

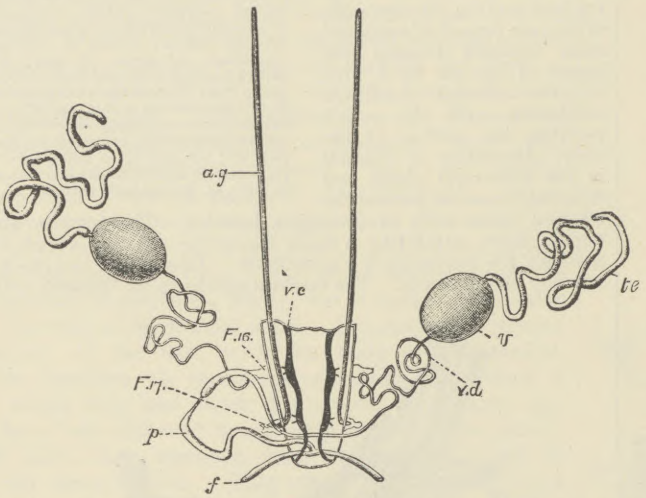

FIG. 10.—Male generative organs of *Peripatus capensis*, dorsal view. (*After Balfour.*) *a.g*, enlarged crural glands of last pair of legs; *F.*16, 17, last pairs of legs; *f*, small accessory glandular tubes; *p*, common duct into which vasa deferentia open; *te*, testes; *v*, seminal vesicles; *v.c*, nerve-cord; *v.d*, vas deferens.

sory glandular tubules (*f*). All the above parts lie in the central compartment of the body cavity. The ovaries consist of a pair of tubes closely applied together, and continued posteriorly into the oviducts. Each oviduct, after a short course, becomes dilated into the uterus. The two uteri join behind and open to the exterior by a median opening. The ovaries always contain spermatozoa, some of which project through the ovarian wall into the body cavity. Spermatozoa are not found in the uterus and oviducts, and it appears probable, as we have said, that they reach the ovary directly by boring through the skin and traversing the body cavity. In all the species except the African species there is a globular receptaculum seminis opening by two short ducts close together into the oviduct, and in the neotropical species there is in addition a small receptaculum ovorum, with extremely thin walls, opening into the oviduct by a short duct just in front of the receptaculum seminis. The epithelium of the latter structure is clothed with actively moving cilia. There appear to be present in most, if not all, of the legs some accessory glandular structures opening just externally to the nephridia. They are called the crural glands.

Development.—Peripatus is found in Africa, in Australasia, in South America and the West Indies, in New Britain, and in the Malay Peninsula and Sumatra. The species found in these various localities are closely similar in their anatomical characters, the principal differences relating to the structure of the female generative organs and to the number of the legs. They, however, differ in the most striking manner in the structure of the ovum and the early development. In all the Australasian species the egg is large and heavily charged with food-yolk, and is surrounded by a tough membrane. In the Cape species the eggs are smaller, though still of considerable size; the yolk is much less developed, and the egg membrane is thinner though dense. In the New Britain species the egg is still smaller (·1 mm.), and there is a large trophic vesicle. In the neotropical species the egg is minute, and almost entirely devoid of yolk. The unsegmented uterine ovum of *P. novæ zealandiæ* measures 1·5 mm. in length by ·8 mm. in breadth; that of *P. capensis* is ·56 mm. in length; and that of *P. trinidadensis* ·04 mm. in diameter. In correspondence with these differences in the ovum there are differences in the early development, though the later stages are closely similar.

The development has been worked out in *P. capensis*, to which species the following description refers. The segmentation is peculiar, and leads to the formation of a solid gastrula, consisting of a cortex of ectoderm nuclei surrounding a central endodermal mass, which is exposed at one point—the blastopore. The enteron arises as a space in the endoderm, and an opacity—the primitive streak—appears at the hind end of the blastopore (Fig. 11, B). The elongation of the embryo is accompanied by an elongation of the blastopore, which soon becomes dumb-bell shaped (Fig. 11, C). At the same time the mesoblastic somites (embryonic segments of mesoderm) make their appearance in pairs at the hind end, and gradually travel forwards on each side of the blastopore to the front end, where the somites of the anterior pair soon meet in front of the blastopore (Fig. 11, D). Meanwhile the narrow middle part of the blastopore has closed by a fusion of its lips, so that the blastopore is represented by two openings, the future mouth and anus. A primitive groove makes its appearance behind the blastopore (Fig. 11, D). At this stage the hind end of the body becomes curved ventrally into a spiral (Fig. 11, E), and at the same time the appendages appear as hollow processes of the body-wall, a mesoblastic somite being prolonged into each of them. The first to appear are the antennæ, into which the præoral somites are prolonged. The remainder appear from before backwards in regular order, viz., jaw, oral papillæ, legs 1–17. The full number of somites and their appendages is not, however, completed until a later stage. The nervous system is formed as an annular thickening of ectoderm passing in front of the mouth and behind the anus, and lying on each side of the blastopore along the lines of the somites. The præoral part of this thickening, which gives rise to the cerebral ganglia, becomes pitted inwards on each side (Fig. 11, F, *c.g*). These pits are eventually closed, and form the hollow ventral appendages of the supra-pharyngeal ganglia of the adult (Fig. 7, *d*). The lips are formed as folds of the side wall of the body, extending from the præoral lobes to just behind the jaw (Fig. 11, F, *L*). They enclose the jaws (*j*), mouth (*M*), and opening of the salivary

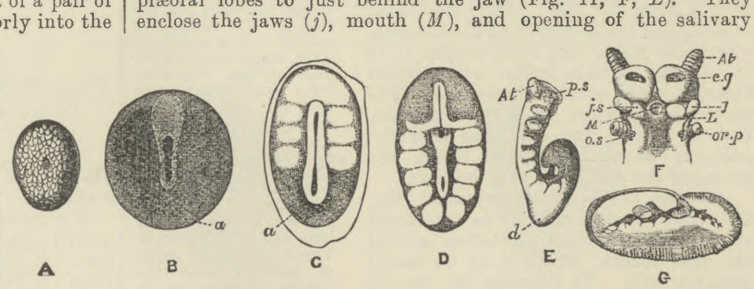

FIG. 11.—A series of embryos of *P. capensis*. The hind end of embryos B, C, D is uppermost in the figures, the primitive streak is the white patch behind the blastopore. (*After Sedgwick.*) A, Gastrula stage, ventral view, showing blastopore. B, Older gastrula stage, ventral view, showing elongated blastopore and primitive streak. C, Ventral view of embryo with three pairs of mesoblastic somites, dumb-bell shaped blastopore and primitive streak. D, Ventral view of embryo, in which the blastopore has completely closed in its middle portion. The anterior pair of somites have moved to the front end of the body. E, side view of later embryo. *At*, antenna; *d*, dorsal projection; *p.s*, præoral somite. F, Ventral view of head of embryo, intermediate between E and G. *At*, antennae; *c.g*, cerebral groove; *j*, jaws; *j.s*, swelling at base of jaws; *L*, lips; *M*, mouth; *or.p*, oral papillae; *o.s*, opening of salivary gland. G, side view of older embryo.

glands (*o.s*), and so give rise to the buccal cavity. The embryo has now lost its spiral curvature, and becomes completely doubled upon itself, the hind end being in contact with the mouth (Fig. 11, G). It remains in this position until birth. The just-born young are from 10 to 15 mm. in length, and have green antennæ, but the rest of the body is either quite white or of a reddish colour. This red colour differs from the colour of the adult in being soluble in spirit. The mesoblastic somites are paired sacs formed from the anterior lateral portions of the primitive streak (Fig. 11, C). As they are formed they become placed in pairs on each side of the blastopore. The somites of the first pair eventually obtain a position entirely in front of the blastopore (Fig. 11, D). They form the somites of the præoral lobes. The full complement of somites is acquired at about the stage of Fig. 11, E. The relations of the mesoblastic somites is shown in Fig. 12, A, which represents a transverse section taken between the mouth and anus of an embryo of the stage of Fig. 11, D. The history of these somites is an exceedingly interesting one, and may be described shortly as follows: They divide into two parts—a ventral part, which extends into the appendage, and a dorsal part (Fig. 12, B). Each of the ventral parts acquires an opening to the exterior, just outside the nerve-cord, and becomes entirely transformed into a nephridium (Fig. 12, D, 2′). The dorsal part shifts dorsalwards and diminishes relatively in size (Fig. 12, C). Its fate differs in the different parts of the body. In the anterior somites it dwindles and disappears, but in the posterior part it unites with the dorsal divisions of contiguous somites of the same side, and forms a tube—the generative tube (Fig. 12, D, 2). The last section of this tube retains its connexion with the ventral portion of the somite, and so acquires an external opening, which is at first lateral, but soon shifts to the middle line, and fuses with its fellow, to form the single generative opening. The præoral somite develops the rudiment of a nephridium, but eventually entirely disappears. The jaw somite also disappears; the oral papilla somite forms ventrally the salivary glands, which are thus serially homologous with nephridia. The various divisions of the perivisceral cavity develop as a series of spaces between the ectoderm and endoderm, and later in the mesoderm. The mesoderm seems to be formed entirely from the proliferation of the cells of the mesoblastic somites. It thus appears that in *Peripatus* the cœlom does not develop a perivisceral portion, but gives rise only to the renal and reproductive organs.

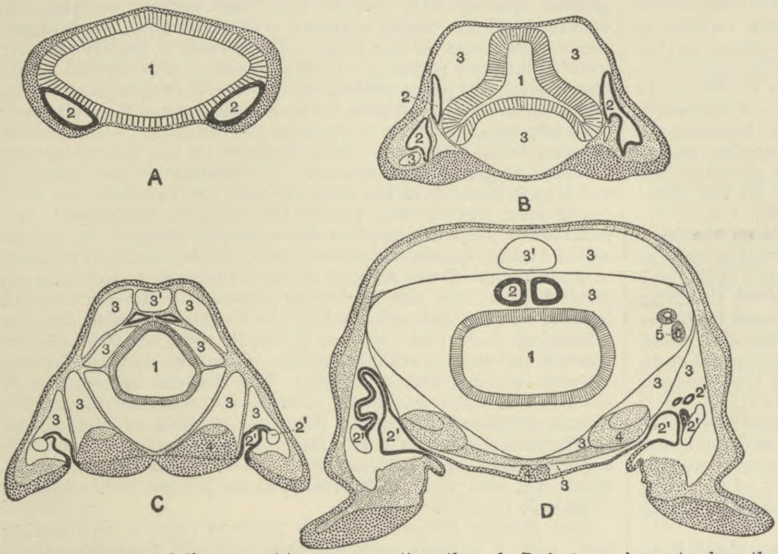

FIG. 12.—A series of diagrams of transverse sections through *Peripatus* embryos to show the relations of the cœlom at successive stages. (*After Sedgwick.*) A, Early stage; no trace of the vascular space; endoderm and ectoderm in contact. B, Endoderm has separated from the dorsal and ventral ectoderm. The somite is represented as having divided on the left side into a dorsal and ventral portion. C, The hæmocœle (3) has become divided up into a number of spaces, the arrangement of which is unimportant. The dorsal part of the somite has travelled dorsalwards, and now constitutes a small space (triangular in section) just dorsal to the gut. The ventral portion (2) has assumed a tubular character, and has acquired an external opening. The internal vesicle is already indicated, and is shown in the diagram by the thinner black line; 1, gut; 2, somite; 2′, nephridial part of cœlom; 3, hæmocœle; 3′, part of hæmocœle which will form the heart—the part of the hæmocœle on each side of this will form the pericardium; 4, nerve-cord; 5, slime glands. D represents the conditions at the time of birth. The cœlom is represented as surrounded by a thick black line, except in the part which forms the internal vesicle of the nephridium.

The genus *Peripatus* was established in 1826 by Guilding, who first obtained specimens of it from St Vincent in the Antilles. He regarded it as a Mollusc, being no doubt deceived by the slug-like appearance given by the antennæ. Specimens were subsequently obtained from other parts of the neotropical region, and from South Africa and Australia, and the animal was variously assigned by the zoologists of the day to the Annelida and Myriapoda. Its true place in the system, as a primitive member of the group Arthropoda, was first established in 1874 by Moseley, who discovered the tracheæ. *Peripatus* is an Arthropod, as shown by (1) the presence of appendages modified as jaws; (2) the presence of paired lateral ostia perforating the wall of the heart and putting its cavity in communication with the pericardium; (3) the presence of a vascular body cavity and pericardium (hæmocœlic body cavity); (4) absence of a perivisceral section of the cœlom. Finally, the tracheæ, though not characteristic of all the classes of the Arthropoda, are found nowhere outside that group, and constitute a very important additional reason for uniting *Peripatus* with it. *Peripatus*, though indubitably an Arthropod, differs in such important respects from all the old-established Arthropod classes, that a special class, equivalent in rank to the others, and called Prototracheata or Onychophora, has had, as we have seen, to be created for its sole occupancy. This unlikeness to other Arthropoda is mainly due to the Annelidan affinities which it presents, but in part to the presence of the following peculiar features: (1) the number and diffusion of the tracheal apertures; (2) the restriction of the jaws to a single pair; (3) the disposition of the generative organs; (4) the texture of the skin; and (5) the simplicity and similarity of all the segments of the body behind the head. The Annelidan affinities are superficially indicated in so marked a manner by the thinness of the cuticle, the dermo-muscular body-wall, the hollow appendages, that, as already stated, many of the earlier zoologists who examined *Peripatus* placed it among the segmented worms; and the discovery that there is some solid morphological basis for this determination constitutes one of the most interesting points of the recent work on the genus. The Annelidan features are: (1) the paired nephridia in every segment of the body behind the first two (Saenger, Balfour); (2) the presence of cilia in the generative tracts (Gaffron). It is true that neither of these features is absolutely distinctive of the Annelida, but when taken in conjunction with the Annelidan disposition of the chief systems of organs, viz., the central nervous system, and the main vascular trunk or heart, they may be considered as indicating affinities in that direction.

SYNOPSIS OF SPECIES.

PERIPATUS (Guilding). Soft-bodied vermiform animals, with one pair of ringed antennæ, one pair of jaws, one pair of oral papillæ, and a varying number of claw-bearing ambulatory legs. Dorsal surface arched and more darkly pigmented than the flat ventral surface. Skin transversely ridged and beset by wart-like spiniferous papillæ. Mouth anterior, ventral; anus posterior, terminal. Generative opening single, median, ventral, and posterior. One pair of simple eyes. Brain large, with two ventral hollow appendages; ventral cords widely divaricated, without distinct ganglia. Alimentary canal simple, uncoiled. Segmentally arranged paired nephridia are present. Body cavity is continuous with the vascular system, and does not communicate with the paired nephridia. Heart tubular, with paired ostia. Respiration by means of tracheæ. Diœcious; males smaller and generally less numerous than females. Generative glands tubular, continuous with the ducts. Viviparous. Young born fully developed. Distribution: Africa (Cape Colony, Natal, and the Gaboon), New Zealand, Australia and Tasmania, New Britain, South and Central America and the West Indies, the Malay Peninsula [and in Sumatra ?].

The genus *Peripatus*, so far as adult conformation is concerned, is a very homogeneous one. It is true, as was pointed out by

Sedgwick, that the species from the same part of the world resemble one another more closely than they do species from other regions, but recent researches have shown that the line between them cannot be so sharply drawn as was at first supposed, and it is certainly not desirable in the present state of our knowledge to divide them into generic or subgeneric groups, as has been done by some zoologists. (The following genera have been proposed: *Peripatus* for the neotropical species, *Peripatoides* for the Australasian, *Peripatopsis* and *Opisthopatus* for the African, *Paraperipatus* for the New Britain, *Eoperipatus* for the Malayan species, and *Ooperipatus* for the supposed oviparous species of Australia and New Zealand.) The colour is highly variable in species from all regions; it is perhaps more constant in the species from the neotropical region than in those from elsewhere. The number of legs tends to be variable whenever it exceeds 19 prægenital pairs; when the number is less than that, it is usually, though not always, constant. More constant points of difference are the form of the jaws, the position of the generative orifice, the presence of a receptaculum seminis and a receptaculum ovorum, the arrangement of the primary papillæ on the distal end of the feet, and above all the early development.

South African Species.—With three spinous pads on the legs, and feet with two primary papillæ on the anterior side and one on the posterior side; outer jaw with one minor tooth at the base of the main tooth, inner jaw with no interval between the large tooth and the series of small ones; last fully-developed leg of the male with enlarged crural gland opening on a large papilla placed on its ventral surface; coxal organs absent; the nephridial openings of the 4th and 5th pairs of legs are placed in the proximal spinous pad. Genital opening subterminal, behind the last pair of fully developed legs; oviduct without receptacula seminis or receptacula ovorum; the terminal unpaired portion of vas deferens short. Ova of considerable size, but with only a small quantity of yolk. The embryos in the uterus are all nearly of the same age, except for a month or two before birth, when two broods overlap.

The following species are aberrant in respect of these characters: *Peripatus* (*Opisthopatus*) *cinctipes* Purcell (Cape Colony and Natal) presents a few Australasian features; there is a small receptaculum seminis on each oviduct, some of the legs are provided with well-developed coxal organs, the feet have one anterior, one posterior, and one dorsal papilla, and the successive difference in the ages of the embryos in the uterus, though nothing like that found in the neotropical species, is slightly greater than that found in other investigated African species. Several pairs of legs in the middle region of the body are provided with enlarged crural glands which open on a large papilla. Male with four accessory glands, opening on each side of and behind the genital aperture. *P. tholloni* Bouvier (equatorial West Africa [Gaboon]) shows some neotropical features; there are 24 to 25 pairs of legs, the genital opening is between the penultimate legs, and though there are only three spinous pads, the nephridial openings of the 4th and 5th legs are proximal to the 3rd pad, coxal organs are present, and the jaws are of the neotropical type; the oviducts have receptacula seminis. The following South African species may be mentioned: *P. capensis* (Grube), with 17 (rarely 18) pairs of claw-bearing legs; *P. Balfouri* (Sedgw.) with 18 (rarely 19) pairs; *P. Moseleyi* (Wood-M.), with 20 to 24 pairs.

Australasian Species.—With 14, 15, or 16 pairs of claw-bearing ambulatory legs, with three spinous pads on the legs, and nephridial opening of the 4th and 5th legs on the proximal pad; feet with one anterior, one posterior, and one dorsal primary papilla; inner jaw without diastema, outer with or without a minor tooth. Last leg of the male with or without a large white papilla on its ventral surface for the opening of a gland, and marked papillæ for the crural glands are sometimes present on other legs of the male; well-developed coxal glands absent. Genital opening between the legs of the last pair; oviducts with receptacula seminis, without receptacula ovorum; the terminal portion of the vas deferens long and complicated; the accessory male glands open between the genital aperture and the anus, near the latter. Ova large and heavily charged with yolk, and provided with a stoutish shell. The uterus appears to contain embryos of different ages. Specimens are recorded from West Australia, Queensland, New South Wales, Victoria, and New Zealand. The Australasian species are in some confusion. The number of claw-bearing legs varies from 14 to 16 pairs, but the number most often found is 15. Whether the number varies in the same species is not clear. There appears to be evidence that some species are occasionally or normally oviparous, and in the supposed oviparous species the oviduct opens at the end of a papilla called from its supposed function an ovipositor, but the oviparity has not yet been certainly proved as a normal occurrence. Among the species described may be mentioned *P. Leuckarti* (Saenger), *P. insignis* (Dendy), *P. oviparus* (Dendy), *P. viridimaculatus* (Dendy), *P. novæ zealandiæ* (Hutton), but it is by no means certain that future research will maintain these. Mr J. J. Fletcher, indeed, is of opinion that the Australian forms are all varieties of one species, *P. Leuckarti*.

Neotropical Species.—With 3 to 5 spinous pads on the legs, nephridial opening of the 4th and 5th legs usually proximal to the 3rd pad, and feet either with two primary papillæ on the anterior side and one on the posterior, or with two on the anterior and two on the posterior; outer jaw with small minor tooth or teeth at the base of the main tooth, inner jaw with diastema. A variable number of posterior legs of the males anterior to the genital opening with one or two large papillæ carrying the openings of the crural glands; well-developed coxal organs present on most of the legs. The primary papillæ usually divided into two portions. Genital opening between the legs of the penultimate pair; oviduct provided with receptacula seminis and ovorum; unpaired part of vas deferens long and complicated; accessory organs of male opening at the sides of the anus. Ova minute, with little food-yolk; embryos in the uterus at very different stages of development. The number of legs usually if not always variable in the same species; the usual number is 28 to 32 pairs, but in some species 40 to 43 pairs are found. The neotropical species appear to fall into two groups: (1) the so-called Andean species, viz., those which inhabit the high plateaux or Pacific slope of the Andes; in these there are 4 (sometimes 5) pedal papillæ, and the nephridial openings of the 4th and 5th legs are on the third pad; and (2) the Caribbean species, viz., the remaining neotropical species, in which there are 3 papillæ on the foot and the nephridial openings of the 4th and 5th legs are between the 3rd and 4th pads. The Andean species are *P. eisenii* (Wh.), *P. tuberculatus* (Bouv.), *P. Lankesteri* (Bouv.), *P. quitensis* (Schm.), *P. Corradi* (Cam.), *P. Cameranoi* (Bouv.), and *P. Balzani* (Cam.). Of the remaining species, which are the majority, may be mentioned *P. Edwardsii* (Blanch), *P. jamaicensis* (Gr. and Cock.), *P. trinidadensis* (Sedgw.), *P. torquatus* (Ken.), *P. im Thurmi* (Scl.).

New Britain Peripatus.—With 22 to 24 pairs of claw-bearing legs, with 3 spinous pads on the legs, and nephridial openings of legs 4 and 5 (sometimes of 6 also) on the proximal pad; feet with one primary papilla on the anterior, one on the posterior side, and one on the dorsal side (median or submedian); outer jaw with a minor tooth, inner jaw without diastema; crural glands absent; well-developed coxal organs absent. Genital opening subterminal behind the last pair of legs; oviduct with receptaculum seminis without recept. ovorum; unpaired part of vas deferens very short; accessory glands two, opening medianly and dorsally. Ova small, ·1 mm. in diameter, with little yolk, and the embryos provided with large trophic vesicles (Willey). Embryos in the uterus of very different ages, and probably born all the year round. One species only known, *P. novæ britanniæ* (Willey).

Sumatran Peripatus.—Peripatus with 24 pairs of ambulatory legs, and 4 spinous pads on the legs. The primary papillæ of the neotropical character with conical bases. Generative opening between the legs of the penultimate pair. Feet with only two papillæ. Single species. *P. sumatranus* (Sedgw.). The existence of this species is doubtful.

Peripatus from the Malay Peninsula.—With 23 to 25 pairs of claw-bearing legs, 4 spinous pads on the legs, and nephridial openings of legs 4 and 5 in the middle of the proximal pad or on its proximal side; feet with two primary papillæ, one anterior and one posterior; outer jaw with 2, inner jaw with 2 or 3 minor teeth at the base of the main tooth, separated by a diastema from the row of small teeth; crural glands present in the male only, in the two pairs of legs preceding the generative opening; coxal glands present. Genital opening between the penultimate legs; oviduct with receptacula seminis and ovorum; unpaired part of vas deferens long; male accessory glands two, opening medianly between the legs of the last pair. Ova large, with much yolk and thick membrane, like those of Australasian species; embryos with slit-like blastopore and of very different ages in the same uterus, probably born all the year round. The species are *P. Weldoni* (Evans), *P. Horsti* (Evans), and *P. Butleri* (Evans). It will thus be seen that the Malay species, while resembling the neotropical species in the generative organs, differ from these in many features of the legs and feet, in the important characters furnished by the size and structure of the ovum, and by their early development.

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Perityphlitis. See APPENDICITIS.

Perkin, William Henry (1838-——), English chemist, was born in London on 12th March 1838. From an early age he determined to adopt chemistry as his profession, although his father, who was a builder, would have preferred him to be an architect. Attending the City of London School—one of the few which at that time included natural science in its curriculum—he devoted all his spare time to chemistry, and on leaving, in 1853, entered the Royal College of Chemistry, then under the direction of A. W. Hofmann, in whose own research laboratory he was in the course of a year or two promoted to be an assistant. Devoting his evenings to private investigations in a rough laboratory fitted up at his home, Perkin was fired by some remarks of Hofmann's to undertake the artificial production of quinine. In this attempt he was unsuccessful, but the observations he made in the course of his experiments induced him, early in 1856, to try the effect of treating aniline sulphate with bichromate of potash. The result was a black precipitate, which he found to contain the colouring matter subsequently known as aniline blue or mauve. He lost no time in introducing this substance to the notice of Messrs Pullar, the well-known dyers, and they expressed a favourable opinion of it, if only it should not prove too expensive in use. Thus encouraged, he took out a patent for his process, and leaving the College of Chemistry, a boy of eighteen, he proceeded, with the aid of his father and brother, to erect works at Greenford Green, near Harrow, for the manufacture of the newly-discovered colouring matter. Various preliminary difficulties were encountered, not only in designing suitable plant, but also in obtaining supplies of raw materials; but these were successfully overcome, and by the end of 1857 the works were in operation. That date may therefore be reckoned as that of the foundation of the coal-tar colour industry, which has since attained such important dimensions—in Germany, however, rather than in England, the country where it originated. The further difficulties of finding methods of successfully dyeing with the material were also grappled with, and it soon came into wide use, first for dyeing silk in London, and then for calico-printing in Scotland. Dr Perkin also had a large share in the introduction of artificial alizarin, the red dye of the madder root. Graebe and Liebermann in 1868 prepared that substance synthetically from anthracene, but their process was not practicable on a large scale, and it was left to him to patent a method that was commercially valuable. This he did in 1869, thus securing for the Greenford Green works a monopoly of alizarin manufacture for several years. About the same time he also carried out a series of investigations into kindred substances, such as anthrapurpurin. About 1874 he abandoned the manufacture of coal-tar colours, and devoted himself exclusively to research in pure chemistry, which, however, he had by no means neglected even while his attention was occupied with the practical problems of manufacture; and among the discoveries he made in this field was that of the reaction known by his name, depending on the condensation of aldehydes with fatty acids. Later still he engaged in the study of the relations between chemical constitution and rotation of the plane of polarization in a magnetic field, and enunciated a law expressing the variation of such rotation in bodies belonging to homologous series. For this work he was in 1889 awarded a Davy medal by the Royal Society, which ten years previously had bestowed upon him a Royal medal in recognition of his investigations in the coal-tar colours. The Chemical Society, of which he became secretary in 1869 and president in 1883, presented him with its Longstaff medal in 1889, and in 1890 he received the Albert medal of the Society of Arts. His eldest son, William Henry Perkin, junior, who was born at Sudbury, near Harrow, on 17th June 1860, and was educated at the City of London School, the Royal College of Science, and the Universities of Würzburg and Munich, became professor of chemistry at the Heriot-Watt College, Edinburgh, in 1887, and professor of organic chemistry at Owens College, Manchester, in 1892.

Perm, a government of East Russia, on both slopes of the Ural Mountains, with an area of 128,211 square miles. Population (1881), 2,520,100; (1897), 3,003,208, of whom 1,552,551 were women, and 176,255 urban. The immense majority of this population are peasants (2,604,207 in 1896), and according to religion they were distributed as follows: Greek Orthodox 2,566,475, Nonconformists 250,361, Mussulmans 141,294, pagans 19,464, Catholics 1510, Jews 1154, and Lutherans 841, leaving 22,119 as nondescript. Agriculture is carried on everywhere, but in the north and north-west the crops are insufficient for the population. Nearly 8,000,000 acres, *i.e.*, 9·5 per cent. of the total area, are under cereals—chiefly rye, oats, barley, and wheat in the south—the average annual yield of the crops in 1895–99 being: rye, 9,424,000 cwt.; wheat, 6,179,000; oats, 11,358,000; barley, 2,862,000; various, 734,000; and potatoes, 2,878,000 cwt. Bees are kept in large numbers. Cattle-breeding is active, especially among the Bashkirs, there being in the province more than 1,200,000 horned cattle, 1,200,000 sheep, and 900,000 horses. Various domestic trades are carried on in the villages, and several new industries, such as the manufacture of agricultural machinery, have sprung up. Mining is developing steadily, but slowly. The iron-works employ some 194,360 workers (11,850 in the Crown works), and their aggregate output in 1898 was: pig iron, 9,568,000 cwt.; iron, 3,902,000 cwt.; steel, 2,366,300 cwt.; metal goods, 700,000 cwt.; copper, 40,000 cwt.; of a total estimated value of 56,320,000 roubles. There were also 16,160 persons engaged in the working of gold and platinum, the annual production of gold being valued at £487,000, and of platinum at £240,800; coal and coke (7,233,000 cwt.), salt (5,930,000 cwt.), asbestos (30,000 cwt.), iron chromates (240,000 cwt.), and sulphates (323,800 cwt.). In 1897, 1090 factories employed 9835 workers, producing goods to the annual value of £2,200,000; and 12,475 workshops employed 37,000 workers, whose production was valued at £5,240,000 annually. The government is intersected by a railway from Perm eastwards across the Urals, and thence southwards along the eastern slope of the Urals to Ekaterinburg, Chelyabinsk (main Siberian trunk line), and Tyumeñ; also by a railway from Perm to Kotlas, at the head of the northern Dvina. Of schools the province had, in 1896, 827 (65,740 pupils) under the Ministry of Public Instruction, and 782 (31,475 pupils) Church primary schools. There are also several mining schools, and 115 village schools have school-farms or gardens attached to them. The Perm *zemstvo* is one of the most active in Russia in promoting the spread of education and agricultural knowledge among the peasants.

The province is divided into 12 districts, the chief towns of which are, in Europe, Perm (45,403), Kungur (14,324), Krasnoufimsk (6427), Okhansk (1896), Osa (5176), Solikamsk (4069), and Tcherdyn (3662); and in Asia, Ekaterinburg (55,488), Irbit (20,064), Kamyshloff (8064), Shadrinsk (11,686), and Verkhoturiye (3178). The chief iron-works forming important towns are: Nijne-Taghilsk (30,000), Neviansk (16,066), Kyshtym (12,331), Revdinsk (9914), Upper and Lower Turinsk (10,795), Bogoslovsk (4510), Suksunsk (3130), Nyazepetrovsk, Verkh-Iset, Nijne-Iset, and Verkhne-Tagilsk. The chief salt-works are at Usolie (7785).

Perm, the capital of the above province, had in 1897 a population of 45,403, as compared with 32,350 in 1879. It has several scientific institutions (the Ural Society of Natural Sciences, Archives Committee, Technical Society), a scientific museum, a theatre, and various philanthropic institutions. Its industries develop but slowly, the chief works being shipbuilding yards, tanneries, chemical works, and rope works, their total annual production being valued at £300,000. Its river port is visited every year by more than 1160 vessels (nearly 150,000 tons, and £350,000 worth of goods being imported, and nearly as much exported), and its connexion by rail with Vyatka and Kotlas, now completed, will probably make it a port for the export of Siberian grain and raw produce to Archangelsk.

Pernambuco, an Atlantic state of Brazil, situated between 7° and 10° 40′ S. and 34° 45′ and 42° 10′ W. Area, 49,625 square miles. It is bounded on the E. by the Atlantic, on the N. by the states of Parahyba and Ceará, on the W. by Piauhy and Bahia, on the S. by Alagoas. Population (1872), 841,539; (1890), 1,101,539. The capital, Recife, and the islands of S. Antonio, S. José, and Boa Vista, are known by the name of Pernambuco, and have a population of 190,000. The total trade was valued at £5,848,360 in 1900—imports, £2,748,360; exports, £3,100,000 (sugar, £1,850,000; cotton, £750,000; and rum, skins, and minor exports, £500,000). Amongst the chief towns in the state are Bezerros, Bom Jardim, Brejo da Madre de Deus, Cabo, Caruarú, Escada, Garanhuns, Gloria de Goitá, Goyana (10,000 inhabitants), Olinda, Rio Formoso (8000 inhabitants). Railways connect Recife with Goyana, Timbaúba, Limoeiro, Caruarú, Palmares, &c. Total length of lines, 186 miles.

Perovsk, formerly Ak-mechet, a fortress of Kokand, and later Fort Perovskiy, a district town of Russian Central Asia, province of Syr-Daria, on the right bank of the navigable Syr-Daria river, 357 miles north-west of the Tashkent railway station. It carries on a considerable trade in cattle. Population (1897), 4662.

Perpignan, chief town of the department of Pyrénées-Orientales, 525 miles south-south-east of Paris, on the railway from Narbonne to the Spanish frontier. A monument to the soldiers who fell in the war of 1870–71 has been erected. Perpignan is the seat of the superior tribunal of the republic of Andorra. Population (1881), 21,895; (1891), 25,167; (1901), 32,950.

Perry, a city of Oklahoma, U.S.A., capital of Noble county, in the north-eastern part of the territory, on the Atchison, Topeka, and Santa Fé Railway. It is regularly laid out on a level site, contains a U.S. Land Office, and has a large trade, as it is the supply-point for a wide range of country. It was settled in 1893. Population (1900), 3351, of whom 127 were foreign-born and 399 negroes.

Perry. See Cider.

Perryville, a town of Boyle county, Kentucky, U.S.A., near the centre of the state. It is famous as the scene of a sharp battle on 8th October 1862, between the retreating forces of General Bragg and the Union forces under General Buell. General Bragg had entered Kentucky, hoping to secure the addition of that state to the Confederacy. His plan, however, was frustrated by General Buell, and he was obliged to retreat into Tennessee. The Union losses were heavy, and the Confederates were allowed to continue their retreat, taking with them a large waggon-train of provisions. Population (1900), 431.

PERSIA.

I. Geography and Statistics.

Since the publication of the ninth edition of the *Encyclopædia Britannica* the labours of many travellers and explorers have materially added to our knowledge of the geography of Persia, but as regards the salient physical features of the country there is little to add.

Mountains.—The Persians have no special names for the great ranges. Mountains and valleys are known only by local names which frequently cover but a few miles. Even the name Elburz, which European geographers apply to the chains and ranges that extend for a length of over 500 miles from Azerbáiján in the west to Khorassan (Khorasán) in the east, stands with the Persians only for the 60 or 70 miles of mountains north and north-east of Teherán (Tehran), including the cone of Demavend; and, as its meaning, "high mountain" (Zend, *Hara-berezaiti*), implies, it probably stood in ancient times for many other high mountains as well. The great central range, which extends, almost unbroken, for nearly 800 miles from Azerbáiján in the north-west to Baluchistan in the south-east, may aptly be called the *Central Range*. It has many peaks of 9000 to 10,000 feet in height, and some of its summits rise to an elevation of 11,000 feet, and near Kermán of nearly 13,000 feet (Kúh-i-Júpár). The valleys and plains west of the central range, as for instance those of Mahallát, Jóshekán, Isfáhán, Sírján, have an elevation of 5000 to 6500 feet; those within the range, as Jásp, Ardahál, Só, Páríz, are about 1000 feet higher; and those east of it slope from an elevation of

5000 to 6000 feet down to the depressions of the central plateau which, east of Kom, are not more than 2600 feet and east of Kermán 1500 to 1700 feet above the sea-level. Some of the ranges west of the Central Range, which form the highlands of Kurdistán, Luristán, Bakhtiári, and Fars, and are parallel to it, end near the Persian Gulf; others follow the central range, and take a direction to the east at some point between Kermán and the sea on the western frontier of Baluchistan. Some of these western ranges rise to considerable elevations; those forming the Turko-Persian frontier west of the lake of Urmia have peaks 11,000 feet in height, while the Sahand, east of the lake and south of Tabriz, has an elevation of 12,000 feet. Farther south, the Takht-i-Bilkís, in the Afshár district, rises to 11,200 feet, the Elvend (ancient Orontes), near Hamadán, to 11,600. The Shuturun Kúh, south of Burújird, is over 11,000 feet in height, the Sháhán Kúh, Kúh-i-Gerra, Zardeh Kúh and Kúh-i-Kuran (by some writers called Kúh-i-Rang), all in the Bakhtiári country west of Isfáhán, are 12,800 to 13,000 feet in height; and the Kúh-i-Diná (by some writers wrongly called Kúh-i-Dínár) has an elevation of over 14,000 feet. Still farther south, towards Kermán, there are several peaks (Bíd-Khún, Lálehzár, Sháh-Kúh, Jamálbáriz, &c.) which rise to an elevation of 13,000 feet or more, and the Kúh-i-Hazár, south of Kermán, is 14,700 feet in height. Commencing near Ardabíl in Azerbáiján, where the cone of Savalan rises to an elevation of 15,792 feet (Russian trigonometrical survey), and ending in Khorasán, the great Elburz range presents on its southern, or inward, face a more or less abrupt scarp rising above immense gravel slopes, and reaches in some of its summits a height of nearly 13,000 feet; and the peak of Demavend, north-west of Teherán, has a height of at least 18,000 feet. There are several important ranges in Khorasán, and one of them, the Binalúd, west of Meshed and north of Nishápúr, has several peaks of 11,000 to 12,000 feet in height. In south-eastern Persia the Kúh-i-Basmán, a dormant volcano, 11,000 to 12,000 feet in height, in the Basmán district, and the Kúh-i-Taftán, *i.e.*, the hot, or burning mountain (also called Kúh-i-Núshádar from the "sal ammoniac," *núshádar*, found on its slopes), an active triple-peaked volcano in the Sarhad district and 12,681 feet in height (Capt. Jennings) are notable features.

Geology.—Since Mr W. T. Blanford's sketch of the geology of Persia was written (see *Ency. Brit.*, 9th edit., xviii. pp. 621–622) several travellers and explorers have gathered much valuable information, but no writer of note has as yet combined the new information into a general survey, and Mr Blanford's sketch is still the only trustworthy one. The following short sketch of the geology of the country between Teherán and Isfáhán, including a part of the Elburz, is given in the author's *Eastern Persian Irák* (London, 1896):—

"The part of the Elburz in the neighbourhood of Teherán is composed of a few granitoid and schistose rocks, sedimentary rocks of various ages from Devonian to Miocene, and volcanic rocks of various periods. There is no central axis of crystalline rocks, and Palæozoic rocks are very sparsely represented. In the Lár district, north-east of Teherán, are some Old Red Sandstone strata and Carboniferous limes with *Fuselina;* and at Hív, north-west of Teherán, there is a thin layer of Carboniferous limestone with *Productus.* Jurassic rocks form most of the southern slopes, and immediately under them, in Liassic formations, most of the coal which supplies Teherán is obtained. Between the Palæozoic and Liassic strata occur some rocks which have been classed as Triadic, although no fossils were found in them to prove it; and some of the volcanic rocks and tuffs which enter into the composition of the Elburz also seem to belong to the Triadic period. Cretaceous rocks with hippurites run out from the Elburz and form a ridge south-east of Teherán. Some of the volcanic rocks of the Elburz belong to the Miocene age, but the trachytic Demavend, raised up at the southern end of the Caspian depression, is probably post-Tertiary. The hills parallel to the Elburz, and between it and the central range, form a zone of trachytic rocks and tuffs and other volcanic formations associated with Cretaceous limes, sandstones, shales, and newer Tertiary formations. The hills south of Hív, and south-west of Teherán as far as Savah, are composed of volcanic rocks—dolerites, quartz-porphyries, andesites, rhyolites—and of Cretaceous limes without fossils, Eocene limes with corals, Miocene sandstones, limes with *Echinidæ* and *Pecten*, and Miocene gypsiferous strata and conglomerates. Most of the ridges between Teherán and Kom are composed of trachytic and gypsiferous formations. Near Hawz-i-Sultan, Cretaceous limes and sandstones rest on trachytic rocks. The Siah Kúh, south-east of Teherán, is composed of trachytes and green trachytic tuffs of the Cretaceous period, underlying limes and sandstones of the lower Miocene and Miocene gypsiferous formations of variegated marls, salt, and gypsum. The hills through which the "Caspian Gates" (Sarderreh Pass) east of Teherán lead also belong to the gypsiferous formation. The great central range possesses a distinct axis of crystalline rocks and granite, and granitoid formations form a great zone or band extending from Azerbáiján to Kermán. Volcanic formations, mostly of the Cretaceous period, occupy an extensive area, and are associated with Cretaceous and Tertiary beds, which generally rest on old rocks. Between Kom and Isfáhán we see black slates and massive Cretaceous limes interstratified with diorites, andesites, trachytes, and other volcanic formations of the same age, resting on granites, syenites, and tonalites which occasionally pass into gneissose and schistose rocks. The hills of the Isfáhán valley are composed of Cretaceous limes resting on black slates and shaly limestones. On the outer edges of the central range, particularly towards the east, Miocene formations, principally of the gypsiferous series, and resting on crystalline schists and dolerites, andesites and trachytes, abound. South-east of Natanz, and towards Naïn, the schists are broken through by basalts, and south of the Isfáhán–Naïn road the Gavkhání depression, which takes up the Isfáhán river, is in the gypsiferous series resting on trachytes. The rocks composing the hills parallel to and east of the central range are similar to those of the central range, and comprise Cretaceous and Miocene formations resting on gneiss, granite, and volcanic rocks."

From this sketch it will be seen that the Palæozoic rocks are rare, but that, from the Trias upwards, nearly all the principal formations are represented. The Miocene salt formation, "the gypsiferous series" of Loftus, covers vast extents of ground. During the Cretaceous period, when much volcanic action took place, the central desert of Persia was a sea; but the Miocene salt formation, which is so largely represented in inner Persia, is completely wanting on the Caspian side of the Elburz, proving that the Elburz range must already then have been a dividing wall between the Caspian depression and inner Persia. The greatest changes probably took place at the end of the Miocene, or perhaps during the Pliocene period, and the volcanic forces acted most at those places which offered the least resistance—as, for instance, all along the precipitous inner sides of the ranges and towards the depressions of central Persia. During the post-Tertiary period, when the hills and valleys were very much as they are now, Demavend was formed; and then also the immense recent, or sub-recent, accumulations of gravel, pebbles, and boulders, which form gentle inclines from the base of the hills down to the alluvial flats and fill up with long slopes the broad valleys opening into the plains, were deposited from the detritus of the hills. The lowest portion of these accumulations consist of fine alluvial loam, shifting sands, and sometimes swamp or marsh; then follows the gravel, first fine, then getting coarser as one ascends. The most remarkable gravel slopes are that south of Káshán and that on which the city of Teherán is situated. The former extends from Gebrábád, at the foot of the Kúhrúd hills, to Káshán, a distance of about 12 miles, and the latter from the foot of the Elburz to five or six miles south of Teherán, a distance of 16 miles. The depth of these deposits must be great: a well bored at Teherán, 10 miles away from the base of the hills, had not reached the end of the gravel at a depth of over 500 feet.

Rivers.—Three rivers, *Kizil Uzain*, *Atrak*, and *Gurgán*, are mentioned in the ninth edition (p. 620), as belonging essentially to Persia in reference to the Caspian watershed, but there is a fourth, the *Herház*, which, though not important in length of course or drainage, also, like the *Kizil Uzain*, breaks through the Elburz range from the inner southern scarp to the north. It rises on the slopes of the *Kasíl Kúh*, a peak 12,000 feet in height within the Elburz and about 25 miles north of Teherán, flows in an easterly direction through the Lár plateau, where it is known as the Lár river, and takes up several affluents; turns to the north-east at the foot of Demavend, leaving that mountain to the left, and flows due north past Amol to the Caspian. Its length is about 120 miles. The late Sir Oliver St John estimated the drainage of the rivers which have no outlet to the sea, and form inland salt lakes and swamps (kavírs) at 380,000 square miles, including the drainage into the lake of Urmia, which he estimated at 20,000 miles. There are fourteen rivers which flow into the lake of Urmia:

Ají Chái, Sáfí Chái, Murdí Chái, and Jaghatú from the east, the Tatává (Tataú) from the south, and nine smaller rivers from the west. During heavy rains and at the end of winter, when the snows on the hills melt, thousands of streams, mostly nameless, flow from all directions into the innumerable depressions of inner Persia, or help to swell the perennial rivers which have no outlet to the sea. These latter are few in number, and some of them barely suffice for purposes of agricultural irrigation, and in summer dwindle down to small rills. The perennial streams which help to form the kavírs (salt swamps) east of Kom and Káshán are the Hableh-rúd, rising east of Demavend, the Jájrúd, rising north of Teherán, the Kend and Kerej rivers, rising north-west of Teherán, the Shúreh-rúd (also called Abhar-rúd), rising near Sultaníeh on the road between Kazvín and Tabriz, and the Kara-sú, which rises near Hamadán and is joined by the Zarín-rúd (also known as Dó-áb), the Rezá Chái (also called Mazdakán-rúd), the Jehrúd river and the Kom-rúd. The river of Isfahán, Zendeh-rud, *i.e.*, "the great river" (from Persian *zendeh* [Pehleví, *zendek*], great), but now generally known as Záyendeh-rúd, *i.e.*, "the life-giving river," flows into the Gavkháni or Gavkháneh swamp, east of Isfáhán. In Fars the *Kur* with its affluents forms the lake of Bákhtegán (also known as lake of Nairíz), and is, in its lower course, generally called Bandámír (made famous by Thomas Moore) from the band (dam) constructed by the Amír (prince) Azud-ed-dowleh in the 10th century. ("Note on the Kur River in Fars," *Proc. Royal Geogr. Soc.*, London, 1891.) With regard to the rivers which flow into the Persian Gulf and the Indian Ocean, St John, after mentioning the Shatt-el-Arab, Jerráhi, and Táb, states that "after this, not a single stream *unfordable at all seasons* bars the passage of the traveller along the coast till he reaches the Indus, eighteen degrees of longitude to the east and five degrees of latitude farther south, a stretch of riverless waste perhaps unequalled save on the neighbouring shores of Arabia and the Red Sea" (*Eastern Persia*, i. 8). There are, however, many streams which though fordable at most seasons (some of them are often quite dry) are quite unfordable during the rains. Two of these may be mentioned here, viz., the Mánd, erroneously mentioned as *Mira* in the ninth edition (p. 620), and the Mínáb, which St John (*loc. cit.* p. 9) considered as being "of far more importance than the maps would lead the observer to suppose." The former, after a run of over 300 miles from its sources in the hills west of Shiráz, debouches at Khor-i-Ziáret, about 60 miles south of Bushire. It is mentioned by the old Arab and Persian geographers as the Sitakán (in some MSS. misspelt Sakkán), and is the Sitakos of Arrian and the Sitioganus of Pliny. In its upper course it is now known as the Kara-aghach (Wych-elm) river (cf. "Notes on the River Mand in Southern Persia," *Royal Geogr. Soc.*, London, December 1883). The Mínáb has two outlets into the Persian Gulf, one the Khor-i-Mínáb, a salt-water creek into which the river overflows during the rains, about 30 miles east of Bander Abbási, the other the true Mínáb, at Khágún, some miles south of the creek. It rises in the hills about 100 miles north of Bander Abbási, and has a considerable drainage. Its bed near the town of Mínáb (15 miles from the coast) is nearly a mile in width, and during the rains the water covers the whole bed, rendering it quite unfordable. During ordinary weather, in March 1884, the water flowing past the town was 100 yards in width and 2 feet deep (Preece, *Proc. Royal Geogr. Soc.*, January 1885). In ordinary seasons very little water of the river runs in its original bed, being diverted into canals, &c. The creek, the Anamis of Nearchus, is navigable nearly all through the year as far as Shahbander, the custom-house, about 7 miles inland, for vessels of 20 tons burden.

Climate.—Since the paragraphs "rainfall and winds" and "climate" in the article PERSIA of the ninth edition were written (pp. 621, 623), many meteorological observations have been taken at various places in and near Persia, and much additional information can now be given. For the rainfall on the watershed of the Persian Gulf we have two places of observation, Bushire and Jask; at the former place it is a little in excess of that of inner Persia, while at the latter place it is very much less. The rainfall on the Caspian watershed greatly exceeds that of inner Persia; at Astrábád and Ashúrada, in the south-eastern corner of the Caspian, it is about 50 per cent. more; and at Resht and Lenkoran, in the south-western corner, it is four and five times that of the adjoining districts across the ridges to the south. With the exception of the Caspian watershed and that of the Urmia basin, the country has probably in no part a yearly rainfall exceeding 13 to 14 inches, and throughout the greater part of central and south-eastern Persia the yearly rainfall probably does not exceed 6 inches. The following mean values of the rainfall at Teherán have been derived from observations taken by Dr Tcherepnine during the years 1884–87 (Symons's *Monthly Meteorological Mag.*, November 1893) and by the writer during the years 1892–99:—

	Jan.	Feb.	Mar.	April.	May.	June.	
Mean	in. 2·00	in. 1·69	in. 2·09	in. 1·55	in. ·49	in. ·12	Total for Year. in. 10·71
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
	in. ·03	in. ·04	in. ·05	in. ·30	in. 1·10	in. 1·25	

Good harvests depend on the rainfall from October to April, and on an amount of snow sufficient to cover the crops during frosts. During normal winters in Teherán and surrounding districts the rainfall amounts to 9 or 10 inches, with 3 to 4 of snow, but in the winter 1898–99 it was only 5½ inches, with only 1 inch of snow; and in 1899–1900 the harvests were in consequence exceptionally bad, and large quantities of wheat and flour had to be brought from the provinces and even from Russia at high freights, causing the price of bread at Teherán to rise 200 per cent. The following table, which has been compiled from the latest available information, shows the mean annual rainfall in inches at fifteen stations in and near Persia:—

Station.	Lat. N.	Long. E.	Altitude.	Period of Observations.	Year.	Authority
			Feet.	Years.		
Lenkoran	38° 46′	48° 51′	−60	28¼	46·82	Supan.[1]
Resht	37° 17′	49° 35′	−50	2	56·45	British Consul.[2]
Ashúrada	36° 54′	53° 55′	−80	19	17·17	Supan.[1]
Astarábád	36° 51′	54° 25′	−40	7	16·28	Symons.[3]
Meshed	36° 17′	59° 36′	3180	6	6·43	British Consul.[4]
Quetta	30° 11′	67° 3′	5500	19	10·09	Supan.[1]
Kelat	28° 53′	66° 28′	6500	15	8·98	"
Maskat	23° 29′	58° 33′	..	3	6·13	"
Jask	25° 39′	57° 46′	..	10	3·24	English Telegraph.[5]
Bushire	28° 59′	50° 49′	..	19	13·36	Supan.[1]
Isfáhán	32° 37′	51° 40′	5370	6	3·23	English Telegraph.[5]
Teherán	35° 41′	51° 25′	3810	12	10·71	The writer.
Urmia (Sair)	37° 28′	45° 8′	6225	1	21·51	Symons.[3]
Baghdad	33° 19′	44° 26′	..	7	10·59	Supan.[1]
Merv	37° 35′	61° 50′	700	1	6·36	Symons.[3]

The figures for Meshed and Isfáhán do not give the total rainfall at those places, because the observers have measured only the falls of rain and neglected those of snow. The mean annual rainfall of Meshed and Isfáhán, as given in the table, is therefore considerably less than what it ought to be, and would no doubt, if the falls of snow were added, amount to quite as much as that of Teherán, or 10 to 11 inches instead of 6½ and 3¼ as given in the table. Among the prevailing winds should be noted the dry and warm wind which comes down from the snowy Elburz to Gilán in December and January, and much resembles the foehn of the Alps (Dr Tholozan, "Sur les vents du Nord de la Perse et sur le foehn du Guilan," *Comptes Rendus*, Acad. d. Sciences, March 1882). Observations for temperature have been taken for many years at the stations of the Indo-European Telegraph and for a few years at the British consulate in Meshed, and the monthly and annual means shown in the table on the following page have been derived from the indications of maximum and minimum thermometers in degrees Fahrenheit.

Very few hygrometrical observations have been taken, and only those of the British Residency at Bushire are more or less trustworthy, and have been regularly registered for a number of years. In inner Persia the air is exceptionally dry, and in many districts polished steel may be exposed in the open during a great part of the year without becoming tarnished. Along the shores of the Caspian, particularly in Gilán and Mázandarán, and of the Persian Gulf from the mouth of the Shatt-el-Arab down to Bander Abbási, the air during a great part of the year contains much moisture—dry- and wet-bulb thermometers at times indicating the same temperature—and at nights there are heavy falls of dew. In Gilán and Mázandarán the air contains much moisture up to considerable elevations and as far as 30 to 40 miles away from the sea; but along the Persian Gulf, where vegetation is very scanty, stations only a few miles away from the coast and not more than 20 or 30 feet above the sea-level have a comparatively dry climate.

[1] Dr A. Supan, "Die Vertheilung des Niederschlag's auf der festen Erdoberfläche," *Pet. Mitt.*, Suppl. 124, 1898.

[2] Consular report, Gilán, 1897.

[3] Symons's *Monthly Meteorological Mag.*, December 1893.

[4] Consular reports for Khorasán.

[5] Observations taken at the telegraph stations, and kindly communicated by Mr R. C. Barker, C.I.E., director of the Indo-European Telegraph Department in Persia.

Station.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.	Highest observed.	Lowest observed.	Difference between Extremes.
Meshed	32	34	49	59	68	76	78	70	67	55	48	40	56·3	91	15	76
Teherán	38	38	48	51	71	81	84	81	73	64	53	43	60·4	111	3	108
Tabriz [1]	17	25	39	54	63	74	79	81	73	62	48	34	54·1	99	−18	117
Kashan [2]	35	36	43	60	74	83	90	85	77	68	53	42	62·2	113	9	104
Isfáhán	...	...	...	...	...	...	...	...	...	...	...	...	58·0	100	−3	103
Abadeh [3]	41	41	47	56	68	75	79	75	71	59	55	46	59·5	96	14	82
Dehbíd [4]	27	30	38	45	57	65	69	65	61	52	43	36	49·0	91	−19	110
Shiráz [5]	48	47	55	63	73	80	85	81	76	67	55	49	65·0	113	21	92
Kazerún [6]	51	50	52	67	84	93	95	94	87	79	70	56	73·2	110	36	74
Borazjún [7]	55	57	66	80	94	97	100	99	92	83	72	64	80·0	117	48	69
Bushire	58	60	65	74	82	86	90	90	87	80	71	62	75·4	109	41	68

Frequently when the temperature in the shade at Bushire is not more than 85° or 90°, and the great humidity of the air causes much bodily discomfort, life is almost pleasant 12 or 20 miles inland with a temperature of over 100°.

Area and Population.—In 1880, when a great part of the northern and the whole of the eastern and western frontiers were not defined, the area of Persia was estimated at 1,647,070 square kilometres, or 635,934 square miles ("Die Bevölkerung der Erde," *Pet. Mitt.* Erg. Heft. 69, p. 28). Since then the northern and eastern frontiers have been demarcated, but the Turco-Persian frontier, from Mount Ararat in the north to Muhamrah in the south, a distance of 700 miles, is still an undefined line lying within a border-strip of from 20 to 40 miles in width, and the area has been estimated at 628,000 square miles. In 1881 the writer estimated the population of Persia at 7,653,600; 1,963,800 urban, 3,780,000 rural, and 1,909,800 wandering ("Bevölkerung der Erde," p. 28; ninth edit. *Ency. Brit.*, p. 628); and, allowing for an increase of about 1 per cent. per annum, the population for 1900 may be estimated at 9 to 9¼ millions. E. Lorini (*La Persia economica contemporanea*, Roma, 1900, p. 378) estimates it at 9,333,000. No statistics whatever being kept, nothing precise is known of the movement of the population. During the 'eighties many Persian subjects emigrated, and a number of Persian villages were deserted and fell to ruins; since then a small immigration has set in and new villages have been founded. In some districts the population increases very slowly, perhaps only ½ per cent. per annum; in others the increase exceeds 1½ per cent. and even reaches 2 per cent. Persians say that the females exceed the males by 10 to 20 per cent., but wherever the present writer has been able to obtain trustworthy information, he found the excess to be less than 2 per cent. Of the deaths in any place the only check obtainable is from the public body-washers, but many corpses are buried without the aid of the *public* body-washers; and the population of the place not being accurately known, the number of deaths, however correct, is useless for statistical purposes. Medical men have stated that the number of deaths, in times when there are no epidemics, amounts to 19 or 20 per thousand, and the number of births to 25 to 40 per thousand.

The prices of the staple articles of food and all necessaries of life have risen considerably since 1880, and, particularly in the large cities, are now very high. As salaries and wages have not increased at the same rate, many of the upper classes and officials are not so well off as formerly. By dismissing their servants in order to reduce expenditure, they have thrown great numbers of men out of employ, while many labourers and workmen are living very poorly and often suffer want. Tradesmen are less affected, because they can sell the articles which they manufacture at values which are more in proportion with the increased prices of food. In 1880 a labourer earning 25 krans, or £1 sterling a month, could afford to keep a family; by 1901, in krans, he earned double what he did then, but his wage, expressed in sterling, was the same, and wherever the prices of food have risen more than his wages he could not afford to keep a family. In many districts and cities the number of births is therefore reduced, while at the same time the mortality, in consequence of bad and often insufficient food, is considerably increased.

Constitution and Government. — The government of Persia is an absolute monarchy, and resembles in its principal features that of the Ottoman empire, with the exception, however, that the monarch is not the religious head of the community. His powers over his subjects and their property are absolute, but only in so far as they are not opposed to the *shar'*, or "divine law," which consists of the doctrines of the Mahommedan religion, as laid down in the Koran, the oral commentaries and sayings of the Prophet, and the interpretations of the same by his successors and the high priesthood. The government is, therefore, much like that of the French monarchy until a few centuries ago, viz., on the principle of the old Roman "quod principi placuit, legis habet vigorem," with the restriction, as the French lawyer Beaumanoir has it, "pourvu qu'il ne soit pas fet *contre Dieu*, ne contre bonnes meurs, car s'il le feroit, ne le devroient pas si souget soufrir."

The form of government as it now exists is admirably described by Lord Curzon of Kedleston in *Persia and the Persian Question.* "The language," says that author, "in which the Shah addresses his subjects and is addressed by them, recalls the proud tone in which an Artaxerxes or Darius spoke to his tributary millions, and which may still be read in the graven record of rock-wall and tomb. He remains the *Shâhanshâh*,[8] or 'King of Kings'; the *Zill Ullah*, or 'Shadow of God'; the *Kibleh Alam*, or 'Centre of the Universe'; 'Exalted like the planet Saturn; Well of Science; Footpath of Heaven; Sublime Sovereign, whose standard is the Sun, whose splendour is that of the Firmament; Monarch of armies numerous as the Stars.' Still would the Persian subject endorse the precept of Sadi, that 'The vice approved by the king becomes a virtue; to seek opposite counsel is to embrue one's hands in his own blood.' The march of time has imposed upon him neither religious council nor secular council, neither *ulema* nor senate. Elective and representative institutions have not yet intruded their irreverent features. No written check exists upon the royal prerogative.

"And yet the power of the Persian king by no means corresponds to its arrogant definition, nor is it now equal to what it once was. In the first place, the Shah is no longer the religious head even of the *Shiah* community of the Mussulman world. At no time have the sovereigns of Persia enjoyed the spiritual supremacy that was conceded to the caliphs of Baghdad and that is still claimed for the sultan of Constantinople. But the Sefavi monarchs, by virtue of their descent from a famous saint, who was himself a *Seyid*, or descendant of Ali, the son-in-law of the Prophet, were invested with a semi-sacred character, to which

[1] 38° 5′ N.; 46° 18′ E.; altitude 4423 feet.
[2] 34° „ ; 51° 27′ „ ; „ 3190 „
[3] 31° 18′ „ ; 52° 38′ „ ; „ 6200 „
[4] 30° 37′ „ ; 53° 10′ „ ; „ 8000 „
[5] 29° 37′ „ ; 52° 32′ „ ; „ 5000 „
[6] 29° 37′ „ ; 51° 43′ „ ; „ 2800 „
[7] 29° 15′ „ ; 51° 3′ „ ; „ 100 „

[8] We see this title in its old Persian form, *Khsháyathiya Khsháyathiy*, in the cuneiform inscriptions; as Βασιλέως Βασιλεῶν on the coins of the Arsacides, and as the Pehlevi *Malkán Malká* on the coins and in the inscriptions of the Sassanians. With the Mahommedan conquest of Persia and the fall of the Sassanians the title was abolished; it was in use for a short time during the 10th century, having been granted to Shah Ismail Samáni by the Caliph Motadhid A.D. 900; it appeared again on coins of Nadir Shah, 1736–47, and was assumed by the present dynasty, the Kajárs, in 1799.

alone can we attribute the passiveness with which, for a whole century, their subjects submitted to the rule of a succession of capricious and dissolute drunkards. Chardin says that they were regarded as vicars and successors of the *Imams;* and Kaempfer records that the water in which they had washed was deemed holy, and was eagerly sought after as a cure for all complaints. No such pretensions, however, have been made, or could be made, on behalf of any subsequent dynasty; least of all on behalf of a family like the Kajárs, of Turkish extraction. The Shah of Persia, therefore, must be dissociated from any claims of personal sanctity, and both the scope and limitations of his prerogative must be sought on purely secular grounds.

"Besides the respect for the religious teachers and law, there are many other restraints upon the Shah's powers. Regard for established usage has been found a stronger deterrent. So long as the revenue is collected and robbery is suppressed, the complete assertion of the royal power is not, in hazardous cases, too rigorously pressed. In other words, political expediency acts as a further deterrent. But, strongest of all, in the case of the reigning monarch, and of great interest as proving the extent to which Persia has been drawn into the vortex of civilized states, is the deterrent of foreign opinion, which, in the absence of any indigenous public opinion worthy of the name, has taken its place, and has operated as a safeguard for which the Persian people are probably quite without gratitude, and of which they are, as may be suspected, wholly unaware. It may safely be predicted that any extravagant or savage exercise of the royal prerogative, such as has been a familiar incident in the Persian history of the past, will rarely occur, if at all, in the future, and that in any case it will prove an exceptional instead of a normal feature of government. This remarkable change is to be attributed to the permanent presence of foreign ministers and to the electric telegraph."

In the task of government the Shah is assisted by the *Sadr Azam* ("Grand Vizír"), a number of *vizírs*, ministers, or heads of departments somewhat on European lines, and a "grand council of state," composed of some ministers and other members nominated by the Shah himself as occasion may require. Many of the "ministers" would be considered in Europe merely as chiefs of departments of a ministry, as, for instance, the minister for Crown buildings, that for Crown domains, the minister of ceremonies, those for arsenals, army accounts, &c.; also an accumulation of several offices without any connexion between their functions, in the hands of a single person, has frequently been a characteristic departure from the European model. The ministers are not responsible to the Crown in a way that ministers of a European Government are; they rarely take any initiative, and generally refer their affairs to the Grand Vizír or to the Shah for final decision. This irresponsibility on the part of the ministers, and the system of referring all affairs, even unimportant ones, to the head of the State, makes the Shah, whenever the office of Grand Vizír is vacant—which has frequently happened — one of the hardest-worked sovereigns in the world, and the post of Grand Vizír is anything but a sinecure.

The official *Sálnámeh* ("Year-book") for 1899 enumerates twenty-seven *vizírs* (ministers), but only some of them are consulted on affairs of State. The departments that have a *vizír* at their head are the following: Court, Ceremonies, Shah's secretarial department, Interior, Correspondence between Court and Governors, Revenue accounts and budget, Finance, Treasury, Outstanding accounts, Foreign Affairs, War, Army accounts, Military stores, Arsenals, Justice, Commerce, Mines and industries, Agriculture and Crown domains, Crown buildings, Public Works, Public Instruction, Telegraphs, Posts, Mint, Religious endowments and pensions, Customs, Press. In addition to these twenty-seven *vizírs* with portfolios, there are some titulary *vizírs* at Court, like *Vizír i Huzúr i Humayún* (Minister of the Imperial Presence), *Vizír i makhsús* (Extraordinary Minister), &c., and a number in the provinces assisting the governors in the same way as the Grand Vizír assists the Shah.

Political and Administrative Divisions.—The empire of Persia, officially known as *Mamálik i Mahrúseh i Irán*, "the protected kingdoms of Persia," is divided into a number of provinces, which, when large, and containing important sub-provinces and districts, are called *mamlikat*, "kingdom," when smaller, *viláyat* and *ayálat*, and are ruled by governor-generals and governors appointed by and directly responsible to the Crown. These provinces are further divided into sub-provinces, *viláyats*, districts, sub-districts, and parishes, *bulúk*, *nahíyeh*, *mahál*, and towns, cities, parishes, and villages, *shehr*, *kassábeh*, *mahalleh*, *dih*, which are ruled by lieutenant-governors and other functionaries appointed by and responsible to the governors. The administrative system of Persia is practically the same as it was in ancient times when the empire of the *Sháhansháh*, the "Great King," βασιλεύς μέγας of the Arsacides, was divided into a number of provinces ruled by satraps, or governors, who were responsible for the due payment of the tributes and taxes. All governors are called *hákim*, or *hukmrán*, but those of large provinces generally have the title of *váli*, and sometimes *firmán-firmá*. A governor of a small district is a *zábit;* a deputy-governor is called *náib el hukúmeh*, or *naïb el ayáleh;* an administrative division is a *kalamró*, or *hukúmat*. Until recently the principal governorships were conferred upon the Shah's sons, brothers, uncles, and other near relatives, but now many of them are held by men who have little if any connexion with the royal family. Also, the governors are now, as a rule, resident in their provinces instead of being absentees at the capital.

Every town has a mayor, or chief magistrate, called *beglerbegi*, "lord of lords," *kalántar*, "the greater" (same as mayor), and sometimes *dárogha*, "overseer," or chief of police; every ward or parish, *mahalleh*, of a town and every village has a head-man called *ked-khodá*, "house-lord." These officers are responsible to the governor for the collection of the taxes and the orderly state of their towns, parishes, and villages. In the important provinces and sub-provinces the governors are assisted by a man of experience, to whom the accounts and details of the government are entrusted. This person, called *vizír*, or *píshkár*, is often nominated by the Shah, and his functions in the provincial government are similar to those of the Grand Vizír in the central government, and comprise very extended administrative powers, including at times the command of the military forces in his province. Among the nomads a different system of titles prevails, the chiefs who are responsible for the taxes and the orderly conduct of their tribes and clans being known as *ilkháni*, *ilbegi* (both meaning "tribe-lord," but the latter being considered an inferior title to the former), *khán*, *raïs*, *amír*, *mír*, *shaikh*, *tushmál*, &c.

The governors and chiefs, excepting those possessing hereditary rights, are frequently changed; appointments are for one year only and are sometimes renewed, but it does not often occur that an official holds the same government for longer than that period, while it happens rarely that a province is governed by the same person for two or three years. This was not so formerly, when not infrequently an official, generally a near relation of the Shah, held the same governorship for five, ten, or even more years. The governorship of the province of Azerbáïján is an exception, and has, under the now reigning dynasty, always been held by the *valiahd*, "heir-apparent," or "Crown Prince."

The political divisions of Persia, provinces, sub-provinces, districts, &c., ruled by *hákims* number over 200 (cf. the statement in Nöldeke's *Geschichte des Artachšîr Pâpakân*, "after Alexander's death there were in Irán 240 local governors"), but the administrative divisions, *hukúmat*, or *kalamró*, with governors appointed by the Crown and responsible to it for the revenues, have been under fifty for sixty-five years or more. In 1840 there were twenty-nine administrative divisions, in 1868 twenty-two, in 1875 twenty-nine, in 1884 nineteen, in 1890 forty-six, and in 1900 thirty-five.

Mamlikats.—1. Azerbáïján; 2. Fárs; 3. Khorasán; 4. Kermán and Baluchistan; 5. Gilán and Tálish.

Viláyats.—1. Teherán; 2. Isfáhán; 3. Nishápúr; 4. Kermánsháh, and frontier (Turkish); 5. Kurdistán; 6. Gerrús; 7. Astrábád and Gurgán; 8. Mázandarán; 9. Irák, Kamareh, Gulpáigan, and Khunsár; 10. Luristán and Burújird; 11. Yezd; 12. Kazvín; 13. Maláyir, Túsirkán, and Nehávand; 14. Hamadán; 15. Kashán; 16. Khamseh; 17. Kharkán; 18. Sháhrúd and Bostám; 19. Semnán and Damghhán; 20. Kom; 21. Sáveh, Zerend and Sháhsevèn-i-Baghdádí; 22. Arabistán and Bakhtiarí; 23. Fírúzkúh; 24. Demavend; 25. Nátanz; 26. Kangáver; 27. Khár; 28. Jóshekán; 29. Tálikán; 30. Tárom 'uliá.

Justice.—By the theory of a Mahommedan State there should be no other courts of justice except those established for the administration of the *shar'*, the "divine, or written law," but in Persia there is another judicature, which is called *'urf* and represents the "customary," or "known and unwritten law." This *'urf* may be considered an emanation of the supreme temporal authorities subordinate to the Shah, while the *shar'* is interpreted and administered by the ecclesiastical authorities, the *'ulemá*, or clergy. Justice, therefore, is administered by the Shah and his representatives according to one law and by the clergy according to another, but necessarily the decisions of the former must not be opposed to the fundamental doctrines of Islám. On the other hand, it frequently happens that decisions by the ecclesiastical authorities are not in accordance with the views, or wishes, of the authorities administering the *'urf*, and much friction between the two authorities, leading sometimes to serious disorders, ensues, but generally ends in favour of the clergy. The Shah's representatives for the administration of justice are the governors and other officers already mentioned. The officials charged with the administration of justice according to the *shar'* are judges, called *shaikh-ul-islám* and *kázi* (*kadhi*, *kadi* of Arabs and Turks), members of the clergy appointed by the Government and receiving a fixed salary, but at present some cities are without regular appointed judges and the title of *kázi* is almost obsolete; decisions according to the *shar'* are given by all members of the clergy, ranging from ignorant *mullás* of little villages and cantons to learned *mujtahids* of the great cities. A judgment given by a lower member of the ecclesiastical hierarchy is not always executed, for, if the parties to the suit are dissatisfied with the judgment, they may appeal to a priest who stands higher in public estimation, or one of the parties may induce a higher authority by bribery to quash the judgment of the first. Unfortunately, many members of the clergy are corrupt, but the *mujtahids*, as a rule, are honest and entirely trustworthy. The functions of the representatives of the *shar'* are now limited to civil cases, while all criminal cases are referred to the *'urf*, which, however, also takes cognizance of civil disputes, should the parties desire it.

In criminal cases the dispensation of justice is always summary, and, when the offence is small, the whole procedure, including the examination of witnesses and criminal, as well as the decision and the punishment, a bastinado, is a matter of some minutes. For commercial cases, not paying a bill in time, bankruptcies, &c., a kind of jurisdiction is exercised by the Minister of Commerce, or a board of merchants, but the decisions of the minister, or those of the board, are rarely final. In Teherán the board of merchants is presided over by the *malik ut tujjár*, "King of Merchants," in the provincial cities by a person called *malik amín*, and *muín* of merchants.

After his second journey to L rope in 1878 the late Shah desired to organize a police for the whole of Persia on the European system, but this intention was not carried out in its entirety, and only a small body of police, whose services were confined to the capital and its immediate neighbourhood, was created in 1879. Its strength is 60 mounted policemen and 190 foot, with 11 superior and 40 subaltern officers. There are also 280 men for cleaning streets. Two battalions of infantry have been attached to the police department, and the whole force is under the "Minister of Police."

There is also a "Tribunal of the Ministry for Foreign Affairs," presided over at Teherán by an official of the Foreign Office, and in the provincial cities by the *kárguzárs*, "agents," of that department. The functions of this tribunal are to inquire into and judge differences and suits between Persian subjects and foreigners, and it is stipulated in the treaty of Turkmanchaï, which is the basis of all existing treaties between Persia and other countries, that "such differences and suits shall only be examined and judgment given in the presence of the dragoman of the mission or consulate (of the foreign subject), and that, once judicially concluded, such suits shall not give cause to a second inquiry. If, however, circumstances should be of a nature to require a second inquiry, it shall not take place without previous notice given to the minister, or the chargé d'affaires, or the consul, and in this case the business shall only be proceeded with at the supreme chancery of the Shah at Tabriz or Teherán, likewise in the presence of a dragoman of the mission, or of the consulate." (Article vii.)

A foreign subject implicated in a criminal suit cannot be pursued or molested in any way unless there exist full proofs of his having taken part in the crime imputed to him, and should he be duly convicted of the crime, he is handed over to his legation, which either sends him back to his own country to undergo the punishment established by law, or, according to more recent usage, punishes him in Persia by fine, imprisonment, &c. In this respect the powers of the foreign representatives in Persia, now numbering ten (Great Britain, Russia, France, Turkey, Austria-Hungary, Germany, United States of America, Italy, Belgium, and the Netherlands) vary considerably, some having the power of condemning a criminal to death, while others cannot do more than fine and imprison for short periods. Suits, civil and criminal, between foreign subjects are altogether out of Persian jurisdiction, and are judged by the representatives of the foreign powers accredited to Persia.

In 1889, after the late Shah's return from his third visit to Europe, the Council of State was instructed to compile a code of law for the regulation of justice. A beginning was made by ordering the translation of the Code Napoléon, the Indian Mahommedan code, and the Code Napoléon as modified for Algeria; but, as Lord Curzon says, "one more excellent scheme went into the waste-paper basket, and one more stone had to be added to the cairn of abortive reforms so conscientiously piled by Nássir-ed-dín Shah."

Religion.—About 8,000,000 of the population are Mahommedans of the Shía'h faith, and 800,000 or 900,000, principally Kurds in north-western Persia, are said to belong to the other great branch of Islám, the Sunni, which differs from the former in religious doctrine and historical belief, and is the State religion of the Turkish empire and other Mahommedan countries. Other religions are represented in Persia by about 80,000 to 90,000 Christians (Armenians, Nestorians, Greek Orthodox and Roman Catholics, Protestants), 36,000 Jews, and 9000 Zoroastrians.

Society in Persia, being based almost exclusively on religious law, is much as it was in Biblical times among the Jews, with this difference, however, that there exists no sacerdotal caste. In Persia any person capable of reading the Koran and interpreting its laws may act as a priest (*mullá*), and as soon as such a priest becomes known for his just interpretation of the *shar'* and his superior knowledge of the traditions and articles of faith, he becomes a *mujtahid*, literally meaning "one who strives" (to acquire knowledge), and is a chief priest. The *mullás* are referred to in questions concerning religious law, hold religious assemblies, preach in mosques, teach in colleges, and are appointed by the Government as judges, head-preachers, &c. Thus the dignitaries, whose character seems to us specially a religious one, are in reality doctors, or expounders and interpreters of the law, and officiating ministers charged with the ordinary accomplishment of certain ceremonies, which every other Mussulman, "true believer," has an equal right to fulfil. Formerly there were only four or five *mujtahids* in Persia, now there are many, sometimes several in one city—Teherán, for instance, has ten; but there are only a few whose decisions are accepted as final and without appeal. The highest authority of all is vested in the *mujtahid* who resides at Kerbela, or Najaf, near Baghdad, and is considered by many *Shía'hs* as the vice-regent of the Prophet and representative of the *imám*. The Shah and the Government have no voice whatever in the matter of appointing *mullás* or *mujtahids*, but frequently appoint *shaikhs-ul-islám* and *kazis*, and occasionally chief priests of mosques that receive important subsidies out of Government funds. The chief priest of the principal mosque of a city, the *masjid i jámi'*, is called *imám i juma'h*, and he, or a representative appointed by him, reads the *Khutbeh*, "Friday oration," and also preaches. The reader of the *Khutbeh* is also called *khatib*. The leader of the prayers in a mosque is the *pishnamáz*, and the crier to prayers is the *mu'azzin*. Many priests are appointed guardians of shrines and tombs of members of the Prophet's family (*imáms* and *imámzádehs*) and are responsible for the proper administration of the property and funds with which the establishments are endowed. Some shrines possess much landed property with considerable revenues. The guardian of a shrine is called *mutavali*, or, if the shrine is an important one with much property and many attendants, *mutavali-báshi*, and is not necessarily an ecclesiastic; for instance, the guardianship of the great shrine of Imám Reza in Meshed is generally given to a high court functionary or minister as a reward for long services to the State. A *mutavali* of a great shrine like that at Meshed is a very important personage, frequently equalling, or even surpassing, the governor in influence. He has on his staff a large number of priests, and other officials and attendants as secretaries, accountants, librarians, treasurers, inspectors, guards, doorkeepers, &c. The important shrines and their precincts afford inviolable sanctuary, or *bast*, to any malefactor who succeeds in entering them. In the precincts of a great shrine a malefactor finds a safe refuge from his pursuers and is lodged and fed, and from the security of his retreat he can arrange the ransom which is to purchase his immunity when he comes out.

Formerly all cases, civil and criminal, were referred to the clergy, and until the 17th century the clergy were subordinate to a kind of chief pontiff, named *sadr-us-sudár*, who possessed a very extended jurisdiction, nominated the judges, and managed all the religious endowments of the mosques, colleges, shrines, &c. Shah Safí (1629–1642), in order to diminish the influence of the clergy, appointed two such pontiffs, one for the court and nobility, the other for the people. Nádir Shah (1736–1747) abolished these offices altogether, and seized most of the endowments of the ecclesiastical establishments in order to pay his troops, and, the lands appropriated by him not having been restored, the clergy have never regained the power they once possessed.

Many members of the clergy, particularly those of the higher ranks, have very liberal ideas and are in favour of progress and reforms so long as they are not against the *shar'*, or divine law; but, unfortunately, they form the minority.

The *Armenians* of Persia, in so far as regards their ecclesiastical state, are divided into the two dioceses of Azerbáïján and Isfáhán, and, since the late troubles in Turkey, which caused many to take refuge in Persia, are said to number over 50,000. About three-fifths of this number belong to the diocese of Azerbáïján, with a bishop at Tabriz, and reside in the cities of Tabriz, Khoï, Selmás, Urmia, and Marágha, and in about thirty villages close to the north-western frontier; the other two-fifths, under the diocese of Isfáhán, with a bishop in Julfa, reside in Teherán, Hamadán, Julfa, Shiráz, Bushire, Resht, Enzeli, and other towns, and in some villages in the districts of Chahár Mahál,Ferídan, Barbarúd, Kamareh, Kazáz, Kharakán, &c. Many Persian Armenians are engaged in trade and commerce, and some of their merchants dispose of much capital, but the bulk live on the proceeds of agriculture and are poor.

The *Nestorians*, or Chaldeans, in Persia, all living in cities and villages close to the Turkish frontier, numbered about 25,000 to 30,000, but many of them, some say half, together with two or three bishops, recently went over to the Greek Orthodox (Russian) Church, in consequence of the unsatisfactory protection afforded them by their patriarch, who resides in Mosul. These latter are now cared for by an archimandrite of Russian nationality and some Russian priests.

The *Greek Orthodox Catholics* are represented by Russians, who reside in northern Persia; they have a church at the Russian legation in Teherán, and another at the Russian consulate in Tabriz.

The *Roman Catholics* in Persia, Europeans and natives (mostly Armenians), number about three or four thousand, and have churches in Teherán, Julfa, and Azerbáïján, served by members of the French Lazarist Mission. They also have some orphanages, schools, and medical dispensaries, under the care of Sisters of Charity of St Vincent de Paul.

The *Protestants*, Europeans and natives (converted Armenians and Nestorians), number about 6500. The religious missions ministering to their spiritual welfare are :—

1. The Board of Foreign Missions of the Presbyterian Church in the United States of America, which has four establishments in Persia: Urmia since 1835, Teherán since 1872, Tabriz since 1873, and Hamadán since 1880. The establishments of Tabriz and Urmia form the Western Persia Mission, those of Teherán and Hamadán the Eastern Persia Mission. The former mission has 37 churches, with 800 communicants, 150 schools with 3800 pupils, 2 hospitals and 4 dispensaries; the latter 4 churches with 200 communicants, 10 schools with 580 pupils, 1 hospital and 4 dispensaries.

2. The Church Missionary Society, established in Persia since 1869. It has at Julfa (near Isfáhán) a church with 146 communicants, 3 schools with 478 pupils (258 boys, 220 girls), 2 hospitals and 3 dispensaries; in Yezd a dispensary; in Karmán a school with 16 pupils. The establishment of the Church Missionary Society is under the care of a bishop, who resides at Julfa and is under the bishop of London.

3. The Anglican Mission, which was established by Dr Benson, archbishop of Canterbury, and has its work among the Nestorians in Azerbáïján.

4. The London Society for promoting Christianity among the Jews, which was established at Teherán in 1876, and at Isfáhán and Hamadán in 1889. It has in Teherán a church with 10 communicants and a school with 20 pupils, at Isfáhán a school with 95 pupils, and at Hamadán a small school (number of pupils not stated).

5. The British and Foreign Bible Society, which was represented at Isfáhán since 1878, and is at present looked after by the Church Missionary Society.

The *Jews* in Persia number about 36,000, and are found in nearly all cities of the country, but communities with synagogues and priests exist only in the larger cities like Teherán, Isfáhán, Yezd, Shiraz, Hamadán, &c.

The *Zoroastrians*, commonly called "gabrs," numbering about 9000, reside principally in the cities and villages of Yezd and Kermán, and only three or four hundred live in Teherán, Kashán, Isfáhán, and Shiraz, some engaged in trade and commerce, but most of them employed in agricultural work and gardening. Their interests are attended to by a delegate who is appointed by the Bombay Parsis and resides at Teherán.

The non-Mussulman Persian subjects, particularly those in the provinces, were formerly much persecuted, but since 1873, when the late Shah returned to Persia from his first journey to Europe, they have been treated more liberally, and the central authorities do their utmost to prevent their being persecuted or injustice being done to them. In cities where many non-Mussulman subjects reside, a special official is appointed to protect them; and the Ministry of Justice has a special section, now directed by a gentleman who was educated in England, to look after them and see that they are protected against fanaticism and injustice.

Instruction.—Primary schools, *maktab* (where Persian and a little Arabic, sufficient for reading the Koran, and sometimes also a little arithmetic, are taught to boys between the ages of seven and twelve), are very numerous, there being one in many villages which have a population of not more than forty or fifty families. These schools are private establishments, receive no aid from the State, and are not under any supervision whatever, and in consequence many teachers are inefficient, children are frequently improperly treated, and schoolrooms are often highly insanitary. The payment for tuition is very small, varying from fourpence or fivepence to tenpence a month for each child. Colleges, *madrasah* (where young men are instructed, fed, and frequently also lodged gratuitously), exist in nearly every town. Most of them are attached to mosques, and all are supported by religious endowments. The teachers are members of the clergy, and receive fixed salaries out of the college funds, and the education is practically the same as it was in similar establishments many centuries ago. The students are instructed in Arabic and Persian literature, religion, interpretation of the Koran, Mussulman law, logic, rhetoric, philosophy, and other subjects necessary for admittance to the clergy, for doctors of law, &c., while modern sciences are neglected. Families who have means and do not desire their children to become members of the clergy, employ private tutors, and several have latterly obtained the services of English and French professors to educate their children, while others send their boys to schools in England, France, Germany, and Russia. At the beginning of the late Nassir-ed-din Shah's reign, a public school on the lines of a French *lycée* was opened in Teherán, principally with the object of educating officers for the army, but also of introducing a knowledge of Western science and languages, and a ministry of public instruction was created at the same time. Military and civilian teachers were obtained from Europe, and the State granted a large sum of money for the support of the establishment. The tuition is gratuitous, and the pupils are clothed and partly fed at Government expense. Some years later a similar school, but on a much smaller scale, was opened in Tabriz. After a time the annual grant for the support of these two schools was reduced, and during the ten years 1890–1900 amounted to only £5000. The average number of pupils was about 250, and until the beginning of 1899 these two schools were the only establishments under the supervision of the Minister of Public Instruction. Soon after his accession in 1896 the Shah expressed a desire that something more should be done for public instruction, and in the following year a number of Persian notables formed a committee, subscribed considerable sums of money, and opened some schools in Teherán and other places in the beginning of 1898. A year later the new schools, until then private establishments, were placed under the Minister of Public Instruction. The new schools at Teherán have from 1000 to 1400 pupils. Much has been and is being done for education by the Armenians and the Protestant and Roman Catholic Missions in Persia, but Mussulmans only rarely attend their schools. The Alliance Israélite has also opened a school in Teherán. In 1899 the American Protestant Mission had 160 schools with 4380 pupils, the English Protestant Missions had 5 schools with 579 pupils, the Roman Catholic Mission (Lazaristes) had 3 schools with 400 pupils, and the Armenians had 4 schools and 646 pupils. All these schools are supported by voluntary subscriptions and donations, and instruct both boys and girls.

Finance.—The fixed revenues of Persia are derived from (1) regular taxation (*máliát*) composed of taxes on lands, flocks, herds, shopkeepers, artisans, and trade; (2) revenues from Crown lands; (3) customs; (4) rents and leases of State monopolies. There is also a kind of irregular revenue derived from public requisitions, presents, fines, confiscations, &c., nowadays not producing much. The land tax, which varies much according to localities, is paid in money and kind, and should amount on an average to about 25 per cent. of the yield of the soil. The taxation on flocks and herds exists either as a supplementary method of land taxation, or as a contribution of a certain sum per animal, and the tax on shopkeepers, artisans, and trades sometimes takes the form of a poll-tax, sometimes that of an impost on the profits of the trades. The revenue from Crown lands consists of a certain proportion of the produce, and also varies much according to localities. The customs are composed of a uniform *ad valorem* duty of 5 per cent. upon merchandise exported and imported by foreign subjects, as stipulated by the treaty concluded between Russia and Persia at Turkmancháï in 1828, and of a duty varying from $1\frac{1}{2}$ to 8 per cent. upon merchandise exported or imported by Persian subjects. Until March 1899 all the customs were farmed out, but since then an attempt has been made to organize them on European principles, with the help of Belgian officials, beginning with the two provinces of Azerbáïján and Kermánsháh, and, the attempt having been successful, other provinces have now been taken in hand, and it is hoped that the farm system, so far as concerns the customs, may be entirely done away with. It is also intended to introduce other reforms, either by establishing a uniform *ad valorem* duty of 5 per cent. upon the merchandise of both Persian and foreign subjects, or, with the assent of Russia, abolishing the 5 per cent. duty fixed by the Turkmancháï treaty and establishing an equitable tariff. The revenues from rents and leases of State monopolies are derived from the proceeds of various establishments, institutions, concessions, &c., leased out by the Government, as, for instance, posts, telegraphs, mines, mint, forests, banks, fisheries, factories, &c., and now amount to about £110,000 per annum.

The total revenue of Persia, from all sources, amounted in 1876 to 58,700,000 krans, in 1884 to 50,800,000, in 1890 to 60,000,000; it is now about 70,000,000 krans. This would seem to show a steady increase, but when we consider that the value of the kran in 1876 was nearly $8\frac{9}{10}$d., and has fallen in consequence of the great depreciation of silver to only $4\frac{4}{5}$d., the total revenue really decreased from £1,950,000 in 1876 to £1,400,000 in 1900. Out of the actual total revenue £350,000 is represented by customs and £110,000 by rents and leases of State monopolies, leaving £940,000 for máliát and revenues of Crown lands. In 1876 the two latter items amounted to about £1,600,000, while the two former were only £350,000 instead of £460,000 in 1900. While the prices in krans of agricultural produce, and hence the profits of the landowners, and the wages and profits of artisans and tradesmen, were in 1900 more than double what they were in 1876, the máliát, the backbone of the revenue, has hardly increased at all, being 47,000,000 krans (£940,000) against 43,200,000 krans (£1,600,000) in 1876, and showing a decrease of over 40 per cent. in sterling money. A new assessment of the máliát, based upon the present value of the produce of lands and actual profits of artisans and tradesmen, has frequently been spoken of, and Government, aided by a strong Minister of the Interior and an able Minister of Finance, ought to have no difficulty in raising the máliát to its proper level and the total revenues of the country to about two millions sterling. Until a few years ago the yearly expenditure was less than the yearly income, and every year a surplus found its way into the Shah's treasury, but lately, on account of the small máliát, the revenues have not been sufficient to cover the expenditure, and many payments have fallen in arrear in spite of large disbursements out of the reserve in the Treasury.

In May 1892 the Persian Government concluded a contract with the Imperial Bank of Persia, established by British royal charter in 1889, for a loan of £500,000 at 6 per cent., repayable in the course of forty years, and guaranteed by the customs of Fars and the Persian Gulf ports. The produce of this loan served for the payment of an indemnity to the Imperial Tobacco Corporation, which began in 1890 and had to cease its operations in January 1892. In January 1900 the Persian Government, in order to pay the arrears and start afresh with a clear balance-sheet, contracted a new loan, this time through the Banque des Prêts de Perse, a Russian institution connected with the Russian State Bank, and established in 1890. This loan was for $22\frac{1}{2}$ million roubles (£2,400,000) at 5 per cent. interest, guaranteed by all the Persian customs with the exception of those of Fars and the Persian Gulf ports, and repayable in the course of seventy-five years. In the contract, which was signed at St Petersburg at the end of January 1900, the Persian Government undertook to redeem all its former foreign obligations (the 1892 loan) out of the proceeds of the new loan, and not to contract any other foreign loan before the redemption of the new loan without the consent of the Russian bank. The loan was at $86\frac{3}{8}$, less $1\frac{3}{8}$ for commission and charges, the Persian Government thus receiving 85 per cent. of the nominal capital, or £2,040,000. The bonds enjoy the full guarantee of the Russian Government. The yearly charge for interest and amortization, about £124,000, is to be paid in two half-yearly instalments, and in the event of default the Russian bank will have the right to exercise effective control of the customs with a maximum number of twenty-five European employés. When the contract for the new loan was concluded, the liabilities of the Persian Government for the balance of the 1892 loan (about £435,000), temporary loans from various banks, arrears of pays and salaries, and other debts, amounted to over £1,500,000, so that not much margin was left.

Defence.—Lord Curzon says that the Persian army, nominally 200,000 men strong, has an effective force of 30,000 men actually serving with the colours. Persia had no regular army until 1807, when some regiments of regular infantry (*sarbáz*) were embodied and drilled by the first French military mission to Persia under General Gardane. Since then seven other military missions (two British, two French, two Austrian, and one Russian) have come to Persia at the request of the Persian Government, and many officers and non-commissioned officers, and even civilians, of various nationalities, as Spanish, Italian, French, Bavarian, Austrian, Prussian, British, Danish, and Bulgarian, have been engaged as army instructors. The last serious attempt to reorganize the Persian army was made in 1879, when the second Austrian mission, composed of a colonel, a major, ten captains and lieutenants, and a bandmaster, formed the "Austrian Corps" of seven new battalions of 800 men each. A relic of the Austrian régime still survives in a number of Persians who were drilled by the Austrians as officers of the new battalions. These new battalions were in 1882 disbanded and resolved into the territorial elements from which they had sprung. The Russian mission of 1879 has been the most successful, and the so-called "Cossack Brigade" which it formed has always been and is now commanded by Russian officers. The strength of the brigade is now being raised to about 1500 men, and it will cost £50,000 per annum. The total annual expenditure for the army amounts to about a third, or a little more, of the total revenues of the Government.

The Persian Government possesses three steamers, and no other vessels. These are the *Persepolis*, registered tonnage 600, 450 h.p., built at Bremerhaven in 1884, armed with one 8·5 and three 7·5 centimetre steel Krupp guns, and stationed in the Persian Gulf; the *Susa*, tonnage 36, 30 h.p., built at Bremerhaven in 1884, and stationed on the river Karun; the *Nassir-ed-dín*, a yacht of about 120 tons, presented by the emperor of Russia, and stationed at Enzeli, the port of Resht. The annual expenditure for the navy is about £3500.

Minerals and Mining.—Persia possesses considerable mineral riches, but the absence of cheap and easy means of transport, and the scarcity of fuel and water which prevails almost everywhere, make any exploitation on a large and remunerative scale impossible, and the various attempts which have been made in Persia to work mines with European capital and under European superintendence have been financially unsuccessful. Deposits of rich ores of copper, lead, iron, manganese, zinc, nickel, cobalt, &c., abound; but either the distance from the deposits to the nearest shipping port is so great that the freight to the port exceeds the price of the ore on the European market, or the difficulty of obtaining fuel and water raises the cost of reducing the ore to more than the price of the metal imported from abroad. The result is that the Persian mining industry is very small. A few mines are worked by natives in a primitive, systemless manner, and without any great outlay of capital—the value of the plant in some mines the writer has visited not being more than twenty pounds. There are turquoise mines near Nishápúr (for description of mines, manner of working, &c., see A. Houtum-Schindler, *Report on the Turquoise Mines in Khorasán*, F. O. Reports 1884, and "Die Gegend zwischen Sabzwar und Meschhed," *Jahrbuch, k. k. geol. R. A. Wien*, vol. xxxvi.;

also E. Tielze, *Verhandl. k. k. geol. R. A.*, 1884, 93); several copper mines in Khorasán, Semnán, Azerbäiján, and Kermán; some of lead, two considerably argentiferous, in Khorasán, Túdarvár (near Semnán), Angúrán, Afshár (both west of Zenján), and Kermán; two of iron at Masúlah in Gílán and Núr in Mázandarán; two of orpiment in Afshár and near Urmia; one of cobalt at Kamsar (near Kashán); one of alum in Tarom (near Kazvín); and a number of coal in the Lár district, north-east of Teherán, and at Hív and Abyek, north-west of Teherán. There are also many quarries of rock-salt, gypsum, lime, and some of marble, alabaster, soapstone, &c. The annual revenue of the Government from the leases, rents, and royalties of mines does not amount to more than £15,000, and about £6000 of this amount is derived from the turquoise mines near Nishápúr. As the rents and royalties, excepting those on the turquoise mines, amount to about one-fifth of the net proceeds, it may be estimated that the value of the annual output does not exceed £50,000, while the intrinsic value of the ores, particularly those of lead, iron, cobalt, and nickel, which have not yet been touched, can be estimated at millions. There are also some very rich coal seams in eastern Persia, far away on the fringe of the desert, and under existing conditions quite valueless. The richest deposits of nickel, cobalt, and antimony ores are also situated in localities where there is little water and the nearest useful fuel some hundred miles away. Auriferous alluvial strata have been discovered in various localities, but everywhere the scarcity of water has been a bar to their being exploited with profit. A rich naphtha-bearing zone stretches from the Luristán hills near Kermánsháh on the north down to the Persian Gulf in the south. Competent engineers and specialists have declared that borings in the Bakhtiari hills, west of Shushter, would give excellent results, but the difficult hilly country and the total absence of roads, as well as the antipathy of the inhabitants of the district, would make the transport and establishment of the necessary plant a most difficult matter.

Agriculture.—Wheat, barley, and rice are grown in all districts, the two former up to considerable altitudes (8000 feet), the last wherever the water-supply is abundant, and in inner Persia generally along rivers; and all three are largely exported. The most important rice-growing districts which produce more than they require for local consumption and supply other districts, or export great quantities, are Astrábád, Mázandarán, Gilán, Verámín (near Teherán), Lenján (near Isfáhán), and some localities in Fars and Azerbaïján. Peas, beans, lentils, gram, maize, millet, are also universally cultivated, and exported in not inconsiderable quantities from the Persian Gulf ports to India and the Arabian coast. The Persian fruit is excellent and abundant, and large quantities, principally dried and called *khushkbár* (dry fruit), as quinces, peaches, apricots, plums (of several kinds), raisins, figs, almonds, pistachios, walnuts, and dates (the last only from the south), as well as oranges (only from the Caspian provinces), are exported. Nothing is being done to improve the vine, and the Persian wines, until recently of world-wide reputation, are yearly getting thinner and poorer. The phylloxera has done much damage. Cotton is largely grown, principally in the central districts and Khorasán, and some qualities are excellent and command high prices in the European markets. 12,490 tons of raw cotton, valued at £384,013, were exported to Russia in 1897. Good hemp grows wild in Mázandarán. Tobacco of two kinds, one the *tumbakú* (*Nicotiana persica*, Lindl.), for water pipes, the other the *tutun* (*Nicotiana rustica*, L.), for ordinary pipes and cigarettes, is much cultivated. The tumbakú for export is chiefly produced in the central districts round about Isfáhán and near Kashán, while the tumbakú of Shiráz, Fessa, and Daráb in Fars, considered the best in Persia, is not much appreciated abroad. Tutun is cultivated in Azerbäiján, near Urmia and other places near the Turkish frontier, in Kurdistán, and, since 1875, in the district of Resht in Gilán. The cultivation of poppy for opium has greatly increased since 1880, and it is estimated that the annual produce of opium now amounts to over 1000 tons, of which about two-fifths is consumed and smoked in the country. The principal opium-producing districts are those of Shiráz, Isfáhán, Yezd, Kermán, Khorasán, Burújird, and Kermánsháh. The value of the silk produced in Persia in the 'sixties was £1,000,000 per annum, and decreased in consequence of silk-worm disease to £30,000 in 1890. The quantity produced is now again increasing, and its yearly value is estimated at £350,000. Of oil-yielding plants the castor-oil plant, sesame, linseed, olive are cultivated, the last only in a small district south of and near Resht. Very little oil is exported. The potato, not yet a staple article of food, tomatoes, celery, cauliflower, artichokes, and other vegetables are now much more grown than formerly, chiefly in consequence of the great influx of Europeans, who are the principal consumers, during recent years. Horticulture has much improved, the Shah and several princes and nobles retaining European gardeners, and some gardens at Teherán have shows of flowers vying with the prettiest in Europe. Horses, mules, and donkeys, formerly exported in great numbers, are at present not very abundant, and their prices have risen much since 1880. Some nomad tribes who owned many brood mares, and yearly sold hundreds of horses, now hardly possess sufficient animals for their own requirements. The scarcity of animals, as well as the dearness of fodder, is one of the causes of the dearness of transport, and freights have risen on the most frequented roads from 3d. per ton-mile in 1880 to 10d., and even 13d., per ton-mile now.

The following table shows the average prices of staple articles of food and necessaries at Teherán as they were in 1880 and in April 1900, and their apparent and real increases per cent. in local currency and sterling:—

	Average Price, 1880.			Price in April 1900.			Increase per cent.	
	Local currency.	Sterling. 1 kran = 9d.		Local currency.	Sterling. 1 kran = 4⅘d.		Apparent.	Real.
	krans.	s.	d.	krans.	s.	d.		
Wheat, per kharvár (649 lb)	30	22	6	255	102	0	750	353
Barley ,,	20	15	0	160	64	0	700	327
Rice ,,	75	56	3	400	160	0	433	184
Charcoal ,,	30	22	6	87·50	35	0	192	55
Coal ,,	16	12	0	50	20	0	212	66
Firewood ,,	12	9	0	28	11	2⅘	133	24
Bread, per mann (6½ lb)	·40	0	3⅗	2	0	9⅗	400	162
Mutton ,,	1·60	1	2⅖	7	2	9⅗	337	133
Beef ,,	1·20	0	10⅘	4	1	7⅕	233	77
Cheese ,,	2·00	1	6	6	2	4⅘	200	60
Milk ,,	·50	0	4½	2	0	9⅗	300	113
Clarified butter ,,	3·00	2	3	12	4	9⅗	300	113
Water melons ,,	·10	0	$\frac{9}{10}$	·60	0	$2\frac{9}{10}$	500	222 } season 1899.
Sweet melons ,,	·30	0	$2\frac{7}{10}$	2	0	9⅗	566	255 } season 1899.
Grapes ,,	·10	0	$\frac{9}{10}$	1·20	0	5¾	1100	539 } season 1899.
Eggs (per 100)	2·00	1	6	9	3	7⅕	350	140

At the lowest estimate it may be said for all Persia, that while wages since 1880 have risen in the proportion of 5 to 10, the prices of staple articles of food have gone up from 5 to 11.

Forests and Timber.—Timber from the forests of Mázandarán and Gilán has been a valuable article of export for many years, and since about 1870 large quantities of boxwood have also been exported thence; in some years the value of the timber and boxwood exported has exceeded £50,000. This value represented about 200,000 box trees and quite as many others. Much timber is also used for charcoal-burning, and occasionally large parts of forest are burned by the people in order to obtain clearings for the cultivation of rice. The destruction of the forests by timber-cutters and charcoal-burners has been allowed to go on unchecked, no plantations have been laid out, and nothing has been done for forest conservation. Indiscriminate cutting has occasionally been confined within certain bounds, but such restrictions were generally either of short duration or made for the convenience and profit of local governors. The oak forests of Kurdistán, Luristán, and the Bakhtiari district are also being rapidly thinned, and the time is not far distant when there will be no traces left unless the Government create a forest department with proper regulations and bye-laws. A small step in the right direction was made in 1900 by engaging the services of an official of the Prussian forest department, but unfortunately, beyond sending him to inspect the Mázandarán forests belonging to the Crown, and employing him to lay out a small plantation in the Jájrúd valley, east of Teherán, nothing was done. The monopoly for cutting and exporting the timber of the Mázandarán forests is leased to a Greek firm established at Baku, and the rent has been paid in advance for some years. Boxwood has become scarce. There are many kinds of good timber-yielding trees, the best known being alder (*Alnus glutinosa*, Wild., *A. barbata*, *A. cordifolia*, Ten.), ash (*Fraxinus excelsior*, L.), beech (*Fagus sylvatica*), elm (*Ulmus campestris*, *U. effusa*, *U. pedunculata*), wych-elm (*Ulmus montana*), hornbeam (*Carpinus betulus*, L.), juniper (*Juniperus excelsa*, *J. communis*, *J. sabina*), maple (*Acer insigne*, Boiss., *A. campestre*, *A. pseudo-platanus*, L.), oak (*Quercus ballota*, *Q. castaneæfolia*, *Q. sessifloria*, *Q. pedunculata*), walnut, nettle tree (*Celtis australis*, L.), Siberian elm (*Zelkova crenata*, Spach.), and various kinds of poplar. Pipe-sticks, from the wild cherry tree, are exported to Turkey. Considerable quantities of gums, exudations of various plants, drugs, and dyes, some of them produced only in Persia, are gathered and exported.

Fisheries.—Along the shores of the Persian Gulf fish is a staple food, but the Crown derives no revenue from the fisheries there. The fisheries of the Caspian littoral were leased to a Russian firm about 1870 at an annual rent of £16,000, and most of the fish goes to Russia. The fish principally caught are the *ag-máhí* (dog-fish); sturgeon (*Acipenser huso*), which gives the caviare; the *summ* (sheat-fish), or silure (*Silurus glanis*); and the *Azád-máhí*, a kind of salmon (*Salmo sylvaticus*). In inner Persia fish are scarce. There are a few carp and roach in the canals, and salmon-trout and mud-trout abound in some mountain streams.

Manufactures.—Of the articles mentioned under this head in the ninth edition (p. 625) only carpets, shawls, woollen and cotton fabrics, and silk stuffs are of importance. Carpets may be divided into three categories: (1) *Kálí*, with a pile, and cut like plush; (2) *gilím*, smooth; (3) *nimads*, felts. Only the two first are exported. The *Kálí* and its smaller sizes, called *Kálícheh* (in Europe, rugs), are chiefly made in Ferahan, Sultánábád (Irák), Khorasán, Yezd, Kermán, and among the nomad tribes of southern Persia. From the two first-mentioned localities, where two British firms have been established for many years, great quantities, valued in some years at £100,000, find their way to European and American markets, while rugs to the value of £30,000 per annum are exported from the Persian Gulf ports. Of the second kind, *gilím* (used in Europe for curtains, hangings, and chair-covers), considerable quantities are exported from Shushter and Kurdistán. Shawls are manufactured in Kermán and Meshed, and form an article of export, principally to Turkey; and some of Kermán are quite equal to good Cashmere shawls. Woollen fabrics are manufactured in many districts, but are not exported. Coarse cotton-stuffs, chiefly *kerbás*, are manufactured in nearly all districts, but not exported; but cottons, called *kalamkár*, which are Manchester goods that have been block-printed in colours, find their way from Isfáhán and Komisheh to foreign markets. Of the great quantities of silk fabrics manufactured in Persia, principally in Khorasán, Kashán, and Yezd, only a small part is exported to Turkey and Afghanistan. In the environs of Kashán and in Fars, chiefly near Maimand, much rose-water is made, and a considerable quantity of it is exported by way of Bushire to India and Java. Attempts have been made to start manufactures, supported by foreign capital and conducted by foreigners, but nearly all have resulted in loss. In 1879 the Persian Government was induced to spend £30,000 on the erection of a gas factory in Teherán, but work was soon stopped for want of good coal. A few years later a Persian bought the factory and plant for £10,000, and made them over in 1891 to the Compagnie Générale pour l'Éclairage et le Chauffage en Perse, which, after bringing out much additional plant, and wasting much capital in trying for some years in vain to make good and cheap gas out of bad and dear coal, closed the factory. In 1891 another Belgian company, Société anonyme des verreries nationales de Perse, opened a glass factory in Teherán, but the difficulty of obtaining the raw material cheaply and in large quantities was too great to make it a paying concern, and the factory had to be closed. A third Belgian company, Société anonyme pour la fabrication du sucre en Perse, with a large capital, then came to Persia, erected a magnificent factory with the best and most modern machinery obtainable, and began making beetroot sugar in the winter of 1895. But, like the gas and glass companies, it found the cost of the raw material and the incidental expenses too great, and ceased its operations in 1899.

Commerce.—The total annual value of the exports and imports may safely be estimated at ten million pounds sterling. The estimated value of the imports and exports is arrived at by considering the amounts received by the Government from the farmers of the customs as equivalent to 4 per cent. of the value of the imports and exports, and allowing 20 per cent. as profits of the farmers. The following table, compiled from the *Statesman's Year-Book*, shows the farm-money received by the Government at intervals for the years 1879 to 1899, the estimated amounts paid annually for customs, and the estimated value of the imports and exports, obtained by taking the average of the duty at 4 per cent. *ad valorem.*

Year.	Farm money received by Government.		Rate of exchange for the year.	Estimated totals of customs paid. Farm money + 20 per cent.	Estimated value of imports and exports, average duty taken at 4 per cent. *ad valorem.*
	tomans.	£	krs. = £1.	£	£
1879–1880	606,400	219,500	27⅝	263,400	6,585,000
1889–1890	800,000	242,724	33	290,908	7,272,700
1895–1896	1,250,000	250,000	50	300,000	7,500,000
1896–1897	1,250,000	250,000	50	300,000	7,500,000
1897–1898	1,500,000	300,000	50	360,000	9,000,000
1898–1899	1,500,000	300,000	50	360,000	9,000,000
1899–1900	1,750,000	350,000	50	420,000	10,500,000

As has been already stated (see "Finance," *supra*), the customs department is being reorganized, the farm system has been abolished in two provinces since March 1899, and the result has been highly satisfactory; the new system is to be introduced into all the provinces. The new administration estimated the net receipts for 1900–01 at about £400,000; but in this amount were included the transit dues levied in the interior and the gate dues (octroi) levied in all principal towns, amounting to about £50,000; these should be deducted from the total receipts, and the remainder (£350,000) would then represent the amount of customs received on imports and exports. Calculating the customs at a little less than 3½ per cent., the total value of the imports and exports would amount to £9,500,000 or £10,000,000, which may safely be taken as within the mark, while the value of the imports and exports may be put down at not less than £7,500,000 to £8,000,000 for 1879 to 1892, and since then at not less than £8,500,000 to £9,000,000.

The export and import trade may be considered, in relation to the frontiers, under four heads:—

(*a*) *Northern Frontier.*—This extends for a length of about 1300 miles from near Maku in the west to the Afghan frontier in the east, and comprises the Perso-Transcaucasian frontier, with Julfa and Astara as principal stations, the southern Caspian shore, with the principal ports Enzeli (Resht), Meshhed-i-Sar (Barfurúsh), and Bander Gez (Astrábád), and the Perso-Transcaspian frontier, with a carriageable road crossing it north-west of Meshed between Kúchan and Askábád, and an easy road from Meshed eastwards, *viâ* Serrekhs, to Turkistan. For the exports and imports on this frontier the Russian custom-house returns give trustworthy figures, and show that their value exceeded £3,500,000 in 1897.

(*b*) *Western Frontier.*—For the trade on this frontier—a line of about 750 miles from Maku in the north to Muhamrah in the south—the only returns trustworthy as to quantities, but frequently understating values, are those made at Trebizond for the merchandise which passes that port in transit to and from Persia. Of the great trade on the Kermánsháh–Baghdad road and numerous other roads crossing the frontier there are no returns. The value of transit trade at Trebizond to and from Persia, in thousands of pounds sterling, is shown in the following table:—

Year.	Exports.	Imports.	Total.
1885	235	821	1056
1890	312	665	977
1895	212	683	895
1896	189	577	766
1897	216	555	771
1898	208	550	758

Allowing for the understatement of the values of the imports by the Trebizond route, and adding the value of the trade on the Kermánsháh–Baghdad route, estimated in 1898 at a minimum value of £750,000, and that of the lively trade which is carried on between Persia and Asiatic Turkey by many other routes, which may be estimated at a minimum of £250,000, a total value not far short of £2,000,000 is arrived at for the exports and imports by way of the western frontier, and more than one-third of this is in British hands.

(*c*) *Southern Frontier.*—This is formed by a coast-line of about 1100 miles in length from Muhamrah in the west to British Baluchistan in the east. The export and import trade passes through Muhamrah, Bushire, Lingah, Bander Abbási, and many smaller ports, but only the first four are mentioned in the consular reports. Many of the figures given in these reports are based on information which has been obtained from custom-house officials, and do not give the true values of the exports and imports. The value of exports from and imports into Persia by way of Persian Gulf ports, according to British consular reports, in thousands of pounds sterling is shown in the following table:—

Year.	Exports.					Imports.					Total value of exports and imports, four ports.
	Muhamrah.	Bushire.	Lingah.	Abbási.	Total.	Muhamrah.	Bushire.	Lingah.	Abbási.	Total.	
1890	58	720	592	348	1718	146	1268	665	409	2488	4206
1895	98	529	511	325	1463	138	1017	587	478	2220	3683
1896	67	440	498	180	1185	144	788	425	364	1721	2906
1897	87	393	548	231	1259	121	1145	582	382	2230	3489
1898	89	427	571	187	1274	157	843	641	449	2090	3364
1899	59	529	552	202	1342	202	916	612	546	2276	3618
1900	115	710	470	103	1398	282	1323	501	339	2445	3843

In order to arrive at the value of the total trade on the southern frontier, there should be added to the values given in this table a certain percentage for understated values of exports and imports at the four ports and a considerable sum for the trade of the small ports which are not mentioned in the consular reports. The value of the total trade on the southern frontier will then no doubt be found to exceed £4,000,000.

The trade at the four Gulf ports was distributed mainly as follows in 1900:—

Countries.	Imports from.	Exports to.	Countries.	Imports from.	Exports to.
United Kingdom	£788,114	£163,716	Persian ports	£438,059	£346,449
India . . .	1,034,824	745,142	Arab coast .	189,424	207,061
France . .	119,712	7,664	Muskat .	45,467	28,780
Turkey . .	125,112	192,172	Bahrein .	7,516	19,830
China . .	35,920	318,611	Egypt . .	5,289	37,975

(*d*) *Eastern Frontier.*—Of the trade on this frontier, which separates Persia from Afghanistan and British Baluchistan and has a length of about 900 miles, there are also no complete returns, and only since 1892 the British consular reports show the value of the trade between Meshed and Afghanistan as obtained from Persian officials, and quite recently that of the trade on the Quetta–Núshki–Sistan–Meshed road. The value of the exports and imports between Meshed and Afghanistan was £18,000 in 1892; £23,000 in 1893 and also in 1894; £24,000 in 1895; £21,000 in 1896; and £29,000 in 1897. The value of the exports and imports over the eastern frontier probably much exceeds £100,000 per annum.

From the figures given in the above tables the value of the exports and imports at the present time may be estimated as follows:—

	Exports.	Imports.	Total exports and imports.	Proportion exports to imports.
Northern frontier	£2,000,000	£1,800,000	£3,800,000	100 : 90
Western ,,	900,000	1,100,000	2,000,000	100 : 122
Southern ,,	1,500,000	2,500,000	4,000,000	100 : 166
Eastern ,,	50,000	50,000	100,000	100 : 100
Total .	£4,450,000	£5,450,000	£9,900,000	

According to this estimate, the proportion of exports to imports for all Persia would be 100 : 111, but Lorini (*Persia Economica*, &c., pp. 320–321) thinks that the balance of trade is in favour of Persia.

What are the chief imports and exports in the various districts will be seen from the table in the next column and the paragraph which succeeds it. At the four Gulf ports the trade in 1900 was mainly in the following articles:—

Imports.	Value in pounds sterling, 1900.	Exports.	Value in pounds sterling, 1900.
Cottons . .	697,760	Opium . .	348,310
Pearls . .	244,274	Pearls . .	727,447
Tea . . .	196,191	Grain . .	89,982
Dates . . .	44,916	Fruits . .	85,551
Woollens . .	31,277	Mother of pearl .	25,388
Sugar . . .	207,997	Carpets, &c. .	77,057
Wheat and flour .	336,482	Timber . .	28,175
Copper, &c. .	57,038	Dates . . .	27,916
Indigo . .	49,997	Tobacco . .	28,175
Coffee . . .	37,742	Gums . . .	68,919
Specie . .	490,516	Specie . .	368,387

The prohibition against the importation of arms and ammunition that has been in existence since 1881 is only spasmodically enforced, and in 1897 they found their way through the Gulf ports to the value of £132,018; the import in 1898 was *nil*.

From the Gulf ports, excluding Muhamrah, wheat to the value of £84,100 was exported in 1898. At Tabriz in the year 1898–99 the total imports were valued at £682,330, including Manchester shirtings and printed cottons, £376,000; sugar from Russia, £81,600; tea from India, £68,800; cloth and woollen goods from Europe, £57,200; silk stuffs and velvets from France and Germany, £55,400; and haberdashery from Germany and Austria, £28,000. The exports amounted to £219,930, including dried fruits (raisins and almonds), £72,000; carpets, £50,000 (but trustworthy private information makes it £85,000); shawls, £20,000; and native silk, £14,000. In the Resht district in 1896 the imports *viâ* Baku were valued at £842,655, and included sugar, £614,311; tissues, £81,400; silk-worm seed, £67,200; bar silver, £30,000; and petroleum, £15,000. The exports to Russia *viâ* Baku amounted to £365,342, amongst them being rice, £177,220; fruits, £42,350; raw cotton, £40,740; and tea, £31,890. The export of silk of all kinds from Resht, principally *viâ* Kermánsháh–Baghdad, hardly any going to Russia, was valued at £116,280 in 1898. From the Caspian littoral the export of fish to Russia in 1897 was £84,427. Along the whole northern frontier the import of cotton goods from Russia in 1898 was £520,000 (in 1897, £420,452); of glassware in 1897, £32,061; of sailcloth, £26,043; of china, £21,030; the export of rice in 1897 amounted to £336,489; of dried fruit, to £443,902; of cotton, to £360,114; and of live stock, to £58,930. The trade of Khorasán through Meshed in 1896–97 was: imports from India by Bombay and Bander Abbási, £89,547; from Russian territory, £92,547; through Turkey, £19,740; from Afghanistan, £6206: exports to India, £19,681; to Russian territory, £80,320; to Afghanistan, £15,073.

Shipping and Navigation.—Shipping under the Persian flag is restricted to vessels belonging to the Persian Gulf ports. Some of the larger craft, which are called *baglah*, and vary from 50 to 300 tons, carry merchandise to and from Bombay, the Malabar coast, Zanzibar, &c.; while the smaller vessels, called *bagarah*, and mostly under 20 tons, are employed in the coasting trade and the pearl-fisheries on the Arabian coast. No returns as to the number and tonnage of the native craft are available, but it is estimated that the four principal ports and the many smaller ones (as Mashúr, Hindián, Zaidín, Dílum, Ríg, Kongún, Táherí, Kishm, Hormuz, &c.) possess at least 100 *baglahs* and several hundred *bagarahs*, besides a large number of small boats. The following figures from British consular reports show the total and British shipping in thousands of tons (including both entrances and clearances) at the four principal Persian Gulf ports in 1891 and 1898:—

Port.	1891.				1898.			
	Total Tonnage.		British Tonnage.		Total Tonnage.		British Tonnage.	
	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.
Bushire . . .	152	151	148	148	112	97	99	85
Lingah . . .	208	219	167	181	125	76	102	58
Abbási . . .	95	90	86	83	87	86	79	79
Muhamrah . .	76	79	71	74	100	82	91	74
Total . .	531	539	472	486	424	341	371	296

As most of the pearls obtained on the Arabian coast of the Gulf are brought to and exported from Lingah, that port has more native shipping than the others. It will be found from the figures in the last table that the British shipping amounted to 93·3 per cent. of the whole shipping at Muhamrah, to 90·2 per cent. at Bushire, to 78·9 per cent. at Lingah, and to 90·5 per cent. at Bander Abbási, or to 88·2 per cent. of the *total shipping* at the four ports. The percentage of foreign shipping other than

British is very small in the Persian Gulf. All the shipping on the Caspian is under the Russian flag[1] and no returns of arrivals and departures of vessels at the Persian ports exist, but seeing that the value of the merchandise, most of it bulky, exported and imported from and into the Persian ports of Resht, Meshed-i-Sar, and Bander-i-Gez, and the Russian port of Astara, which supplies a great part of Azerbáiján, exceeds £2,000,000, the shipping must be very considerable. Russian statistics for 1897 give for Astara 77 vessels (76 steamers) with an aggregate of 43,101 tons entered, and 272 vessels (240 steamers) with 88,011 tons cleared. The British consul at Resht, in his report dated 3rd March 1893, reports 49 steamers with an aggregate tonnage of 16,702 as plying between the Russian and Persian ports of the Caspian; but he omitted several steamers then already plying, and many more have been added since. Two or three flat-bottomed sailing vessels navigate the lake of Urmia in north-western Persia, carrying merchandise, principally agricultural produce, from the western and south-western shores to the eastern for the supply of Tabriz. The navigation is a State monopoly, and leased out for £250 per annum.

Internal Communications.—1. *Roads.*—Mr A. Hotz, head of a commercial firm long established in Persia, wrote in a paper communicated to the Society of Arts and published in the society's *Journal* of 10th March 1899: "If we consider the present means of conveyance, it is indeed astounding that a country of about 636,000 square miles, without navigable rivers, but inhabited by 9,000,000 people who are remarkable for their intelligence and industry, should have to carry on its foreign trade and local traffic along mule tracks, the like of which are hardly to be met with in any other part of the world, however backward. The passes between the Gulf ports and the Persian plateau are in the same condition as Herodotus described them and as they were found by Marco Polo and his innumerable successors." With the exception of four short roads, having an aggregate length of less than 800 miles, all the roads of the country are as Nature has made them—in other words, mere mule tracks, carriageable in the plains and during the dry season, but totally unfit for continuous wheeled traffic during all seasons, and in the hilly districts often so difficult as to cause much damage to goods and the animals carrying them.[2] The four exceptions are:—(1) Resht–Kazvín–Teherán, 227 miles; (2) Teherán–Kom–Sultánábád, 160 miles; (3) Meshed–Kúchán–Askábád, 150 miles, 30 of which on Russian territory; (4) Isfáhán–Ahváz, 280 miles. The first of these roads consists of two sections: Resht–Kazvín, 135 miles, and Kazvín–Teherán, 92 miles. The first section was constructed in 1897–99 by a Russian company, in virtue of a concession which the Persian Government granted in 1893; and the second section was constructed in 1878–79 by the Persian Government at a cost of about £20,000, ceded to the concessionnaire of the first section in 1896, and repaired and partly reconstructed by the Russian company in 1898–99. Both sections were officially opened to traffic in August 1899. The capital of the company is 3,200,000 roubles (£341,330), of which 1,700,000 is in shares taken by the public, and 1,500,000 in debentures taken by the Russian Government, which also guarantees 5 per cent. on the shares. About two-thirds of the capital has been expended on construction. The company's income is derived from tolls levied on vehicles and animals using the road. These tolls are at present very high, but will be reduced by 15 per cent. in 1904, and by another 10 per cent. five years later. If all the trade between Russia and Teherán were to pass over this road, the tolls would no doubt pay a fair dividend on the capital, but quite 40 per cent. of it goes by way of the Teherán–Meshed-i-Sar route, which is much shorter and has no tolls.

The second road, Teherán–Kom–Sultánábád, 160 miles, also consists of two sections: the first, Teherán–Kom, 92 miles, the other, Kom–Sultánábád, 68 miles. The first section was constructed by the Persian Government in 1883 at a cost of about £12,000, purchased by the Imperial Bank of Persia in 1890 for £10,000, and reconstructed at a cost of about £45,000. The second section formed part of the "Ahváz road concession" which was obtained by the Imperial Bank of Persia in 1890 with the object of connecting Teherán with Ahváz on the Karun by a direct cart-road *viâ* Sultánábád, Burujird, Khorremabad (Luristán), Dizful, and Shushter.

[1] By article v. of the treaty of Gulistan of 1813, confirmed by article viii. of the treaty of Turkmancháí of 1828, it was declared that Russia alone should have the right of maintaining vessels of war on the Caspian, and that no other Power should fly the military flag on that sea; and by a decision of the Council of the Russian empire, published on the 24th November 1869, the establishment of companies for the navigation of the Caspian, except by Russian subjects, and the purchase of shares of such companies by foreigners were prohibited. (*State Papers*, vol. lxiii. 925.)

[2] There are a few miles of roads in the immediate neighbourhood of Teherán leading from the city to royal palaces, but not of any commercial importance.

The third cart-road, Meshed–Askábád, 120 miles to the Persian frontier, was constructed by the Persian Government in 1889–92 in accordance with article v. of the Khorasán Boundary Convention between Russia and Persia of December 1881. The Persian section cost £13,000.

The fourth road, Isfáhán–Ahváz, 280 miles, is the old mule track provided with some bridges, and improved by freeing it of boulders and stones, &c., at a total cost of £5500. The concession for this road was obtained in 1897 by the Bakhtiari chiefs, the necessary capital being advanced by an English firm at 6 per cent. interest, and revenues being derived from tolls levied on animals passing with loads.

2. *Railways.*—Persia possesses only 8 miles of railway and 6½ miles of tramway, both run by a Belgian company. The railway consists of a single line, one-metre gauge, from Teherán to Shah-abdul-Azím, south of Teherán, and of two branch lines which connect the main line with some limestone quarries in the hills south-east of the city. The tramway also is a single line of one-metre gauge, and runs through some of the principal streets of Teherán. The length of the main railway line is 5½ miles, that of the branches 2½. The main line was opened in 1888, the branches were constructed in 1893, and the tramway started in 1889. The capital now invested in this enterprise, and largely subscribed for by Russian capitalists, amounts to £320,000. There are also ordinary shares to the amount of £200,000 put down in the company's annual balance-sheets as of no value. The general opinion is that if Russian capitalists had not been interested in the enterprise the company would have liquidated long ago. (On railways in Persia, the many concessions granted by the Persian Government, and only one having a result, chapter xviii. of Lord CURZON's *Persia* [vol. i. pp. 613–639], and on the Belgian enterprise, LORINI's *La Persia Economica* [pp. 157–158] may be read with great advantage.)

Posts.—Down to 1874 the postal system was in the hands of an official called *chapárchí báshí*, who was the head farmer of the post, or *chapárs*, and letters and small parcels were conveyed by him and his agents at high and arbitrary rates and without any responsibility. The establishment of a regular post was one of the results of the late Shah's first visit to Europe (1873). Two officials of the Austrian postal department having been engaged in 1874, an experiment of a post office upon European lines was made in the following year with a postal delivery in the capital and some of the neighbouring villages where the European legations have their summer quarters. In the beginning of 1876 a regular weekly post was established between Teherán, Tabriz, and Julfa (Russo-Persian frontier), and Resht. Other lines, connecting all the principal cities with the capital, were opened shortly afterwards, and on 1st September 1877 Persia joined the International Postal Union with the rates of 2½d. per ½ oz. for letters, 1d. for post-cards, ½d. per 2 oz. for newspapers, &c., between Persia and any Union country. The inland rates were a little less. There are now between Persia and foreign countries a bi-weekly service *viâ* Russia (Resht–Baku, Tabriz–Tiflis) and a weekly service *viâ* India (Bushire–Bombay). On the inland lines, with the exception of that between Teherán and Tabriz, the service is weekly. There are reported to be ninety-seven post offices. Statistics as to the number of letters, post-cards, newspapers, &c., conveyed are kept but not published; and since 1885, when a liberal-minded director communicated those for the year 1884–85 to the present writer, no others, although many times promised, have been obtained. In the year 1884–85 there were conveyed 1,368,835 letters, 2050 post-cards, 7455 samples, and 173,995 parcels, having a value of £304,720; and the receipts exceeded the expenditure by £466. Since then the traffic has much increased, and the excess of receipts over expenditure in the year 1898–99 was reported to have been £10,000, but is probably more than that, for the minister of posts has farmed the department for £12,000 per annum. Under the most favourable conditions letters from London *viâ* Russia are delivered at Tabriz in 14 days, at Teherán in 16, at Isfáhán in 20, at Meshed in 25, and at Shiraz in 26 days; and *viâ* India, at Bushire in 26 days, at Shiráz in 31, at Isfáhán in 36, and at Teherán in 40 days; but during winter, when the roads are heavy or snowed up, or the mail steamers on the Caspian on account of bad weather cannot land the mails, the times of transmission are much increased, and sometimes letters between London and Teherán take forty days. In the interior the mails are conveyed on horseback, and, being packed in badly-made soft leather bags, are frequently damaged through careless packing and wet. The first Persian postage stamps were issued in 1875 and roughly printed in Persia. Since then there have been many issues, and specimens of the early ones are much valued by stamp collectors. (For information on the postal system of Persia, see G. RIEDERER, *Aus Persien*, Vienna, 1882; FR. SCHUELLER, *Die Persische Post und die Postwerthzeichen von Persien*, Vienna, 1893.)

Telegraphs.—The first line of telegraphs—from Teherán to Sultanieh, about 160 miles on the road to Tabriz—was constructed in 1859. In the following year it was continued to Tabriz, and in 1863 to Julfa on the Russian frontier. With the object of establishing a direct telegraphic communication between England and India, by connecting the European and Indian systems by a land line through Persia from Baghdad—then the most easterly Turkish telegraphic station—to Bushire and by a cable from Bushire eastwards, a telegraphic convention was concluded in the same year between the British and Persian Governments, and a one-wire line on wooden posts from the Turkish frontier, near Baghdad, to Bushire *viâ* Kermánsháh, Hamadán, Teherán, Isfáhán, and Shiráz, was constructed at the cost and under the supervision of the British Government. In 1865 a new convention, providing for a second wire, was concluded, and for some years messages between Europe and India were transmitted either *viâ* Constantinople, Baghdad, Teherán, Bushire, or *viâ* Russia, Tiflis, Tabriz, Teherán, Bushire. An alternative line between Baghdad and India was created by the construction of a land line to Fao, at the head of the Persian Gulf, and the laying of a cable thence to Bushire. The service was very inefficient, and messages between England and India took several days and sometimes weeks to reach their destination, and besides, "the staff in no case was competent, there was hopeless confusion of dates arising from the different calendars recognized, and the mutilation of messages consequent upon the frequent translations and retranslations by ignorant clerks into English, French, Dutch, German, Italian, Greek, Bulgarian, Wallachian, Servian, Russian, Turkish, and Armenian, reduced the patrons of the various lines to a state bordering upon frenzy" (Curzon, *Persia*, ii. 610). In 1869 Messrs Siemens of Berlin, in virtue of concessions obtained in the year before and later disposed of to the Indo-European Telegraph Company, Limited—who also took over Reuter's cable from Lowestoft to Emden (274 knots)—constructed a two-wire line on iron posts through Germany and Russia, and in Persia from Julfa to Teherán. This line was opened 31st January 1870. The British Government then handed the Baghdad–Teherán section, which had become unnecessary for international through traffic between Europe and India, over to the Persian Government, and changed its Teherán–Bushire line into one of two wires on iron posts. In 1873, according to a convention signed December 1872, and renewed concessions to the company, a third wire was added to the line, and there is now a three-wire line on iron posts (415 miles Indo-European Telegraph Company, 675 miles Indian Government) from Julfa to Bushire. It is worked throughout by an English staff, and may be considered one of the finest and most efficient lines in the world. From Bushire messages go by cable (laid in 1864) to Jask, and thence either by cable or by land to Karachi, Bombay, &c. The telegraphic convention between the British and Persian Governments has again been renewed, and is in force until 1925; and the concessions to the company were prolonged to the same year by the Russian Government in March 1900. In addition to these lines, Persia possesses about 3700 miles of single-wire lines on wooden poles, belonging to the Persian Government and worked by a Persian staff; the Teherán-Meshed line, however, is looked after by an English inspector, and since 1885 the Indian Government has allowed a sum not exceeding 20,000 rupees per annum for its maintenance. The minister of telegraphs has the Persian lines in farm for £6000 per annum, and no statistics are published. Statistics of the traffic on the Indo-European line are given in the administration reports of the Indo-European Telegraph Department, published by Government, and from them the figures in the following table have been obtained:—

Year.	Traffic over Lines between London and Karachi.	Earnings in thousands of Pounds.		Net Profits of the Government Dept.	
	Number of Messages transmitted.	Government Department.	Indo-Europ. Telegraph Co.	Total amount. Rupees.	Percentage on Capital Outlay.
1887–88	83,031	74	100	198,381	1·75
1892–93	117,500	84	116	437,668	3·80
1895–96	140,401	102	138	852,631	7·42
1896–97	148,274	101	138	713,030	6·17
1897–98	146,988	106	145	758,172	6·57
1898–99	147,592	105	144	697,303	6·03

Banking.—It was only in 1888 that a European bank (the New Oriental Bank Corporation, Limited) established itself in Persia and modern ideas of banking were introduced into the country. Until then the banking was done by the native money-changers (*sarráfs*) and some merchants—foreign and native—who did the banking operations connected with their business, and occasionally undertook special outside transactions when they considered them sufficiently remunerative. In 1889 the Shah granted a concession to Baron Julius de Reuter for the formation of a State bank with the exclusive right of issuing bank-notes—not exceeding £800,000 without special assent of the Persian Government—on the basis of the local currency, the silver kran. With the title of "The Imperial Bank of Persia" the bank was formed in the autumn of the same year, and incorporated by royal charter granted by Queen Victoria and dated 2nd September 1889. The authorized capital was four millions sterling, but the bank started with a capital of one million, and began its business in Persia in October 1889. In April 1890 it took over the Persian business of the New Oriental Bank Corporation, soon afterwards opened branches and agencies at the principal towns, and issued notes in the same year. During the first two years the bank remitted the greater part of its capital to Persia at the then prevailing exchange, and received for every pound sterling 32 to 34 krans; but in consequence of the great fall in silver in 1893 and 1894, the exchange rose to 50 krans per pound sterling and more, and the bank's capital employed in Persia being reduced in value by more than one-third—100 krans, which at the beginning represented £3, then being worth only £2 or less—the original capital of one million sterling was reduced to £650,000 in December 1894. The bank has made steady progress in spite of innumerable difficulties, and paid a fair dividend to its shareholders.[1]

In the same year, 1889, the Shah granted a concession to Jaques de Poliakov of St Petersburg for the establishment of a "Loan Bank," or, as the original concession said, "Mont de Piété," with exclusive rights of holding public auctions. A company was formed in the same year and started business at Teherán in 1890 as the "Banque des Prêts de Perse." After confining its operations for some years to ordinary pawnbroking, without profits, it obtained the aid of the Russian State Bank, acquired large premises in Teherán, made advances to the Persian Government (since 1898), and in January 1900 financed the loan of £2,400,000 to Persia (see "Finance," *supra*). It has opened branches at Tabriz and Resht.

There is also established at Teherán a branch of the Russian "Banque de Commerce de Moscou," and various Armenian firms, one with branches at many places in Persia and Russia, do banking business, while various European firms at Tabriz, Teherán, Isfáhán, Shiráz, and Bushire facilitate remittances between Europe and Persia.

The chief business of the native *sarráfs* (money-changers, bankers, &c.) is to discount bills at high rates, hardly ever less than 12 per cent., and remit money from place to place in Persia for a commission amounting to from 1 to 5, or even 6 per cent. on each transaction; and in spite of the European banks giving lower rates of discount and remitting money at par, the majority of the people and mercantile classes still deal with the natives. For advances with good security a native *sarráf* charges at least 12 per cent. interest per annum; as the security diminishes in value the rate of interest increases, and transactions at 10 per cent. a month, or more than 120 per cent. per annum, are not infrequent. A Persian who obtains an advance of money at less than 12 per cent. considers that he gets money "for nothing."

The monetary unit is the kran, a silver coin, formerly weighing 28 nakhods (88 grains), then reduced to 26 nakhods (77 grains), and now weighing only 24 nakhods (71 grains) or somewhat less. Before the new coinage came into use (1877) the proportion of pure silver was from 92 to 95 per cent.; subsequently the proportion was for some time 90 per cent.; now it is about 89½ per cent. In consequence of this depreciation of the coinage and the fall in the price of silver, the value of the kran is now only about half what it was in 1874. In that year it was worth a franc, the exchange being 25 to the pound sterling; in 1898–99 the average exchange for a £1 bill to London was 50 krans, which gives the value of 1 kran as 4⅘d. Taking this value of the kran, the values of the various nickel and silver coins in circulation work out as—

Nickel Coins.		Silver Coins.	
Shâhî = 2 pûl . .	0·24d.	Five shâhîs = ¼ kran .	1·20d.
Two shâhîs = 4 pûl .	0·48d.	Ten shâhîs = ½ kran .	2·40d.
		One krân = 20 shahîs = 40 pûl . .	4·80d.
		Two krans . .	9·60d.

In 1899 from 80 to 83 copper shâhîs (weighing about ⅛ lb) were being given for one silver kran. This was owing to the

[1] In his paper on "Banking in Persia" (*Journal of the Institute of Bankers*, 1891), Mr Joseph Rabino pointed out the great difficulties which make the easy distribution of funds—that is, the providing them when and where required—a matter of impossibility in Persia, and gives this fact as the reason why the Imperial Bank of Persia has local issues of notes, payable at the issuing branches only, "for, in a country like Persia, where movements of specie are so costly, slow, and difficult as to become impracticable except on a small scale, the danger of issuing notes payable at more than one place is obvious."

depreciation of the copper coinage from 1896 onwards, consequent upon there being an excess of coinage due to the excessive quantities formerly put in circulation from the mint. Accordingly the Government in 1900 replaced the copper by a nickel coinage. Gold coins are the $\frac{1}{4}$ toman, $\frac{1}{2}$ toman, 1 toman, 2, 5, and 10 tomans. The nominal value of the toman is 10 krans (4s.), but as there are very few gold pieces in circulation, its actual value is now about $16\frac{1}{2}$ krans (6s. $7\frac{1}{2}$d.). Accounts are reckoned in dinârs, an imaginary coin, $\frac{1}{10000}$ of a toman of 10 krans. 1000 dinârs thus equal 1 kran, and 50 dinârs 1 shâhî.

The unit of weight is the miskâl (71 grains), subdivided into 24 nakhods (2·96 grains), a nakhod being further subdivided into 4 gandum (·74 grains). Larger weights, again, are the sîr (16 miskâls) and the abbási, wakkeh, or kervânkeh (5 sîr). Most articles are bought and sold by a weight called batman, or man, of which there are several kinds, the principal being—

Man-i-Tabriz=8 abbásis	= 640 miskâls	= 6·49 lb
Man-i-Noh abbási=9 abbásis	= 720 ,,	= 7·30 ,,
Man-i-Kohneh (the old man)	=1000 ,,	= 10·14 ,,
Man-i-Shâh=2 Tabriz mans	=1280 ,,	= 12·98 ,,
Man-i-Rey=4 ,, ,,	=2560 ,,	= 25·96 ,,
Man-i-Bander abbási	= 840 ,,	= 8·52 ,,
Man-i-Hâshemî=16 mans of	720 ,,	=116·80 ,,

Corn, straw, coal, &c., are sold by kharvâr=100 Tabriz mans =649 lb.

The unit of measure is the zar or gez, of which, as in the case of the man, there are several variants. 40·95 inches is the most common length for the zar, but in Azerbáiján the length is 44·09 inches. Long distances are calculated in farsakhs, a farsakh being equal to 6000 zar. Probably the zar in this measure =40·95 inches, which makes the farsakh 3·87 miles, but the other length of the zar is sometimes used, when the farsakh becomes 4·17 miles. Areas are measured in jerîbs of from 1000 to 1066 square zar of 40·95 inches, the surface unit thus being from 1294 to 1379 square yards.

II. Recent History (1884–1901).

The history of Persia in the ninth edition of this Encyclopædia closed with the statement that in 1884 two steamers for the Persian Government were in course of construction, and that the Karun river was to be opened up to Ahváz, and a carriageable road constructed connecting that place with Teherán. Already in 1865 the Shah had mooted the idea of a Persian naval flotilla in the Persian Gulf, to consist of two or three steamers manned by Arabs and commanded by English naval officers; but the idea was discountenanced by the British Government, to whom it was known that the project really concealed aggressive designs upon the independence of the islands and pearl fisheries of Bahrein (Curzon, *Persia*, ii. 294). Fifteen or sixteen years later it was repeatedly pointed out to the authorities that the revenues from the customs of the Persian Gulf would be much increased if control were exercised at all the ports, particularly the small ones where smuggling was being carried on on a large scale, and in 1883 the Shah decided upon the acquisition of four or five steamers, one to be purchased yearly, and instructed the late Ali Kuli Khan, Mukhber-ed-dowleh, minister of telegraphs, to obtain designs and estimates from British and German firms. The tender of a well-known German firm at Bremerhaven was finally accepted, and one of the minister's sons then residing in Berlin made the necessary contracts for the first steamer. Sir Ronald Thomson, the British representative in Persia, having at the same time induced the Shah to consider the advantages to Persia of opening the Karun river and connecting it with Teherán by a carriageable road, a small river steamer for controlling the shipping on the Karun was ordered as well, and the construction of the road was decided upon. The two steamers were completed in January 1885 at a cost of £32,000, and despatched with German officers and crew to the Persian Gulf (as has been already mentioned). One, the *Persepolis*, an iron schooner-rigged screw steamer, has a registered tonnage of 600, engines of 450 h.p., and a maximum speed of 10 knots; the other, the *Susa*, now on the Karun above Ahváz, is a screw steam launch, with a tonnage of 36, engines of 30 h.p., and speed of 6 knots, and was sent out in sections on the *Persepolis* and put together at Muhamrah in 1885. The *Persepolis* has an armament of one $8\frac{1}{2}$ and three $7\frac{1}{2}$ centimetre Krupp steel guns, and forty old-system Mauser rifles. One of the $7\frac{1}{2}$ centimetre guns was originally on the *Susa*, but transferred to the *Persepolis* in 1886. When the steamers were ready to do the work they had been intended for, the farmer, or farmers, of the Gulf customs raised difficulties and objected to pay the cost of maintaining the *Persepolis*; the governor of Muhamrah would not allow any interference with what he considered his hereditary rights of the shipping monopoly on the Karun, and the objects for which the steamers had been brought were not attained. The *Persepolis* remained idle at Bushire, and the *Susa* was tied up in the Failieh creek, near Muhamrah. The annual cost of maintenance of the two vessels, merely for salaries and wages of officers and crew and expenses of necessary painting, oiling, and scrubbing, amounted to £3500, a large item in the small revenue of Persia, and the Shah wisely desisted from buying more steamers. The scheme of opening the Karun and of constructing a carriageable road from Ahváz to Teherán was also abandoned.

The control of the Persian Gulf.

Frequent interruptions occurred on the telegraph line between Teherán and Meshed in 1885, at the time of the "Panjdeh incident," when the Russians were advancing towards Afghanistan and Sir Peter Lumsden was on the Afghan frontier; and since (often for many days at a time) no news could be obtained, Sir Ronald Thomson concluded an agreement, still in force, with the Persian Government by which the line is kept in working order by an English inspector, the Indian Government paying a share not exceeding 20,000 rupees per annum of the cost of maintenance, and an English signaller is stationed at Meshed. Shortly afterwards Sir Ronald Thomson left Persia (he died 15th November 1888), and Mr (afterwards Sir) Arthur Nicolson was appointed chargé d'affaires. During the latter's tenure of office an agreement was concluded between the Persian and British Governments regarding the British telegraph settlement at Jask, and the telegraph conventions of 1868 and 1872, relative to telegraphic communication between Europe and India through Persia, in force until 1st January 1895, were prolonged until 31st January 1905 by two conventions dated 3rd July 1887. Since then these conventions have been prolonged to 1925. (See "Telegraphs," *supra*.)

Ayúb Khan, son of Shír Ali of Afghanistan, who had taken refuge in Persia in October 1881, and was kept interned in Teherán under an agreement, concluded 17th April 1884, between Great Britain and Persia, with a pension of £8000 per annum from the British Government, escaped on the 14th of August 1887. After a futile attempt to enter Afghan territory and raise a revolt against the Amir Abdur Rahman, he gave himself up to the British consul-general at Meshed in the beginning of November, and was sent under escort to the Turkish frontier and thence *viâ* Baghdad to India. Yahya Khan, Mushir-ed-dowleh, the Persian minister for foreign affairs (died 1892), who was supposed to have connived at Ayúb Khan's escape in order to please his Russian friends, was dismissed from office.

In December 1887 Sir Henry Drummond Wolff was appointed minister to Persia. The appointment greatly pleased the Persian court, and the Shah lent a willing ear to his advocacy for the development of trade and commerce, construction of roads, abolition of various restrictions hampering Persian merchants, &c. The Shah soon afterwards (26th May 1888) issued a proclamation assuring freedom of life and property to all his subjects, and (30th October) declared the Karun river open to international navigation up to Ahváz. At about the same time he appointed Amin-es-Sultán, who had been prime minister since 1884, Grand Vizír (Sadr Azam). In the same year (25th June) the first railway in Persia, a small line of $5\frac{1}{2}$ miles from Teherán to Shah-abdul-Azím, was opened under the auspices of a Belgian company in virtue of a concession granted two years before. A few months later (30th January 1889) Baron Julius de Reuter, in consideration of giving up the rights which he held by his concession obtained in 1873, became, as has been already stated, the owner of a concession for the formation of a Persian State Bank, with exclusive rights of issuing bank-notes and working the mines of iron, copper, lead, mercury, coal, petroleum, manganese, borax, and asbestos in Persia. Russia now insisted upon what she considered a corresponding advantage; and Prince Dolgorouki, the Russian minister, obtained in February 1889 a document from the Shah which gave to Russia the refusal of any railway concession in Persia for a period of five years. The Persian State Bank was established by British royal charter, dated 2nd September 1889, and started business in Persia (23rd October) as the "Imperial Bank of Persia." The railway agreement with Russia was changed in November 1890 into one interdicting all railways whatsoever in Persia, and is still in force.

Shah's visit to Europe, 1889.

In April 1889 the Shah set out upon his third voyage to Europe. After a visit to the principal courts, including a stay of a month in England, where he was accompanied by Sir Henry Drummond Wolff, he returned to his capital (20th October). Sir Henry returned to Persia soon afterwards, and in March of the following year the Persian Government granted another important concession, that of a tobacco monopoly, to British capitalists. In the autumn bad health obliged the British minister to leave Persia. It was during his stay in England that the Shah, for two or three days without his Grand Vizír, who was mourning for the death of his brother, listened to bad advice and granted a concession for the monopoly of lotteries in Persia to a Persian subject. The latter ceded the concession to a British syndicate for £40,000. Very soon afterwards the Shah was made aware of the evil results of this monopoly, and withdrew the concession, but the syndicate did not get the money paid for it returned. This unfortunate affair had the effect of greatly discrediting Persia on the London Stock Exchange for a long time. The concession for the tobacco monopoly was taken up by the Imperial Tobacco Corporation (1891). The corporation encountered opposition fostered by the clergy, and after a serious riot at Teherán (4th January 1892) the Persian Government withdrew the concession and agreed to pay an indemnity of £500,000 (5th April 1892). In order to pay this amount Persia contracted the 6 per cent. loan of £500,000 through the Imperial Bank of Persia, which was redeemed in 1900 out of the proceeds of the Russian 5 per cent. loan of that year. (For details of the tobacco concession and an account of the events which led to its withdrawal, see E. Lorini, *La Persia Economica*, Rome, 1900, pp. 164-169; and Dr Feuvrier, *Trois ans à la Cour de Perse*, Paris, 1899, chap. v., the latter ascribing the failure of the tobacco monopoly to Russian intrigue.)

In November 1889 Malcolm Khan, Nizam-el-Mulk, who had been Persian representative to the court of Great Britain since October 1872, was recalled, and Mirza Muhammad Ali Khan, consul-general at Tiflis, was appointed in his stead, arriving in London the following March, and later receiving the title Ala-es-Saltaneh. In 1890 the scheme of a carriageable road from Teherán to Ahváz was taken up again; the Imperial Bank of Persia obtained a concession, and work of construction was begun in the same year, and continued until 1893. In this year, too, the mining rights of the Imperial Bank of Persia were ceded to the Persian Bank Mining Rights Corporation, and a number of engineers were sent out to Persia. The total absence of easy means of communication, the high rates of transport, and the scarcity of fuel and water in the mineral districts made profitable operations impossible, and the corporation liquidated in 1894, after having expended a large sum of money. The work of the corporation proved that without cheap means of transport no mining operations on a large scale in Persia can be undertaken with profit.

Kate Greenfield case.

Great excitement was caused in the summer of 1891 by the report that an English girl, Kate Greenfield, had been forcibly carried away from her mother's house at Tabriz by a Kurd. The British authorities demanded the girl's restitution from the Persian Government. The Kurd, a Turkish subject, refused to give up the girl, and took her to Saújbulagh, where he and a number of wild tribesmen entrenched themselves, and threatened to resist any attempt on the part of the Persians to recover her. The Turkish authorities protected him, and serious complications were imminent; but finally an interview between the girl and the British agent was arranged, and the matter was promptly settled by her declaring that she had left her mother's house of her own accord, and was the wife of the Kurd. It also became known that she was the daughter of a British-protected Hungarian named Grünfeld, who had died some years since, and an American lady of Tabriz.

Sir Frank Lascelles, who had been appointed minister to Persia in July, arrived at Teherán in the late autumn of 1891. In the following year Persia had a visitation of cholera. The epidemic entered Persia from the East, made many victims, and travelled as far as western Persia. In Teherán the mortality rose for several days to over 1000 a day, and in the city and surrounding villages the number of fatal cases exceeded 28,000, or about 8 per cent. of the population. In 1893 the epidemic appeared again, but in a milder form. In June 1893, by a convention ratified a month later at Peterhof, Persia ceded to Russia the small but very fertile and strategically important district of Firúzeh and the adjacent lands between Baba Durmaz and Lutfábád on the northern frontier of Khorasán, and received in exchange the important village of Hissár and a strip of desert ground near Abbasábád on the frontier of Azerbáiján, which had become Russian territory in 1828, according to the treaty of Turkmanchaï.

French archæological concession.

Sir Frank Lascelles left Persia in the early part of 1894, and was succeeded by Sir Mortimer Durand, who was appointed in July and arrived in Teherán in November. In the following year the Shah, by a firman dated 12th May, gave the exclusive right of exploring ancient sites in Persia to the French Government, with the stipulation that one-half of the discovered antiquities, excepting those of gold and silver and precious stones, should belong to the French Government, which also had the preferential right of acquiring by purchase the other half and any of the other antiquities which the Persian Government might wish to dispose of. The period for which this valuable concession is to remain in force is not mentioned in the firman, and is in consequence considered unlimited. In 1897 the French Government granted the necessary funds, and M. J. de Morgan, who had been on a scientific mission in Persia some years before and later distinguished himself as head of the archæological department in Egypt, was appointed chief of a mission to Persia, and, assisted by an efficient staff, began work at Susa in December. Operations have been continued until now, and so far confined to Susa and southern Persia, but according to recent information the sphere of operations is to be greatly extended, and more than 400 ancient sites are to be explored.

Assassination of the Shah, 1896.

On 1st May 1896 Nássir-ed-dín Shah was assassinated while paying his devotions at the holy shrine of Shah-abdul-Azím, a few miles from Teherán. Five days later he would have entered the fiftieth (lunar) year of his reign, and great preparations for duly celebrating the jubilee had been made throughout the country. The assassin was a small tradesman of Kermán named Mirza Reza, who had resided a short time in Constantinople and there acquired revolutionary and anarchist ideas from Kemál-ed-dín, the so-called Afghan sheikh, who, after having been very kindly treated by the Shah, preached revolution and anarchy at Teherán, fled to Europe, visited London, and finally took up his residence in Constantinople. Kemál-ed-dín was a native of Hamadán and a Persian subject, and as the assassin repeatedly stated that he was the sheikh's emissary and had acted by his orders, the Persian Government demanded the extradition of Kemál from the Porte; but during the protracted negotiations which followed he died. Mirza Reza was hanged 12th August 1896. There were few troubles in the country when the news of the Shah's death became known. The capital and most cities and districts were kept in order by the excellent measures taken by the Grand Vizír and the governors, and serious rioting arose only in Shiráz and Fars, where some persons lost their lives and a number of caravans were looted. European firms who had lost goods during these troubles were afterwards indemnified by the Persian Government. The new Shah, Muzaffar-ed-dín (born 25th March 1853), then governor-general of Azerbáiján, residing at Tabriz, was enthroned there on the day of his father's death, and proceeded a few days later, accompanied by the British and Russian consuls, to Teherán, where he arrived 8th June.

Currency difficulties.

An excessive copper coinage during the past three or four years had caused much distress among the lower classes since the beginning of the year, and the small trade was almost paralysed. Also the price of meat, particularly in the Teherán district, had been extraordinarily high for some months, and was now quite prohibitive to the poorer classes. Immediately after his accession the Shah was made aware of these facts, and decreed that the coining of copper money should cease and the excess of the copper coinage be withdrawn from circulation. An arrangement was concluded with the Imperial Bank of Persia by which that institution advanced the required money and bought up the copper coinage at the rates current in the various cities until its circulating value became 25 shâhîs equal to 1 kran. In order to reduce the price of meat, the meat tax, which had existed since ancient times, was abolished. The Imperial Bank of Persia, which had already advanced a large sum of money, and thereby greatly facilitated the Shah's early departure from Tabriz and enabled the Grand Vizír at Teherán to carry on the government, cheerfully accepted the arrangement, and started buying up the copper coinage at all its branches and agencies. The nominal value of the copper money was 20 shâhîs equal to 1 kran, but in some places the copper money circulated at the rate of 80 shâhîs to the kran, less than its intrinsic value; at other places the rates varied between 70 and 25 shâhîs, and the average circulating value in all Persia was over 40. If Government had been able to buy up the excess at 40 and reissue it gradually after a time at its nominal value when the people required it, the loss would have been small. But although the transport of copper money from place to place had been strictly prohibited, dishonest officials found means to traffic in copper money on their own account, and by buying it where it was cheap and forwarding it to cities where it was dear, the bank bought it at high rates, thus rendering the arrangement for a speedy withdrawal of the excess at small cost to Government futile. It was only in 1899 that the distress caused by the excessive copper coinage ceased, and then only at very great loss to Government. The well-intentioned abolition of the tax on meat also had not the desired result, for by a system of "cornering" the price of meat rose to more than it was before.

In the autumn of 1896 Nizam-es-Saltaneh, governor of Arabistán, and his brother Saad-el-Mulk, governor of Luristán, displayed much unfriendliness of attitude towards the British Government, and were removed from their posts at the instance of Sir Mortimer Durand, the Persian Government at the same time giving a promise that neither should be employed anywhere in Persia for a period of five years. In 1898 the British Government consented to the removal of the prohibition against the elder brother's further employment, provided that a guarantee was given that he should never be employed in southern Persia or in any place where he might injure British trade. This was agreed to, and Nizam-es-Saltaneh became minister of justice and commerce in March, minister of finance in June, and chief administrator of Azerbáïján in May of the following year (1899).

Ministerial changes, 1896-98.

In the autumn of 1896 the Grand Vizír (Amin-es-Sultan) encountered much hostility from some members of the Shah's entourage and various high personages. Amin-ed-dowleh was appointed chief administrator (vizír) of Azerbáïján and sent to Tabriz. Shortly afterwards the Grand Vizír found it impossible to carry on his work, resigned, and retired to Kom (24th November), and the Shah formed a cabinet composed for the greater part of the leading members of the opposition to the Grand Vizír. After three months of the new régime affairs of State fell into arrears, and the most important department, that of the Interior, was completely disorganized. The public treasury was empty. The ministers of the cabinet would not act together, and as all shirked responsibility, every matter, large and small, was brought before the Shah, who accordingly recalled Amin-ed-dowleh from Tabriz (February 1897), and appointed him minister president (Raïs-i-Vuzara) and minister of the interior. In June Amin-ed-dowleh was made prime minister (*Vizír Azam*) and given more extended powers, and in August raised to the dignity of Grand Vizír (*Sadr Azam*). Several reforms were now taken in hand, with a view of reducing expenditure and increasing the revenue; but reducing expenditure meant the pensioning off or dismissal of crowds of functionaries, and this could not be done without paying arrears of salaries due to them. Nássir-el-Mulk was appointed minister of finance (February 1898), and made an attempt to introduce a simple system of accounts, establish a budget, reorganize the revenue department, make a new assessment of the land-tax, &c.; but resistance on the part of the officials rendered it abortive. Other attempts at reform shared the same fate, and only resulted in making Amin-ed-dowleh very unpopular.

In the latter part of 1897 Mr E. Graves, the inspector of the English telegraph line from Jask eastwards, was brutally murdered by Baluchis, and the agents of the Persian Government sent to seize the murderers were resisted by the tribes. A considerable district breaking out into open revolt, troops under the command of the governor-general of Kermán were despatched into Baluchistan. The port of Fannoch was taken in March 1898, and order was restored. One of the murderers was hanged at Jask (31st May).

Abortive negotiations for British loan in 1898.

Various attempts to obtain a foreign loan had been made during the previous year, but with the sole result of discrediting the Persian Government in Europe. In the beginning of 1898 the Shah's medical advisers strongly recommended a cure of mineral waters in Germany or France, and as his departure from Persia without paying the arrears to the army and to thousands of functionaries, or providing a sufficient sum for carrying on the Government during his absence, would have created grave discontent, serious negotiations for a loan were entered upon. It was estimated that £1,000,000 would be required to pay all debts, including the balance of the 1892 loan, and leave a surplus sufficient for carrying on the Government until the Shah's return. Some time before this the Shah had asked Sir Mortimer Durand to assist, and the Persian Government, now applying to London, expected that the required money would be obtained quickly on easy terms, and thus enable the Shah to proceed on his journey to Europe in April. London capitalists offered to float a loan for £1,250,000 at 5 per cent. and on the guarantee of the customs of Fars and the Persian Gulf ports, and to give £1,025,000, or 82 per cent. of the nominal capital, to the Persian Government. They stipulated for a kind of control over the custom-houses by placing their own agents as cashiers in them. This stipulation was agreed to in principle by the Grand Vizír, Amin-ed-dowleh, who in March, in order to meet some pressing demands on the treasury, borrowed £50,000 on the customs receipts of Kermánsháh and Bushire, and agreed to the lenders, the Imperial Bank of Persia's agents, being placed as cashiers in the custom-houses of both cities. He encountered, however, much opposition from the other ministers. Objections were also taken to the low rate of 82, particularly when it was ascertained that a rate of 86 could have been obtained if the claims of some members of the London Stock Exchange, who had lost money over the lottery concession of 1889, had not had to be satisfied in order to obtain the necessary official recognition of the loan by the Stock Exchange. Further negotiations ensued, and the Shah's visit to Europe was abandoned. The assistance of the British Government not being forthcoming, the Grand Vizír's position became more and more difficult, and on 5th June he had to resign. Muhsin Khan, Mushir-ed-dowleh, minister for foreign affairs, then became president of the cabinet, and continued the negotiations, but could not bring them to a successful issue. Moreover, the Persian Government, finding that the previous estimate of the money required for paying its debts was about 50 per cent. below the mark, now asked for double the amount offered by the London capitalists, without, however, proportionately increasing the guarantee. This disorganized all previous arrangements, and the negotiations for a London loan came to an end for a time at the end of July, leaving in the minds of the Persians the unfortunate impression that the British Government had done nothing to aid them.

On 9th July the former Grand Vizír, Amin-es-Sultan, was recalled from Kom, where he had resided since November 1896, arrived at Teherán three days later, and was reinstated as Grand Vizír on the 10th of August. His immense popularity, his friendly relations with the clergy, and some temporary advances from the banks, tided over difficulties for some time. The reform of the customs department was now (September 1898) taken up seriously, and the three Belgian custom-house officials who had been engaged by Amin-ed-dowleh in the beginning of the year were instructed to collect information and devise a scheme for the reorganization of the department and the abolition of the farm system. In March 1899 the custom-houses of the provinces of Azerbáïján and Kermánsháh were given over to the Belgians. The results of this step were so satisfactory that Government was induced to abolish the farm system and set up the new régime in the other provinces in March 1900, and a number of other Belgian custom-house officials were engaged.

In March 1899 a small Persian force took Bander Lingah, one of the Persian Gulf ports, and expelled the Arab sheikh, whose family had enjoyed a quasi-independence there for many generations. The loss of life was unimportant, and British gunboats were present to protect British subjects. The sheikh fled to the hills north of Lingah, obliging the Government to keep a garrison at the port.

Russian loan of 1900.

In September, when renewed negotiations for a loan from London were not appearing to progress favourably, and the long-thought-of visit to Europe was considered to be absolutely necessary in the following year, the Shah issued a firman authorizing the Russian Banque de Prêts de Perse to float a loan. Shortly after this it was said that the London capitalists were willing to lend £1,250,000 without insisting upon the objectionable control clause; but the proposal came too late, and on 30th January 1900, as we have already mentioned, an official announcement appeared at St Petersburg to the effect that the Russian Government had permitted the issue of a loan for 22½ million roubles (£2,400,000) at 5 per cent., guaranteed by all the customs receipts of Persia, excepting those for Fars and the Persian Gulf ports. Only in the event of any default of paying instalments and interests will the bank have the right of exercising control of the custom-houses. Persia received 85 per cent. of the nominal capital, and the Russian Government guarantees the bondholders. Without Government guarantee it is doubtful whether any financial institution would have lent money on such advantageous terms. Money was immediately remitted to Teherán, and nearly all the arrears were paid, while the balance of the 1892 London 6 per cent. loan was paid off by direct remittance to London. The paying off the arrears, and the fact that a large quantity of cash was put into circulation in consequence, greatly revived trade, which had been languishing for a long time, and much distress and discontent disappeared.

Shah's visits to Europe, 1900, 1902.

Sir Mortimer Durand left Teherán in the early spring, and proceeded to Europe on leave. On 12th April the Shah, accompanied by the Grand Vizír and a numerous suite, started on his voyage to Europe, principally to undergo a cure at Contrexéville, but also with the intention of visiting the courts of Russia, France, Great Britain, Belgium, Netherlands, Germany, Italy, Austria, and Turkey. The affairs of State during his absence were entrusted to a council of ministers, under the presidency of his second son, Malik Mansur Mirza, Shua-es-Sultaneh, who had made a long stay on the Continent the year before.

After a residence of a month at Contrexéville, the Shah proceeded (14th July) to St Petersburg, and thence to Paris (29th July), intending to go to London on 8th August. But on account of the mourning in which several courts were thrown through the deaths of the king of Italy (29th July) and the duke of Saxe-Coburg-Gotha (30th July), the visits to England, Germany, and Italy were abandoned. On 2nd August an anarchist made an attempt upon the Shah's life in Paris, and a week later he went to Belgium. In the middle of June serious bread riots, instigated, it was said, by persons opposed to the Grand Vizír with the Shah in Europe, occurred in Teherán; and to prevent a repetition of the disorders, some of the suspected ringleaders or instigators were expelled from the city. Sir Mortimer Durand having been given the post of ambassador to Spain, Sir Arthur Hardinge was appointed minister to Persia 12th August 1900.

In 1902 the Shah made another visit to Europe, and was welcomed by King Edward in England during August.

AUTHORITIES.—The works treating of Persia and written by European writers, or in a European language, beginning with Herodotus, number thousands. The following bibliography has been restricted to works published during the 19th century which have not been quoted in the foregoing text, and, as giving useful information, may be consulted with advantage. The list excludes historical works and articles and papers, many of great value, which have appeared in the transactions, proceedings, and journals of learned societies, in magazines, reviews, newspapers, &c., and comprises only a selection, not a large one, of the works published as books. An able summary of the voluminous literature on Persia is given by Lord CURZON in his *Persia and the Persian Question* (vol. i. pp. 15–25). Col. VALENTINE BAKER. *Clouds in the East.* London, 1873. —H. W. BELLEW. *From the Indus to the Tigris.* London, 1872.—S. G. W. BENJAMIN. *Persia and the Persians.* London, 1887.—H. BINDER. *Au Kurdistan.* Paris.—ISABELLA BIRD (Mrs Bishop). *Journeys in Persia and Kurdistan.* London, 1893.—E. G. BROWNE. *A Traveller's Narrative.* Cambridge, 1891; *A Year among the Persians.* London, 1893.—JANE DIEULAFOY. *La Perse.* Paris, 1887.—E. FLOYER. *Unexplored Baluchistan.* London, 1882.—Sir T. E. GORDON. *Persia Revisited.* London, 1896.—Sir H. LAYARD. *Early Adventures in Persia.* London, 1894.—C. MACGREGOR. *Journey through Khorassan.* London, 1879.—E. L. MITFORD. *Land March from England to Ceylon.* London, 1884.—J. DE MORGAN. *Mission scientifique en Perse.* Paris, 1894–97.—E. O'DONOVAN. *The Merv Oasis.*—P. OGORODNIKOF. *Sketches of Persia* (in Russian). St Petersburg, 1878.—Dr J. POLAK. *Persien, das Land und seine Bewohner.* Leipzig, 1865.—H. POTTINGER. *Travels in Beluchistan.*—Sir LEWIS PELLY. *The Miracle Play of Hasan and Husain.* London, 1879. —Sir H. RAWLINSON. *England and Russia in the East.*—ELISÉE RÉCLUS. *Géographie Universelle,* vol. x.—E. STACK. *Six Months in Persia.* London, 1882.—ELLA SYKES. *Through Persia on a Side Saddle.* London, 1898.—A. VAMBÉRY. *Meine Wanderungen und Erlebnisse in Persien.* Pesth, 1867.—C. J. WILLS. *In the Land of the Lion and Sun.* London, 1883; *Persia as it is.* London, 1886.—Dr JOSEPH WOLFF. *Travels and Adventures.* London, 1861. (A. H.-S.)

Perth, or PERTHSHIRE, an inland county of Scotland, bounded on the N.W. and N. by Inverness, on the N.E. by Aberdeen, on the E. by Forfar, on the S.E. by the Firth of Tay and Fife, Kinross, and Clackmannan, on the S. and S.W. by Stirling, and on the W. by Argyll.

Area and Population.—The area of the county is 1,617,808 acres, or 2528 square miles, with a population in 1881 of 129,007, in 1891 of 126,199, and in 1901 of 123,262, of whom 58,007 were males and 65,255 females, the number of persons per square mile being 48, and of acres to a person 13·01. Between 1881 and 1891 the percentage of decrease in the population was 2·17, and between 1891 and 1901, 2·3. The following table gives the numbers of marriages, births, and deaths, with the number and percentage of illegitimate births, for 1880, 1890, and 1899:—

Year.	Marriages.	Births.	Deaths.	Illegitimate Births. No.	Illegitimate Births. Per cent.
1880	743	3612	2372	357	9·2
1890	695	2869	2359	252	8·8
1899	730	2925	1945	227	8·4

In addition to Perth (32,872), the only town with over 5000 inhabitants is Crieff (5208). In 1891 there were in Perthshire 2465 natives of England, 68 natives of Wales, 1745 natives of Ireland, and 106 foreigners.

Administration.—For parliamentary purposes the county is divided into an Eastern and a Western division. The city of Perth also returns a member to Parliament.

Education.—The total grant to higher-class schools for the year ended 31st March 1900 was over £1651. The total accommodation in elementary schools for the year ended 30th September 1899 was 27,310, the average attendance 16,510, and the average cost per scholar £2, 17s. 11¼d. The amount of rates received in 1898–99 was £31,219, and the average rate per £ on rateable value was at 6·87 in 1895–96, at 6·75 in 1896–97, and at 7·67 in 1897–98.

Agriculture.—Only a little more than one-fifth of the total area of the county is under cultivation, and of this nearly one-third is in permanent pasture, while in addition there are about 930,000 acres of hill pasturage, grazed partly by the native highland cattle, but mainly by sheep, in regard to the number of which Perthshire ranks, in Scotland, next to Argyll. Much of the old sheep pasturage is, however, now occupied by deer forests. Over 94,000 acres are under wood, and nearly 600 acres under orchards. Apples are grown chiefly in the Carse of Gowrie and the district of Menteith. Over 1000 acres are under small fruit. Since 1880 the acreage under corn crops has decreased by about one-sixth, the largest decrease being in the acreage under barley, which now occupies about one-sixth of the corn crop acreage, oats occupying nearly three-fourths, and wheat less than one-fourteenth. Nearly three-fourths of the green crop acreage is occupied by turnips, and less than one-third by potatoes. The following table gives the main divisions of the cultivated area at intervals from 1885:—

Year.	Total Area under Cultivation.	Corn Crops.	Green Crops.	Clover.	Permanent Pasture.	Fallow.
1885	345,136	99,902	47,963	103,533	91,623	2115
1890	349,818	94,826	45,865	118,683	87,735	2130
1895	337,227	89,474	44,294	98,265	103,284	1158
1899	338,737	87,514	43,394	99,918	105,745	986

The following table gives particulars regarding the live stock for the same years:—

Year.	Total Horses.	Total Cattle.	Cows or Heifers in Milk or in Calf.	Sheep	Pigs.
1885	13,249	82,631	19,857	713,191	8902
1890	12,843	79,848	19,459	735,178	9631
1895	13,917	74,861	18,202	707,661	8886
1899	12,183	73,097	17,830	710,933	7212

Industries and Trade.—The total number of persons employed in factories and workshops in 1897 was 12,198, as compared with 11,640 in 1896. Of these 4225 were employed in textile factories, flax, hemp, &c., chiefly coarse linens, in the several towns and villages, employing 2838. In non-textile factories 6258 persons were employed, 3402 of these in the print, bleach, and dye works for which the county town is famous. Of the 1715 persons employed in workshops, 1170 were employed in clothing industries. Handloom weaving is still carried on in many of the villages. In 1899 among the minerals raised were 55,009 tons of igneous rocks, 41,508 tons of sandstone, and 9371 tons of slate.

See ROBERTSON. *General View of the Agriculture of the County of Perth.* Perth, 1799.—ROBERTSON. *Comitatus de Atholiæ.* Edinburgh, 1860.—GUTHRIE. *The Vale of Strathmore.* Edinburgh, 1875.—DRUMMOND. *Perthshire in Bygone Days.* London, 1879.—MARSHALL. *Historic Scenes of Perthshire.* Edinburgh, 1880.—HUNTER. *Woods, Forests, and Estates of Perthshire.* Perth, 1883. —BEVERIDGE. *Perthshire-on-Forth,* 2 vols. London, 1885.—FORD. *The Harp of Perthshire.* Paisley, 1893.—CUNNINGHAME-GRAHAM. *Notes on the District of Menteith.* London, 1895.—HUTCHISON. *The Lake of Menteith.* Stirling, 1899. (W. WA.)

Perth, an ancient city, a royal and parliamentary (one member) burgh, and the county town of Perthshire, Scotland, on the river Tay, at the junction of several lines of the Caledonian and North British railways, 48 miles north-north-west of Edinburgh by rail. Dyeing retains its importance, and there are also glass, linen, wincey, and floorcloth manufactures, steam joinery works, and brick and tile works. There is an Episcopalian cathedral, to which in 1900 considerable additions were made in commemoration of Bishop Wordsworth. The Perth Academy is a higher-class school under the direction of the school board; and Sharp's Institution, besides satisfying the requirements of an organized science school, provides a course of instruction in classics, instrumental music, and gymnastics. In addition to the board schools other educational institutions are Stewart's Free School, the industrial school for girls, and the Fechney industrial school. A scheme of city improvements has been to a large extent (1901) carried out. It includes a fine new street from the North Inch to the South Inch; the erection of a new bridge—a steel structure with handsome freestone piers—between the old bridge and the railway bridge, and connecting South Street with the Dundee Road. Jubilee corporation swimming baths, with bowling greens, were erected in 1887 by public subscription; a handsome new post office was opened in 1898, and in the same year the Sandeman Public Library, founded by a bequest of £32,000 from the late Professor Sandeman of Owens College, Manchester. At the south end of the North Inch a granite column was erected in 1895 to commemorate the achievements of the 90th Light Infantry, now the second battalion Cameron Highlanders. Population (1881), 28,949; (1891), 29,899; (1901), 32,872.

Perth, the capital of West Australia, situated about 12 miles from the sea by rail, on the Swan river, which here widens out into a beautiful lake, one and a half miles long and one mile broad. The city has grown very rapidly since 1890. In 1891 the population was only 8447; in 1899 it was 35,000, of whom some 27,000 were within the limits of the city proper (2560 acres). There is communication by bridge and steam ferry with South Perth, on the opposite side of the river; to the north-west lie the adjoining and rapidly growing municipalities of Leederville and Subiaco. Outlying suburbs are Victoria Park, Burswood, Belmont, Claremont, Cottesloe, Peppermint Grove, and Bayswater. A Jubilee Victoria Public Library was opened in 1887, the Scots College in 1897, and the Mint, an imposing structure of considerable architectural merit, in 1899. An observatory is finely situated on a hill immediately west of the city, and there is a general museum. Chief among several reserves is the Perth Park Reserve, comprising over 1000 acres, now being cleared and laid out. The mean temperature is 64·9° F.; the lowest that has been recorded is 37·5°; and the maximum, an exceptional reading which was taken in 1878, 116·7°. The average rainfall is 33 inches

The municipal council consists of a mayor, elected annually by the whole body of municipal electors, and 15 councillors, representing 5 wards. In the Parliament of West Australia, for the meetings of which the city contains Legislative Council and Legislative Assembly chambers, Perth is represented by 3 members on the Council and 4 members in the Assembly. The total length of streets is 64 miles, of which in 1899 about 40 miles were properly formed and metalled. There are gas and electric lighting works, both as yet in the hands of companies. The water works, however, were acquired in 1896 by the central Government for £220,000; a further sum of £140,000 has been expended on them, and the main reservoir, in the Darling range, is capable of holding 200,000,000 gallons. It is proposed to construct another with a capacity of 1,554,452,000 gallons, and a new service reservoir within the city boundaries is also contemplated. At present Perth has no proper sewerage system, but a scheme of surface drainage is being carried out as a temporary relief, and a permanent system of sewerage has also been approved, which will involve an expenditure of some £350,000. There are three racecourses in the neighbourhood. Three daily papers are published.

Perth Amboy, a city and port of entry in Middlesex county, New Jersey, U.S.A., at the head of Raritan Bay, in the eastern part of the state. Its site is low and level and the street plan regular. It has an excellent harbour and a large commerce, and three railways, the Central of New Jersey, the Lehigh Valley, and the Pennsylvania, afford rail transportation. It contains terra-cotta works, machine works, iron foundries, petroleum refineries, and chemical works. Population (1880), 4808; (1890), 9512; (1900), 17,699, of whom 7978 were foreign-born and 89 negroes.

Peru, a country of South America, bounded on the W. by the Pacific Ocean, on the N. by Ecuador, on the E. by Brazil and Bolivia, and on the S. by Chile. The frontiers towards Ecuador and Bolivia are not yet defined, and the question as to the possession of the provinces of Tacna and Arica, which have been occupied by Chile since 1884, is still pending. According to the agreement between Peru and Chile, a popular vote should have decided in 1894 to which country these provinces should belong, but as a *modus operandi* acceptable to both parties could not be devised, the decision was deferred. On 16th April 1898 a convention for the purpose of carrying out the plebiscite was signed at Santiago, but two years later it was rejected by the Chilian Congress. According to Peruvian claims, the territory of the republic stretches from 1° 29′ to 19° 13′ S., and from 61° 55′ to 81° 20′ 40″ W. Generally speaking, the climate is healthy, though a few endemic diseases are found. The climate in some places, as, for instance, Piura and Jauja, has a curative effect on rheumatic, pulmonary, and other complaints.

Area and population.

The area of Peru, according to estimates published by the Geographical Society of Lima, covers 695,730 square miles. No census of the population has been taken since 1876, when the number of inhabitants was returned at 2,657,853, exclusive of uncivilized Indians, said to number about 350,000. In 1896 the Geographical Society of Lima estimated the population at 4,609,999. In the following table the areas of the 18 departments (including Tacna) and two provinces (Callao and Moquegua) and their population (census for 1876, and estimated for 1896) are set forth:—

	Area Square Miles.	Population.	
		Census, 1876.	Estimated, 1896.
Piura	16,824	135,502	213,909
Cajamarca	12,538	213,391	442,412
Amazonas	13,943	34,245	70,676
Loreto	288,456	61,125	100,596
Libertad	10,206	147,541	250,931
Ancachs	16,562	284,091	428,703
Lima	13,310	226,922	298,106
Callao	14	34,492	48,118
Huancavelica	9,251	104,155	223,796
Huánuco	14,024	78,856	145,309
Junin	23,347	209,871	394,393
Ica	8,718	60,111	90,962
Ayacucho	18,185	142,205	302,469
Cuzco	156,270	238,445	438,646
Puno	41,198	256,594	537,345
Arequipa	21,947	160,282	229,007
Moquegua	5,549	28,786	42,694
Apurimac	8,187	119,246	177,387
Lambayeque	4,614	85,984	124,091
Tacna	12,590	36,009	50,449
Total	695,733	2,657,853	4,609,999

Of the total population in the republic, 57 per cent. are estimated to be aborigines; 23 per cent. of mixed blood, white and Indian, or negro and Indian; the remaining 20 per cent. are the descendants of Spaniards, some 6000 to 8000 Europeans, 15,000 Chinese, and 800 Japanese. No accurate data concerning the movement of population throughout the various departments are collected by the national authorities, but the prevalent opinion is that little change has taken place in the number of inhabitants, any increase from births being counterbalanced by the heavy infantile mortality and the effects of alcoholism amongst adults. The immigration to Peru from Europe or elsewhere is on a very small scale, but no official statistics are kept. The number of Chinese is rapidly decreasing, there being a high death-rate and no immigration. The population of the city of Lima in 1897 was 100,144 (48,728 males and 51,416 females). In 1898 the number of marriages in the city was 405; births, 3885 (illegitimate, 2023); deaths, 4213. The population of the city of Callao, which in 1880 was 35,000, is now stated to be 48,118; that of Arequipa, 35,000; and of Cuzco, 30,000.

In Peru the Spanish spoken by the educated classes, though they have a strain of Indian blood, is less corrupted than in most of the South American republics. The Peruvians are, as a rule, courteous and hospitable, proud in spite of their poverty, and patriotic in disputes with foreign powers. The Roman Catholic Church still holds great power amongst them, although its political influence is not so apparent as in former days. Amongst the Indians, the great bulk of the inhabitants, civilization has made comparatively little progress. They have, with the exception of a few remote tribes, adopted Christianity, but in other respects they retain the habits of life practised by their Inca forefathers. Away from the principal towns they live by cultivating small patches of ground, spinning by hand the cloth they need for their simple dress and household purposes, and tending flocks of alpacas and llamas; they are content to acknowledge the authority of the locality. In many districts little Spanish is understood, in some none at all. The inhabitants of the higher valleys possess great power of endurance, and travel long distances over mountainous country with only coca leaf and the barest modicum of food for sustenance. Unfortunately, drunkenness is a common vice in the interior, and is increasing.

National character.

The political constitution is that of 1860. The legislative power is vested in a Senate of 48 members and Chamber of Deputies of 108 members. Members of both houses are chosen for six years, by indirect popular election, in such manner that one-third of the number retire every two years. The executive power is vested in a President, elected by popular vote for four years; with him are elected two Vice-Presidents. The retiring President cannot be elected for the next presidential term. There are six ministers of state—the heads of the departments of foreign relations; justice, worship, and public instruction; the interior and police; war and navy; finance and commerce; public works, industry and internal development.

Government.

Local Government.—The executive power is represented in each of the eighteen departments by a prefect, in each province by a sub-prefect, in each district by a governor, and in each town by a lieutenant-governor. The prefects and sub-prefects are appointed by the President of the Republic, the governors by the prefects, and the lieutenant-governors by the sub-prefects. Each department is governed by a junta or council elected by the provincial councils, each consisting of twelve or sixteen members, according to its importance, and of forty members in the case of Lima. The smaller town districts are under district councils of three members, one chosen by the people and two by the provincial council.

By the constitution the Roman Catholic religion is the religion of the State, and the public exercise of any other is prohibited. Practically, however, there is a certain amount of toleration, and there are Anglican churches and mission schools in Callao and Lima. The marriage disabilities of non-Catholics were modified by an Act of 1897 and by a presidential decree published in May 1899.

Religion and education.

Primary instruction is in charge of the municipal authorities, and though it is nominally compulsory between the ages of five and fifteen, little more than 10 per cent. of the children of school age are under instruction. In 1898 there were 1456 primary schools, with 1618 teachers and an attendance of 60,732. Of the schools, 1152 were official and 304 were private. Of the teachers, 349 were men and 450 were women certificated, while 799 were assistants. Of the children, 39,547 were boys and 21,185 were girls. The expenditure on primary education in 1897 was 476,889 soles, equivalent to about £47,000, equal to 9 soles 78 centavos for each pupil attending the public schools. There is a normal school for the training of women teachers, founded in 1878, and upon which the Government expended 118,560 soles between 1878 and 1897. For secondary education there are twenty-three national colleges in different parts of the republic, twenty-two being for the instruction of boys, and one at Cuzco for girls. In 1897 the number of students at these colleges was 1984, and the average attendance 1403, of whom 1186 passed satisfactory examinations. The number of their teachers was 163. The expenditure on the twenty-three colleges was 186,045 soles (£18,604), equal to 156 soles 86 centavos or about £15 for each student passing the examinations. For higher education there are four universities, at Lima, Arequipa, Cuzco, and Trujillo, granting degrees in theology, law, medicine, science, and literature. In 1897 there were 792 students, of whom 519 passed the requisite tests. The revenues of the four universities in the same year amounted to £20,670, and their expenditure to £20,770. Lima has a school of mines and civil engineering, and there are also military and naval schools. There is a free library in the capital, in addition to one at the university and another at the school of mines. In several of the larger towns there are high schools under the direction of English and German teachers.

Justice is administered by the Supreme Court at Lima, and by superior and minor courts in nine judicial districts. Complaints against the administration of justice, both civil and criminal, are frequently made. On 1st July 1899 the police force consisted of 1152 officers and men of the civil guard, and 1266 officers and men of the mounted gendarmerie.

Justice.

There are in Peru forty-eight charitable societies, formed chiefly for the support of thirty public hospitals within the republic. Their revenues are derived chiefly from lotteries. There is but one national lunatic asylum. There are French, Italian, and Chinese hospitals. Floating hospitals have been authorized at Callao.

Charity.

The army, as fixed by the budget voted in 1899, consists of six battalions of infantry, with a strength of 1940 men; two regiments of cavalry containing 250 men each; four squadrons of 125 men to furnish the presidential escort; and a regiment of mountain artillery of 510 men. Since 1896 a preparatory school has been established for the education of officers for the army and navy, and a military school has been founded at Chorrillos for the instruction of officers and non-commissioned officers of the army. This institution is under the supervision of instructors from the French army, sent out at the request of the Peruvian Government. The small-arm in use is the Männlicher rifle. The Peruvian navy consists of the cruisers *Lima* and *Constitution;* and the transports *Santa Rosa* and *Chalaco*. There are also some smaller vessels, of little practical value for defence.

Defence.

The revenue and expenditure, which, before the outbreak of the war with Chile in 1891, amounted each to about 15,000,000 soles (or £1,500,000) annually, have been as follows in recent years (the sole being taken at the uniform rate of 2 shillings):—

Finance.

Years.	Revenue.	Expenditure.
1887	£525,380	£492,490
1897	1,053,990	1,114,570
1900	1,311,987	1,272,990

For 1900 the sources of revenue and the branches of expenditure were as follows (10 soles = £1):—

Revenue.		Expenditure.	
Customs . .	£741,291	Finance . .	£333,541
Taxes . .	471,982	Army, navy .	304,366
Posts . .	28,144	Government .	378,969
Telegraphs .	5,215	Justice, &c. .	115,429
Various . .	65,355	Various . .	140,685
Total .	£1,311,987	Total .	£1,272,990

The revenue is derived mainly from customs and internal taxes on alcohol, tobacco, opium, and stamps. These taxes have been farmed out since 1896; and a new contract was made in 1900 with a syndicate specially formed for the purpose. Of the total amount collected, the syndicate retains £60,000 for the expenses of collection; of the balance, 94 per cent. goes to the Government and 6 per cent. to the syndicate. Other sources of revenue are a tax on real property and another on mining. The proceeds of the salt monopoly are, by law of 1896, set apart for the redemption of Tacna. The foreign debt, contracted in 1870 and 1872, amounted to £31,580,000, but on this amount no interest was paid after 1876. In 1889 the arrears had accumulated to £23,000,000, and in January 1890 the Government entered into an agreement with the bondholders whereby it was released from all responsibility for the loans. To the bondholders were ceded the State railways for sixty-six years, the remaining guano deposits, and certain mines and lands. The Government agreed to pay them for thirty-three years an annual subsidy of £80,000, secured on the Callao customs; while they undertook, among other responsibilities, the extension and improvement of the railway system. For the purpose of carrying out the terms of this contract a company, called the Peruvian Corporation, was constituted in 1890, the bondholders becoming stockholders in the company on exchanging their bonds for shares. (See below.)

The outstanding internal debt in 1899 consisted of:—

Description.	Soles.
Interest-bearing funded debt . . .	26,606,645
Non-interest-bearing debt	7,500,000
Floating debt	5,000,000
Miscellaneous claims on the treasury . .	9,500,000
Total . . .	48,606,645
	= £4,850,000

The rate of interest paid on the funded debt is 1 per cent. per annum, and the stock is quoted at 7 to 8 per cent. of the nominal value. The non-interest-bearing debt is amortized by tender by law at the rate of 20,000 soles monthly, but this provision has not been regularly attended to. This stock was quoted in 1899 at 3 to 4 per cent. of the nominal value.

Sugar-growing and manufacture have been important for many years, and a considerable extension of the industry took place during the period 1888 to 1898, so that in 1899 the area planted with cane exceeded 160,000 acres. In 1871 the sugar available for export was 4500 tons; in 1881, 80,000 tons; in 1891, 41,400 tons; and in 1901, 110,000 tons. The home consumption of sugar is estimated at 20,000 tons annually. The climate is exceptionally favourable

Industrial development.

for the sugar-planting industry, the labour difficulty being the great hindrance to a more rapid extension. The number of Chinese coolies employed on the plantations is rapidly diminishing; Japanese have been tried, but have proved deficient in strength, and they suffered severely from the climate. The sugar exports to Great Britain in three years were, in tons: 1898, 43,000; 1899, 21,200; 1900, 15,700; to the United States the quantities were: 1898, 14,200; 1899, 38,400; 1900, 57,800. The total value of sugar exported in 1899 was £1,010,351; in 1900, £1,455,842. Next in importance to sugar amongst agricultural products is cotton, both the fibre and seed being exported. The cotton grown in the department of Piura, where extensive works for irrigation are in progress, is of exceptionally good quality. The production was as follows during the specified years:—

Year.	Cotton Fibre.		Cotton Seed.	
	Quantity.	Value.	Quantity.	Value.
	Tons.	£	Tons.	£
1891	4765	105,800	1,695	15,610
1892	9837	322,520	11,378	22,760
1898	6712	247,000	3,322	9,970

In 1899 the exports of cotton fibre amounted to the value of £178,747; in 1900, £326,074. In 1898 the shipments of cotton-seed cake amounted to 1469 tons, valued at £2344. Four-fifths of the total cotton products exported are shipped to Great Britain. The production of rice shows a steady increase. In 1891, 1259 tons, valued at £15,000, were exported; in 1898 it was 4295 tons, valued at £63,350. The shipments of coca-leaf were 128 tons in 1891, 818 tons in 1896, and 406 tons in 1898. Cocoina to the amount of 9590 ℔, worth £65,200, was exported in 1898. In the same year cochineal to the value of £710 was exported, as compared with £3210 in 1896. For the cultivation of coffee many new plantations were formed a few years ago in the Chanchamayo, Pérené, and Paucartambo districts of central Peru. For this purpose the Peruvian Corporation granted land on easy terms, and lent other assistance to settlers, the Government also offering facilities to European immigrants. The result was an increase in production from 191 tons in 1891 to 1215 tons in 1899. Unfortunately, owing to the heavy cost of transport, the scarcity of labour, and the fall in the price of coffee, these enterprises have proved unsuccessful, and the plantations are being abandoned. The cultivation of cacao shows a marked increase. In 1891 the amount exported was 17 tons; in 1898 it reached 618 tons, valued at £34,840. But this industry is hindered by difficulties similar to those which have checked the development of coffee cultivation. The rubber industry promises an important development in the near future. The rubber trees are principally found near the affluents of the Amazon, extending from Iquitos southwards to the rivers Beni, Madre de Dios, and Madeira. Accurate information concerning the quantity collected cannot be obtained, as the greater portion of the product is conveyed to Brazilian ports and shipped as Brazilian. The export from Iquitos, by way of the Amazon, in 1884 was 540 tons; in 1894, 1294 tons; and in 1898, 1525 tons. Pastoral industry is confined to breeding cattle for home consumption, horses for local use, sheep and alpacas for food and wool, llamas for transport purposes, goats for skins and meat, and vicuñas for the hair and hides. No official statistics have been compiled in regard to the number of cattle; the supply is, however, barely sufficient to meet the local demand. The exportation of hides in 1898 was 2127 tons, valued at £83,110. In 1896 the shipments of wool were:—sheep wool, 2,698,000 ℔; alpaca, 2,888,000 ℔; vicuña, 9200 ℔. In the same year 559,000 ℔ of vicuña skins and 677,000 ℔ of goat skins were exported. In 1898 the total amount of all wools exported was 7,674,900 ℔, valued at £308,260. The home consumption of native wools is considerable, the Indian population making the bulk of the cloth they need for the ponchos and other rough clothing for general use in the interior. The principal centres of the wool industry are Arequipa and Cuzco. In the coast provinces there are extensive areas of extremely fertile land, which might be made available for agriculture by irrigation. For instance, in the provinces of Tumbes, Nepena, and elsewhere vast networks of old irrigation canals, made before the Spanish conquest, prove that irrigation was extensively employed by the inhabitants in the time of the Incas. And at the present day the little valley of Chicama, to the north of Trujillo, in which irrigation is to some extent practised, is a standing illustration of the fertility of these coast-lands when properly watered; there, 25,000 acres produce a crop of more than 40,000 tons of sugar annually.

Mining has made substantial progress, partly owing to comparative freedom from revolutionary disturbances, and partly in consequence of the rise in the price of copper. The total mineral output of the republic in 1900 was 32,929 tons, valued at £1,695,055. The Cerro de Pasco copper mines, which have been developed only since 1897, yielded in 1900, 5040 tons of bar copper and 11,700 tons of copper ore, the metal being carried a distance of 65 miles on llamas or donkeys to reach the nearest point of railway communication with the seaboard. Silver is found in greatest abundance in the maritime Andes, especially in the valleys of the Rio Santa, near Carhuaz, Huaraz, and Recuay. Cerro de Pasco is a great mining district, with over 360 silver mines open and at work. Farther south, at Yauli, there are 225 silver mines in operation. Still farther south, in the province of Huarochiri, there are 117; in Huancavelica and Castro Vireyna, 54; in Caylloma, 24; at Puno, over 50.

The official returns of precious metals and mineral ores exported in 1898 and 1899 are:—

Description.	1898. Value in Soles.	1899. Value in Soles.
Silver in bars and piña and mineral ores	9,481,213	10,667,010
Coined silver	482,365	379,940
Worked silver	439,807	11,160
Gold in coin and bars	41,500	6,460
Total	10,444,885	11,064,570
	=£1,044,490	=£1,106,450

The output of copper and copper ores in 1900 was valued at £619,260. Discoveries of rich quartz and placer mines in the Sandia and Carabaya districts occurred in 1896, and attempts were made to work these fields. The natural obstacles of climate and difficulties of transport have as yet prevented any great development in this direction. Deposits of borax, discovered in 1892 about 45 miles south-east of Arequipa, are worked by a British company, which exported in 1897, 11,850 tons, valued at £94,800; and in 1898, 7177 tons, valued at £57,420. Recent explorations have demonstrated that extensive beds of anthracite and bituminous coal exist in the province of Hualgayoc. Coal is found also in the districts of Huamachuco and Cerro de Pasco, where it is used for the mining establishments. Petroleum is found in considerable quantities in the department of Piura. The oil is extracted at Negritos, 6½ miles south-east of Talara. Some of the wells have been sunk to a depth of 900 feet. The kerosene is consumed in Peru, and a considerable quantity of crude oil is used as fuel by factories and other industrial undertakings.

Manufacturing industries are carried on on a small scale. "Panama" straw hats are made especially in the neighbourhood of Payta and Piura, but this industry is declining. In 1897 hats were exported to the value of £16,700; in 1898, of £10,600. About 2,000,000 gallons of spirits are produced annually from sugar-cane. Other manufactures (cotton, woollen, matches, soap, beer, cigars, &c.) have only local interest.

Commerce.—The foreign trade from 1891 to 1900 was as follows (10 soles=£1):—

Year.	Imports.	Exports.
1891	£1,700,133	£1,665,705
1894	1,174,470	1,495,860
1899	2,123,020	3,361,530
1900	2,317,000	4,498,000

In 1899 the chief imports and exports were:—

Imports.		Exports.	
Haberdashery	£798,860	Minerals	£1,066,700
Cottons	377,030	Sugar	1,010,350
Woollens	145,140	Wool	311,810
Furniture, &c.	132,450	Cotton	178,750
Provisions	238,100	Coffee	48,410
Drugs, &c.	92,770	Borax	61,100
Wines, &c.	36,590	Hides	78,340
		Cocaine	67,510

Of the imports in 1900, 46 per cent. were from Great Britain, 16 per cent. from Germany, 13 per cent. from the United States, and 4 per cent. from Chile. Of the exports, 47 per cent. went to Great Britain, 21 per cent. to the United States, 13 per cent. to Chile, and 11 per cent. to Germany.

Shipping.

The sea-borne trade passes mainly through the port of Callao. In 1901, 531 vessels of 755,461 tons entered and 537 of 753,334 tons cleared at that port. Of those entered, 232 of 393,483 tons, and of those cleared 233 of 393,358 tons were British. There entered also 959 small vessels aggregating 12,697 tons, and cleared 952 aggregating 12,951 tons. The ports of Peru are visited regularly by the vessels of the Pacific Steam Navigation Company, and by those of the Chilian Compañia Sud Americana de Vapores. The German "Kosmos" Company, and the "Gulf Line," a Glasgow company, also maintain communication with the Peruvian ports, and another line connects Callao with New York *viâ* Magellan Strait. In 1900 the merchant vessels belonging to Peru were 5 steamers of altogether 4253 tons, and 57 sailing vessels of 24,295 tons.

Roads are badly needed throughout the interior, although the Government is devoting some attention and money to the subject. Since 1896 communication has been opened up through the valley of Chanchamayo, by way of the river Pichis, to Puerto Bermudez, and thence to Iquitos by steamer. But "as a matter of fact it is still easier to reach Iquitos *viâ* New York and Pará, or *viâ* the Strait of Magellan and Pará, than by going across country."[1] A serviceable cart-road has also been made between Sicuani and Cuzco, through the productive provinces of Canchis and Quispicanchis. The total length of railways open to traffic in 1899 was 971 miles, the majority of the lines being held by the Peruvian Corporation. In 1899 there were within the republic 339 post offices, and the postal movement comprised the transmission of 7,481,207 letters and post-cards in the internal service and 1,830,649 in the external. The post office receipts amounted to £80,625, and the expenses to £80,150. The telegraph system in 1899 extended 2037 miles, of which 1438 with 52 offices were under the administration of the Government, and 599 miles in the hands of the Peruvian Corporation. Peru is placed in communication with the outside world by the submarine cables of the Central and South American Company and the West Coast of America Company. The length of telephone wires erected was 3000 miles in 1900, offices being established in all the principal towns for telephonic service in the vicinity.

Communications.

There are four commercial banks in Peru, with paid-up capital and reserve funds amounting in the aggregate to £568,560. A savings bank has also been established, with a paid-up capital of 96,070 soles; the deposits on 31st December 1900 amounted to 1,504,422 soles. The customary rate of interest for loans is 8 per cent. per annum on sound securities. For several years the currency was based on the value of the silver sol, 25 grammes in weight, and ·900 fine. By decree of 9th April 1897 the free coinage of silver was suspended, and the reimportation of Peruvian silver money was prohibited. On 11th December 1897 it was enacted that, pending the coinage of Peruvian gold, customs duties were payable in gold at the rate of 10 soles to £1 sterling in gold coin or in silver, with a surcharge to equal the difference in value. On 29th December 1897 a decree was issued authorizing the coinage of Peruvian gold pieces of 10 soles of the same weight and fineness as the £ sterling. A decree on 10th January 1898 described the new gold coin as 22 millimetres in diameter, ·916 fine, weighing 988 milligrammes, and containing 2 milligrammes of alloy. The name of libra is given to these pieces. The value of Peruvian gold coins minted, 1898–1901, was £218,726. In 1900–01 the rate of exchange was about 10 soles 20 cents. to the libra. The silver coins in circulation are the sol (actual value about 2s.); half-sol = 50 cents.; peseta = 20 cents.; real = 10 cents.; and half-real = 5 cents. There are also current copper coins for values of less than 5 cents. The French metric system is the official standard of weights and measures, but is not in general use. The ounce, 1·104 oz. avoirdupois; the libra, 1·014 ℔ avoirdupois; the quintal, 101·44 ℔ avoirdupois; the arroba, 25·36 ℔ avoirdupois, and of wine, 6·70 imperial gallons; the gallon, ·74 of an imperial gallon; the vara, ·927 yard; and the square vara, ·859 square yard, are all commonly employed.

Money and credit.

As a result of the Grace-Donoughmore contract with the Peruvian Government, the Peruvian Corporation was constituted in 1890 with the following capital:—ordinary shares, £9,000,000; 4 per cent. preference shares, £7,500,000, and power to issue £6,000,000 in 6 per cent. debentures: of the latter, a sum of £3,700,000 has been issued to provide working capital, to cover costs of railway extension, and to settle certain outstanding claims. The Peruvian Government found that the national resources were unequal to the payment of the annual subsidy of £80,000, and in 1893 the amount was reduced to £60,000, and shortly afterwards the payments ceased altogether. In consequence of the failure of the Government to meet its obligations, the Corporation was unable to build an additional 100 miles of railway agreed to in the original contract. The Government is also heavily indebted to the Corporation for the transport of troops and other expenses, and has no funds to discharge these liabilities. The revenues of the Corporation are derived from the earnings of the railways, the steamer traffic on Lake Titicaca, the transport of freight on the river Desaguadero, the sales of guano, and some other small incidental items. The net earnings in 1900–01 were £204,189. In 1896 the interest on the debentures was temporarily reduced to 3 per cent. per annum, higher rates of interest to be paid as the earnings of the Corporation permitted. The Corporation has spent large sums of money in the endeavour to colonize the land conceded to it in the Pérené district, but without achieving satisfactory results. Considerable shipments of guano have been made of recent years, the net income in 1900–01 being £57,441, but the deposits in possession of the Corporation are rapidly becoming exhausted. The hope of the Corporation lies in the development of traffic in the mineral districts and for this an extension of the existing railway system is necessary, especially in connexion with the Central Railway. The Peruvian Government dispute the right of the Corporation to work the mineral deposits at Cerro de Pasco, on the ground that the privilege originally conceded has now lapsed.

The Peruvian Corporation.

[1] *Brit. Cons. Report for 1899–1900*, p. 20 (No. 2639).

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(W. W. R.; I. P. A. R.; C. E. A.)

Political History since 1880.—The victory of the Chilians over the combined forces of Peru and Bolivia at Tacna on 7th June 1880 marked the close of the second stage of the war which had broken out in April of 1879. In November 1880 the Chilians began to make preparations for the landing of an army to attack the Peruvian capital. A force of 25,000 men was concentrated at Tacna and Arica under the command of General Baquedano. These troops were embarked on transports and convoyed by Chilian warships to a point a little to the south of Callao, there disembarking on 21st December 1880. The Peruvians, meanwhile, had not been idle. After the crushing defeat at Arica, every effort was made to put Lima in an effectual state of defence. Under the direction of Señor Nicolas de Pierola, who had assumed dictatorial powers after the departure of General Prado to Europe, all the remaining strength of Peru was organized for resistance. The military command was confided to General Andrés Cáceres. Two lines of defence were planned to intercept the advance of the enemy from the seaboard, trenches being dug, the mud walls dividing the various farms loopholed, artillery mounted on all commanding positions, and large supplies of ammunition and stores collected to enable the defenders to sustain a lengthy siege. The Peruvian army at this juncture numbered 26,000 men of the line and 18,000 in the reserves. The defensive measures inspired great confidence, both Señor Pierola and General Cáceres considering the position of Lima practically impregnable. At daybreak on 13th January 1881 the Chilian attack began, and the action soon became general throughout the whole length of the Peruvian first line of defence. The Chilian troops carried the trenches at the point of the bayonet after repeated charges, and at mid-day the defenders were forced to fall back upon the second line of fortifications. In this engagement, known as the battle of Chorrillos, the Chilian loss was 800 killed and 2500 wounded; the Peruvian 5000 killed, 4000 wounded, and 2000 prisoners. On the following day an attempt was made by the diplomatic representatives of foreign Governments in Lima to negotiate peace, but it proved abortive. On 15th January at 2 P.M. the final struggle of the war, known as the battle of Miraflores, commenced, and continued for some four hours. The Chilians were again victorious, and carried the second line of defence, this success placing Lima completely at their mercy. When the fate of the day was no longer in doubt, Señor Pierola, General Cáceres, and such officers as could escape retired to the interior for the purpose of endeavouring to organize further resistance in the mountain districts. At the battle of Miraflores the Chilian losses were 500 killed and 1625 wounded, the Peruvian 3000, including killed and wounded. On 17th January a division of 4000 Chilian troops under command of General Saavedra entered Lima under instructions from the Chilian commander-in-chief to occupy the city and restore order within the municipal limits.

Desultory fighting was now maintained by the remnants of the Peruvian army in the interior, under direction of General Cáceres, against Chilian authority. An attempt was made to constitute a Government with Señor Calderon as President of the Republic and General Cáceres as first Vice-President. The negotiations between this nominal administration and the Chilian authorities for a treaty of peace proved futile, the Chilian occupation of Lima and the Peruvian seaboard continuing uninterruptedly until 1883. In that year Admiral Lynch, who had replaced General Baquedano in command of the Chilian forces after the taking of Lima, sent an expedition against the Peruvians under General Cáceres, and defeated the latter in the month of August. The Chilian authorities now began preparations for the evacuation of Lima, and to enable this measure to be effected a Peruvian administration was organized with the support of the Chilians. General Iglesias was nominated to the office of President of the Republic, and in October 1883 a treaty of peace, known as the treaty of Ancon, between Peru and Chile was signed. The army of occupation was withdrawn from Lima on 22nd October 1883, but a strong Chilian force was maintained at Chorrillos until July 1884, when the terms of the treaty were finally approved. The principal conditions imposed by Chile were the absolute cession by Peru of the province of Tarapacá, and the occupation for a period of ten years of the territories of Tacna and Arica, the ownership of these districts to be decided by a popular vote of the inhabitants of Tacna and Arica at the expiration of the period named. A further condition was enacted that an indemnity of 10,000,000 soles was to be paid by the country finally remaining in possession—a sum equal to about £1,000,000 to-day. The Peruvians in the interior refused to recognize the validity of the nomination of President Iglesias, and at once began active operations to overthrow his authority on the final departure of the Chilian troops. A series of skirmishes now took place between the men in the country under Cáceres and the supporters of the administration in Lima. Affairs continued in this unsettled state until the middle of 1885, Cáceres meanwhile steadily gaining many adherents to his side of the quarrel. In the latter part of 1885 President Iglesias found his position, after some severe fighting in Lima, impossible, and he abdicated his office, leaving the field clear for Cáceres and his friends to assume the administration of public affairs. Under the guidance of General Cáceres a *junta* was then formed to carry on the government until an election for the Presidency should be held and the Senate and Chamber of Deputies constituted. In the following year (1886) General Cáceres was elected President of the Republic for the usual term of four years. The task assumed by the new President was no sinecure. The disasters suffered in the war with Chile had thrown the country into absolute confusion from a political and administrative point of view. Gradually, however, order in the official departments was restored, and peaceful conditions were reconstituted throughout the republic.

The four years of office for which General Cáceres was elected passed in uneventful fashion, and in 1890 Señor Morales Bermudez was nominated to the Presidency, with Señor Solar and Señor Borgoño as first and second Vice-Presidents. Matters continued without alteration from the normal course until 1894, and in that year President Bermudez died suddenly a few months before the expiration of the period for which he had been chosen as President. General Cáceres, who was the power behind the scenes, brought influence to bear to secure the nomination of Vice-President Borgoño to act as chief of the executive for the unexpired portion of the term of the late President Bermudez. This action in regard to the nomination of Señor Borgoño was illegal and unconstitutional, and was bitterly resented by Vice-President Solar, who by right should have succeeded to the office. Armed resistance to the authority of President Borgoño was immediately organized in the south of Peru, the movement being supported by Señores Nicolas de Pierola, Billinghurst, Durand, and a number of influential Peruvians. In the month of August 1894 General Cáceres was again elected to fill the office of President, but the revolutionary movement set afoot against President Borgoño was continued against his successor, and rapidly gained ground. President Cáceres adopted energetic measures to suppress the outbreak: his efforts, however, proved unavailing, the close of 1894 finding the country districts in the power of the rebels and the authority of the legal Government confined to Lima and other principal cities held by strong garrisons. A concentration of the revolutionary forces was now made upon the city of Lima, and early in March 1895 the insurgents encamped near the outskirts of the town. On 17th, 18th, and 19th March severe fighting took place, ending in the defeat of the troops under General Cáceres. A suspension of hostilities was then brought about by the efforts of H.B.M. consul, Mr St John. The loss on both sides to the struggle during these two days was 2800 between killed and wounded. President Cáceres, finding his cause was lost, left the country, a provisional Government under Señor Candamo assuming the direction of public affairs. On 8th September 1895 Señor Pierola was declared to be duly elected as President of the Republic for the following four years. The Peruvians were now heartily tired of revolutionary disturbances, and the administration of President Pierola promised to be peaceful and advantageous to the country. In these circumstances it is not surprising that an insurrectionary outbreak in the district of Iquitos met with small sympathy, and was speedily crushed. In 1896 a reform of the electoral law was sanctioned. By the provisions of this Act an electoral committee was constituted, composed of nine members, two of these nominated by the Senate, two by the Chamber of Deputies, four by the Supreme Court, and one by the President with the consent of his ministers. To this committee was entrusted the task of the examination of all election returns, and of the proclamation of the names of successful candidates for seats in Congress. Another reform brought about by President Pierola was a measure introduced and sanctioned in 1897 for a modification of the marriage laws. Under the new Act marriages of non-Catholics solemnized by diplomatic or consular officers or by ministers of dissenting churches, if properly registered, are valid, and those solemnized before the passing of this Act were to be valid if registered before the end of 1899. Revolutionary troubles again disturbed the country in 1899, when the Presidency of Señor Pierola was drawing to a close. In consequence of dissensions amongst the members of the election committee constituted by the Act of 1896, the President ordered the suppression of this body. Seizing on this action as a pretext, a group of malcontents under the leadership of one Durand, a man who had been prominent in the revolution against General

Cáceres in 1894–95, conspired against the authorities and raised several armed bands, known locally as *montaneras*. Some skirmishes occurred between these insurgents and the Government troops, the latter generally obtaining the advantage in these encounters. In 1899 several of these armed bands were still at large in the mountainous districts, but they were not regarded as formidable antagonists by the authorities, nor was any great sympathy extended to them by the rural population. In September 1899 President Pierola vacated the Presidency in favour of Señor Romaña, who had been elected to the office as a popular candidate and without the exercise of any undue official influence. President Romaña was educated at Stonyhurst, in England, and was a civil engineer by profession. He was credited with the desire to help on the development of Peru without any political ambitions to serve either on his own behalf or on that of his friends.

The principal political problem before the Government of Peru at the opening of the 20th century was the question with Chile of the ownership of the territories of Tacna and Arica. The period of ten years originally agreed upon for the Chilian occupation of these provinces expired in 1894. At that date the peace of Peru was so seriously disturbed by internal troubles that the Government was quite unable to take active steps to bring about any solution of the matter. Since 1894 negotiations between the two Governments have been attempted from time to time, but without any satisfactory results. The question hinges to a great extent on the qualification necessary for the inhabitants to vote, in the event of a plebiscite being called to decide whether Chilian ownership be finally established, or the provinces revert to Peruvian sovereignty. Peru has proposed that only Peruvian residents shall be entitled to take part in a popular vote; Chile rejects this proposition, on the ground that all residents in the territories in question shall have a voice in the final decision. The agreement between Chile and Bolivia, by which the disputed provinces are to be handed over to the latter country if Chilian possession be recognized, is also a stumbling-block, a strong feeling existing among Peruvians against this proceeding. It is not so much the value of Tacna and Arica that makes the present difficulties in the way of a settlement as it is that the national pride of the Peruvians ill brooks the idea of permanently losing all claim to this section of country. The money, about £1,000,000, could probably be obtained to indemnify Chile if occasion for it arose.

The question of the delimitation of the frontier between Peru and the neighbouring republics of Ecuador, Colombia, and Brazil has also cropped up at intervals. A treaty was signed with Brazil as far back as 1876, by which certain physical features were accepted by both countries as the basis for the boundary, but nothing has been accomplished towards definitely surveying the proposed line of limits. In the case of Ecuador and Colombia a dispute arose in 1894 concerning the ownership of large tracts of uninhabited country in the vicinity of the head-waters of the Amazon and its tributaries. An agreement was proposed between Peru and Ecuador in connexion with the limits of the respective republics, but difficulties were created to prevent this proposal from becoming an accomplished fact by the pretensions put forward by Colombia. The latter state claimed sovereignty over the Napo and Marañon rivers on the grounds of the ecclesiastical jurisdiction exercised over this section of territory during the period of Spanish dominion, the Government of Colombia pretending that these ecclesiastical rights to which Colombia became entitled after her separation from the Spanish Crown carried also the right of absolute ownership. In a treaty signed by the three interested states in 1895 a compromise was effected by which Colombia withdrew a part of the claim advanced, and it was agreed that any further differences arising out of this frontier question should be submitted to the arbitration of the Spanish Crown. The boundaries had in 1902 not yet been surveyed. (C. E. A.)

Peru, a city of Lasalle county, Illinois, U.S.A., on the north bank of the Illinois river, and on the Chicago, Burlington, and Quincy and the Chicago, Rock Island, and Pacific railways, north of the centre of the state, at an altitude of 462 feet. It is built on the face and top of the river bluffs, with a regular plan, and is divided into five wards. It is in an agricultural and coal-mining region, and has large trade and varied manufactures. Population (1890), 5550; (1900), 6863, of whom 2095 were foreign-born.

Peru, a city of Indiana, U.S.A., capital of Miami county, on the Wabash river, the Wabash and Erie canal, and the Wabash and the Lake Erie and Western railways, north of the centre of the state, at an altitude of 649 feet. It is in an agricultural region, has considerable trade, and contains varied manufactures. Population (1880), 5280; (1890), 7028; (1900), 8463, of whom 737 were foreign-born and 67 negroes.

Pesaro, a town, episcopal see, and capital of the province of Pesaro and Urbino, the Marches, Italy, on the Adriatic coast, 37 miles by rail north-west of Ancona. The house in which Rossini was born now contains collections of paintings, pottery, and furniture. The Rocca Costanza is now used as a prison. Pesaro possesses a technical institute, an agricultural school, a school of the industrial arts, and a meteorological observatory; also a monument (1896) to the statesman and author, Mamiani delle Rovere (1799–1885), and a statue to Garibaldi (1891). The Foglia is crossed by an ancient Roman bridge. Pesaro is famous for its figs. Population (1881), 13,943; (1901), 25,115.

Pescadores.—A group of islands (called by the Japanese *Hôko tô*, or *Hôko Guntô*), lying 30 miles westward of Formosa, between 23° and 24° N. Flat and with unproductive soil, they are swept during one half of the year by violent north-east winds, and also lie full in the path of the numerous typhoons that rush up the Gulf of Formosa. The anchorage is at Makyû (Japanese, *Makun*). The islands number 48, have a coast-line of 98·67 miles, a total area of 85·50 miles, and a population of 51,719. Meteorological observations taken by the Japanese during a period of three years show that the annual average of tempestuous days is 237.

Pesháwar, a city of British India, giving its name to a district and division of the Punjab, the capital of the North-West Frontier Province. The city is 1165 feet above the sea, near the left bank of the river Bara, 11 miles from Jamrud, at the entrance of the Khaibar Pass; the railway station is 1588 miles north-west of Calcutta. Population (1881), 79,982; (1891), 84,191; municipal income (1897–98), Rs.1,97,509; death-rate (1897), 27 per thousand. The city proper is surrounded by a mud wall with sixteen gates. The suburbs contain gardens stocked with fine fruit-trees. Two miles west lie the cantonments, which accommodate a strong force of all arms. Pesháwar is the depot for trade with Afghanistan and central Asia, and has manufactures of scarves and cutlery. The water-supply is derived from the river Bara. The station of the Church Mission is called after Sir Herbert Edwardes. There are four high schools, nine printing-presses, and Hindu and Mahommedan religious associations. In May 1898 there was a very destructive fire.

The district of PESHÁWAR has an area of 2444 square miles; population (1881), 592,674; (1891), 703,768; (1901), 786,406; showing an increase of 19 per cent. between 1881 and 1891, and of 11·7 per cent. between 1891 and 1901, the increase having been continuous since 1868; average density, 322 persons per square mile. The land revenue and rates in 1897–98 were Rs.11,43,287, the incidence of assessment being Rs.0:13:3 per acre; cultivated area, 697,020 acres, of which 405,290 were irrigated, including 155,066 from Government canals; number of police, 1117; number of schools (1896–97), 297, attended by 7401 boys, being 9·3 per cent. of the boys of school-going age; death-rate (1897), 22·9 per thousand. The principal crops are wheat, barley, maize, millet, oil-seeds, with a little cotton and sugar-cane. In 1897–98 the Swat river canal irrigated 138,557 acres, and the net profits were Rs.1,41,184, being 3·5 per cent. on a capital outlay of just Rs.40,00,000. The North-Western Railway crosses the district from Attock, with its terminus at Pesháwar city, 47 miles. The Indus is navigable for 146 miles.

The division of PESHÁWAR consists of the three frontier districts of Hazara, Pesháwar, and Kohat. Total area, 8206 square miles; population (1891), 1,423,231; (1901), 1,715,248, showing an increase of 20·5 per cent.; average density, 209 persons per square mile.

Pesth. See BUDAPEST.

Pĕtâni. See MALAY PENINSULA.

Peterborough, an ancient city and parliamentary and municipal borough of Northamptonshire, on the river Nene, 76 miles north of London by rail. The choir of the cathedral was reopened in 1889 after being closed, for thorough restoration, for six years. During 1888–89 the lantern tower was rebuilt, the north and south transepts were underpinned, and three columns repaired in the choir. During 1889–90 the internal masonry of the nave, aisles, and western transepts was cleaned, and in 1895 the restoration of the west front and other parts was commenced. Great care has been exercised in preserving the many interesting discoveries made during the carrying out of this work—the most important being the site of the cruciform Saxon church, enclosed within a crypt under the south transept. A public library was established in 1893. The school of art, science, and technology in the minster precincts consists of nine class-rooms and two workshops. Certain free studentships are offered annually by examination, and the students numbered in 1898 about 300. On the outskirts extensive brick-works have grown up, their forest of stalks forming a remarkable feature in the landscape. The soke, or liberty, of Peterborough was in 1888 declared a separate administrative county from the remainder of Northamptonshire. Except for parliamentary and militia purposes, it is entirely independent. Population (1881), 21,228; (1891), 25,171; (1901), 30,870.

Peterborough, a town and port of entry of Ontario, Canada, and capital of the county of the same name, situated 70 miles north-east of Toronto, on the Otonabee river and the Grand Trunk and Canadian Pacific railways. The five falls of the Otonabee at this point, with a total descent of 50 feet, furnish power for a large number of manufacturing establishments, whilst its canalization as part of the Trent canal will give communication with Lake Ontario and Georgian Bay. The most important buildings are the post office, custom-house, hospital, and Young Men's Christian Association building. It has an electric railway, and contains manufactories of electrical machinery and supplies, iron and steel bridges, and agricultural implements, saw, flour, and woollen mills, and pork-packing establishments. Exports for 1898–99 were valued at $616,972, and imports, $697,467. Population (1881), 6812; (1891), 9717; (1901), 11,239.

Peterhead, a seaport, market town, and parliamentary burgh (Elgin group) of Aberdeenshire, Scotland, 33 miles by road north-north-east of Aberdeen. The harbour comprises three basins covering an area of 21 acres. In 1888, 590 vessels of 63,802 tons entered; 540 vessels of 62,066 tons in 1898. Exports (mostly herrings) were valued at £259,040 in 1888 and £156,250 in 1898 (228,307 barrels). The value of the fish landed at the port in 1899 was £117,467. There are three trawling companies employing six trawlers, and a steam herring fishing company has been formed. The Arctic seal and whale fishing is extinct. The harbour of refuge has been under construction by convict labour since 1886. New police buildings have been erected. There is an academy with an elementary department. Population (1881), 10,922; (1891), 12,195; (1901), 11,763.

Petermann, August Heinrich (1822–1878), German cartographer, was born at Bleicherode, near Nordhausen, on 18th April 1822. At the age of seventeen he entered the Geographical School of Art in Potsdam, and in 1845 proceeded to Edinburgh to assist Dr Keith Johnston in the production of an English edition of the *Physical Atlas* of Berghaus. In 1847 he came to London, and during the next seven years published a large number of maps, including an atlas of physical geography (with Thomas Milner), and an account of Barth's expedition to Central Africa, 1855, besides contributing a number of geographical articles to the *Encyclopædia Britannica* which was then appearing. In 1854 he became director of the Geographical Institute of Julius Perthes in Gotha, and editor of its well-known *Mitteilungen*. His diligent research and careful delineation did much towards elucidating the geography of the interior of Africa and of the North Polar regions, and he drew up the plans, descriptions, and maps of all the German expeditions to Africa and to the Poles in his time. His merits as a scientific cartographer were universally recognized, and most of the geographical societies of the world numbered him among their honorary members. The University of Göttingen conferred an honorary degree upon him, and Queen Victoria, at the suggestion of Chevalier Bunsen, appointed him Physical Geographer-Royal. Dr Petermann died by his own hand at Gotha, 25th September 1878. (G. F. B.)

Peters, Karl (1856–——), German colonial administrator, was born at Neuhaus on the Elbe on 27th September 1856, being the son of a Lutheran clergyman. He studied at Göttingen, Tübingen, and Berlin, and in 1879 was awarded a gold medal by the Berlin University for his "Frieden zu Venedig" ("Peace of Venice, 1178"). After visiting London to study English principles of colonization, he returned to Berlin, and promoted the German Colonization Society (Deutsche Kolonialverein). In the autumn of 1884 he proceeded to East Africa, and concluded in the name of his society treaties with the chiefs of Useguha, Nguru, Usagara, and Ukami. Returning to Europe early in 1885, he undertook the management of the German East Africa Company, which had obtained an imperial charter. In 1888 he undertook an expedition from the east coast of Africa for the relief of Emin Pasha. He reached Victoria Nyanza in 1889 after great hardships, and learned of the departure of Emin with Stanley's expedition. Hearing of the hostilities between the Christians and Mahommedans in Uganda, he went to the assistance of King Mwanga, with whom he concluded treaties in favour of Germany. These treaties were, however, annulled by the Anglo-German Convention of July 1890. On his return to Germany Peters was received with great honours, and in 1891 published an account of his expedition entitled *Die deutsche Emin-Pasha-Expedition*, which was translated into English. In 1891 he went out to East Africa as Imperial High Commissioner, assisted in determining the Anglo-German boundary, and founded a German station on Kilimanjaro. Returning to Germany in the following year, he was employed in the Colonial Office from 1893 to 1895. In 1896 he removed to London, where he occupied himself in forming the Dr Karl Peters Estates and Exploration Company. The company, which was registered on 11th July 1898, was formed to prospect certain regions in Central and South-Eastern Africa, and to acquire the right to locate 500 mining shares in the British South Africa Company's territory, the same number in the Mozambique Company's territory, and also in the Zambezi Company's territory. In the interests of the company Peters explored the Fura district and Macombe's country on the Zambezi, where in 1899 he discovered ruins of ancient cities and deserted gold mines. On his return in 1901 he brought out an account of his explorations, and settled in London as managing director of the company for South Africa. Besides the books already mentioned, and some smaller treatises, Peters has published a philosophic work entitled *Willenswelt und Weltwille* (1883), and a disquisition on early gold production entitled *Das Goldene Ophir Salomos* (1895), translated into English in 1898.

Petersburg, a city of Virginia, U.S.A., on the right bank of the Appomattox river, 12 miles from its mouth, at the head of navigation and at the foot of the falls. It was formerly in Chesterfield, Dinwiddie, and Prince George counties, but is now independent of county government. It is well laid out on the sloping river bank, is divided into six wards, and has an excellent water-supply by pumping. It is on the Atlantic Coast line, the Seaboard Air line, and the Norfolk and Western railways. It has in the falls a fine water-power, which is largely utilized in manufactures. In 1890 the city contained 271 manufacturing establishments with a total capital of $3,911,240, employing 5525 hands, and with a total product of $7,167,004. The principal article of manufacture was tobacco, the value of which was $2,900,000; other prominent industries were canning and the making of cotton goods and flour-milling. Petersburg is the seat of the Southern Female College, a non-sectarian institution, which had in 1899 twelve instructors and 100 students. Population (1890), 22,680; (1900), 21,810, of whom 269 were foreign-born and 10,751 negroes.

Petit-Quevilly, Le, town, arrondissement of Rouen, department of Seine-Inférieure, France, 2½ miles south-west of Rouen by rail, on the Seine. The chapel of St Bruyères represents a leper hospital founded by Henry II. of England. The principal industries are cotton spinning and weaving, dyeing, and the manufacture of cables, gear for machinery, gutta-percha goods, chemicals, soap, cartridges and safety matches for mines. Population (1881), 7181; (1901), 13,885. The commune of Le Grand-Quevilly had in 1901 a population of 1939.

Petőfi, Alexander (1823–1849), the greatest lyric poet of Hungary, was born at Kis-Körösö, Pest county, on New Year's Day, 1823. The family received its diploma of nobility from the Emperor Leopold in 1688, but the ultra-patriotic Alexander early changed the old family name, Petrovics, which pointed to a Croatian origin, into the purely Magyar form of Petőfi. The lad's early days were spent at Félegyház and Szabadszállás, the most Hungarian parts of Hungary, where he got most of his early education, including a good grounding in Latin. German he learnt subsequently at Pesth, and French he taught himself. He began writing verses in his twelfth year, while a student at the Aszód gymnasium, where he also displayed a strong predilection for the stage, to the disgust of his rigorous father, who formally disowned his son, early in 1839, for some trifling peccadillo, and whose tyrannical temper became downright furious when a series of misfortunes ruined him utterly in 1840. For the next three years Petőfi led the wretched life of a strolling player, except for a brief interval when, to escape starvation, he enlisted as a common soldier in an infantry regiment. During the greater part of 1842 we find him a student at the Calvinist College at Pápá, where he made the acquaintance of young Jókai, and wrote the poem "Borozó," which the great critic Bajza at once inserted in the leading literary review, the *Athenæum*, 22nd May 1842. In November of the same year the restless poet quitted Pápá to join another travelling troupe, playing on one occasion the Fool in *King Lear*, and after wandering all over Hungary and suffering incredible hardships, finally settled down at Pesth (1844), where for a time he supported himself by all sorts of literary hack-work. Nevertheless, in the midst of his worst privations he had read voraciously, and was at this time profoundly influenced by the dominant Romanticism of the day; while, through Tieck, he learnt to know and value the works of Shakespeare. His first volume of original poems was published in 1844 by the Society Nemzeti Kör, through the influence of the poet Vörösmarty, when every publisher had refused his MS., and the seventy-five florins which he got for it had become a matter of life or death to him. He now became a regular contributor to the leading papers of Pest, and was reconciled to his parents, whom he practically supported for the rest of their lives out of his literary earnings. His position, if not exactly brilliant, was now at least secure. The little volume published by the Nemzeti Kör was followed by the parody, *A Helység Kalapácsa* (1844); the romantic epic, *János Vitéz* (1844); *Ciprislombok Etelké Sirjáról*, a collection of passionate elegies over his lost love, Etelké Csapó (1845); *Uti Jegyzetek*, an imitation of Heine's *Reisebilder* (1845); *Szerelem Gyöngyei* (1845); *Felhök* (1846); *Szerelme ès házassága* (1846), and many other volumes. The first edition of his collected poems appeared in 1847. Petőfi was not yet twenty-five, and, despite the protests of the classicists, who regarded him with something of the cold dislike with which the Scottish reviewers regarded the Lake School, the best heads in Hungary, poets like Vörösmarty and critics like Szemere, already paid him the homage due to the prince of Magyar lyrical poets. The great public was enthusiastic on the same side, and posterity, too, has placed him among the immortals. Petőfi is as simple and genuine a poet of nature as Wordsworth or Christian Winther, and his erotics, inspired throughout by a noble idealism, have all Byron's force and fervour, though it is perhaps in his martial songs that Petőfi's essentially passionate and defiant genius asserts itself most triumphantly. On 8th September 1847 Petőfi married Julia Szendrey, who bore him a son. When the revolutionary war broke out, he espoused the tenets of the extreme democratic faction with a heat and recklessness which estranged many of his friends. He took an active part in the Transylvanian campaigns of the heroic Bem; rose by sheer valour to the rank of major; was slain at the battle of Segesvár (31st July 1849), and his body, which was never recovered, is supposed to have been buried in the common grave of the fallen honveds in the churchyard of Fehéregyház. The first complete edition of Petőfi's poems appeared in 1874. The best critical edition is that of Haras, 1894. There are numerous indifferent German translations.

See Ferenczi. *Petőfi Életrajza.*—Fischer. *Petőfi's Leben und Werke.* (R. N. B.)

Petoskey, a city of Emmet county, Michigan, U.S.A. It is in the north-west part of the lower peninsula on Lake Michigan. It is entered by the Pere Marquette and the Grand Rapids and Indiana railways. Population (1890), 2872; (1900), 5285, of whom 856 were foreign-born and 24 negroes.

Petra, a ruined site, in 30° 19′ N. and 35° 31′ E., lying east of Wady-el-Arabah, the great valley running from the Dead Sea to the Gulf of Akabah. Access has been easy since the occupation of the plateau of Moab and Edom by Turkish troops, and a complete survey of the ruins and site of the ancient town has been made by Dr Brünnow. Petra was built in a basin in the "Nubian" sandstone through which the Wádi Músá brook runs—entering it by a deep, narrow gorge, the Sík, and leaving it by another of somewhat similar character. The Roman road running northwards from Petra, over the Edomite plateau, can be traced almost throughout, and the actual approach to the town is not nearly so difficult as travellers entering it by the Sík have supposed. Petra was occupied by Baldwin I. of Jerusalem, and formed the second fief of the barony of Krak, under the title Château de la Vallée de Moyse, or Sela—the territory being called Li Vaux Moyse. It remained in the hands of the Franks until 1189, and in 1217 there was still a small monastery on Mount Hor. There are several remains of the Frank occupation. The Nabataean inscriptions found in recent years have been edited for the Corpus of Semitic Inscriptions by Euting. At el-Beidha and el-Barid, near Petra, the rock excavations are almost of equal interest.

A few details noticed by recent travellers will be found in the *Quarterly Statements* of the Pal. Exp. Fund for 1898 and 1900, and in the *Revue Biblique* for 1897. There is a good general description of the site and ruins in BAEDEKER-SOCIN'S *Handbook to Syria and Palestine.*

Petrie, William Matthew Flinders (1853-——), English Egyptologist, was born at Charlton on 3rd June 1853, being the son of William Petrie, C.E. His mother was the daughter of Captain Matthew Flinders, the Australian explorer. He took an early interest in archæological research, and between 1875 and 1880 was busily engaged in studying ancient British remains at Stonehenge and elsewhere; in 1880 he published his book on Stonehenge, with an account of his theories on this subject. He was also much interested in ancient weights and measures, and in 1875 published a work on *Inductive Metrology;* his profound knowledge of the history of weights and measures was afterwards shown in his article in the ninth edition of this Encyclopædia. In 1881 he began the series of surveys and excavations in Egypt with which his name is so prominently connected, beginning with the pyramids at Ghizeh, and following up his work there by excavations at the great temple at Tanis (1884), and discovering and exploring the long-lost Greek city of Naukratis in the Delta (1885), and the towns of Am and Daphnæ (1886), where he found important remains of the time when they were inhabited by the Pharaohs. Between 1888 and 1890 he was at work in the Fayum, opening up Hawara, Kahun, and Lachish; and in 1891 he discovered at Medum the earliest known temple. Much of this work was done in connexion with the Palestine Exploration Fund. By this time his reputation was established. He published in 1893 his *Ten Years' Diggings in Egypt*, was given the honorary degree of D.C.L. by Oxford, and was appointed Edwards Professor of Egyptology at University College, London. In this position he continued to do most valuable work, organizing collections and exhibitions, and lecturing in connexion with them, besides constantly adding by active research and excavation to a scientific knowledge of ancient Egypt. For an account of the results of his work, see EGYPTOLOGY. Here it is only possible to mention his discovery of ancient sculpture at the temple of Koptos (1894), his remarkable find of evidences of an unknown race of prehistoric Egyptians at Nagada (1895), his exploration of the six temples at Thebes (1896), and his discovery of traces of Libyan foreigners in Egypt during the 12th dynasty (1898). Professor Flinders Petrie has published many volumes dealing with his work.

Petrolea, a town and port of entry in Lambton county, Ontario, Canada, situated 42 miles west of London on Bear creek, an affluent of Sydenham river, and on the Grand Trunk and Michigan Central railways. It is in the midst of the oil region of Canada, and there are in the neighbourhood about 6000 producing wells, with an aggregate output of 20,000 barrels of crude oil per annum. Population (1881), 3465; (1891), 4357; (1901), 4135.

PETROLEUM.

I. INDUSTRY AND PRODUCTION.

DURING the period which has elapsed since the article PETROLEUM in the ninth edition of the *Encyclopædia Britannica* was published (in 1885), the petroleum industry has undergone remarkable expansion. Fresh sources of supply have assumed importance, new uses have developed, and very considerable improvements, with resulting economies, have been effected in the work of production of the crude oil, and still more in the methods adopted in the refining, transport, and distribution of the commercial products. The author of that article (a high authority) felt justified in devoting nearly the whole space allotted to his subject to a description of American petroleum, and did not consider it necessary to make more than a brief mention of the petroleum of Russia and other countries. Since that time the Russian petroleum industry has assumed an importance not inferior to that of the oil business of the United States; while in Java, Sumatra, and Borneo, in Burma and Assam, and in Galicia, Rumania, and Alsace, highly productive oil-fields have been opened up. The rapid growth of the Russian petroleum trade has unquestionably been mainly due to the circumstance that the residuum, for which at first it was difficult to obtain a market, has long since been found to be an excellent fuel, and has become the principal product. This virtual conversion of the business into a fuel industry has admitted of the marketing of the immense quantities of oil produced in Russia without interference with the sale of American petroleum. The present tendency is towards the creation of a number of more or less local industries, with the result that the world's supplies of petroleum, which at one time were contributed almost entirely by the United States, and more recently by that country and Russia, are being obtained from a gradually increasing number of centres.

That markets can be found for all the oil which can be produced in localities so situated geographically that the cost of transport is not prohibitive, is usually admitted, and indeed is scarcely open to doubt when the scope for increased employment of the various products is considered. So long as petroleum was chiefly of value as yielding an oil for burning in lamps, as a candle-making material, or as a lubricant for machinery, the fear of over-production was justifiable, for the growth of the trade in countries already using petroleum products for the purposes specified could not be very rapid, and new markets had to be sought in less civilized countries, where inferior illuminating agents and lubricating materials were in use. With the recognition, however, of the value of petroleum as liquid fuel, and as a source of gas for illuminating purposes, the whole complexion of the case became altered, and the industry at once assumed an extensive character, which, notwithstanding its vast aggregate volume, it had not previously possessed. The effect of this upon the Russian petroleum trade has already been mentioned, but it remains to be said that the substitution of petroleum for coal in gas-making has also been a prominent feature of the development which the industry as a whole has undergone in recent years. A very large proportion of the gas used as a source of light in the United States is water-gas, to which light-giving power is furnished by carburetting it with the gaseous products of petroleum, and already in Great Britain large quantities of petroleum distillate are similarly employed. Amongst other recent uses to which petroleum products are being put is that of furnishing power, through the agency of an internal-combustion motor similar to a gas engine, the most successful types of automobile vehicles for carrying light weights at high speed for long distances being furnished with petroleum-spirit motors. Oil engines, in which the ordinary petroleum burning oil is similarly used, are also now largely employed in rural districts where gas is not obtainable, or is comparatively costly. Apart from these modern features of the industry, there has been a steady progression in the world's consumption of petroleum, and especially in the substitution of mineral oils for animal and vegetable oils in the lubrication of machinery. To afford some idea of the present magnitude of the trade, it may be stated that a pipe 41 inches in diameter would be needed for the conveyance of the petroleum which the world is at present using, assuming a rate of flow of 3 feet a second; and that for the storage of a year's supply, a tank 929 feet in length, breadth, and height would be required.

Expansion of the industry.

The technology of the business has been marked by several important advances. The system of drilling the wells in the United States, which closely resembles the ancient method practised by the Chinese, has been improved only in points of detail, and has remained practically unaltered for many years. In Russia a different system, in which the drilling instruments are attached to iron rods instead of to a manila cable, is usually employed. The wells in the latter country, though of less depth than the majority of those in the United States, are of far larger diameter and are much more costly to bore. The productiveness of a Russian oil "fountain" is, however, enormously in excess of the average production of wells in America, though the flow is not, as a rule, long sustained. In the Russian and Rumanian oil-fields electric motors have been substituted to a considerable extent for steam engines, and in a few instances oil engines have been successfully introduced. From those wells in the Russian oil-fields which do not flow, it is customary to raise the oil by means of a cylindrical baler, the presence of sand in the oil interfering with the use of the ordinary lift-pump adopted in the United States. Recently a system of raising the oil by means of a stream of compressed air has been successfully tested in the Baku district, and seems likely to be largely employed. In the refining of petroleum the principal features of improvement have been, in Russia, the general introduction of the continuous system of distillation, which effects considerable economy in time, fuel, and labour; and in the United States, the successful treatment of crude oil containing sulphur compounds, whereby these impurities are practically eliminated, and a class of crude oil, which could not previously be advantageously worked, is rendered commercially valuable.

Recent advances.

Doubtless, however, the salient feature of advance has been the general adoption of the bulk system of transport and distribution. It is not many years since competent authorities expressed grave doubts as to the possibility of safely carrying petroleum in bulk across the Atlantic in stormy weather, and it must be admitted that the first experiments in this direction were not attended with hopeful results. The Russian petroleum trade was the first to benefit by the successful introduction of a system of marine transport of petroleum, the credit for which belongs to the brothers Nobel. Subsequently British shipbuilders, and notably the firm of Armstrong, Mitchell and Company, directed their attention to the construction of steamships suitable for this traffic, and at the present time the fleet of petroleum tank steamers is a large and very valuable one. These vessels sail regularly at frequent intervals from American and Russian ports, carrying cargoes of oil in bulk for the supply not only of the markets of Great Britain and the European continent, but also those of the East and elsewhere. Concurrently with this general introduction of marine transport in bulk, there has been a corresponding extension in the use of pipe lines, tank barges, tank railway waggons, and tank road waggons for distribution, so that much of the oil finds its way from the mouth of the well to the shop of the retailer, or even to the premises of the actual consumer, without having been put into any special package, such as the 40-gallon barrel or 4-gallon tin can in which it was formerly delivered; and this, as will be readily understood, results in a considerable saving of expense.

The closer study which has for some years been devoted to the geological features of petroliferous territories has resulted in the acquisition of more exact knowledge of the age and structure of the rock-formations concerned. This knowledge has been found of high practical value in enabling the expert to select favourable sites for boring operations, and it may be urged that no labour should be spared which may contribute to the completeness and accuracy of the available records. On all well-conducted petroleum properties it is now customary to note with care and precision the character of the strata perforated by the drill, so that a complete section may be prepared from the recorded data. In some cases the depths are stated with reference to sea-level instead of being taken from the surface, and it is much to be desired that this practice should become universal, as the correlation of the rapidly-accumulating data is thus simplified. There is scarcely any part of the globe which does not afford some trace of bitumen, in the gaseous, liquid, or solid state, and it is a common fallacy that petroleum is a comparatively rare substance, in the sense of occurring in only a few localities. On the other hand, while the areas in which it occurs in sufficient concentration, or in such quantity as to be of commercial value, are both fairly numerous and extensive, the discovery of petroleum in a given locality is not necessarily of industrial importance. There are few substances more widely distributed in nature, but the conditions requisite

Geological occurrence.

for the creation of a valuable store of the material exist only in a limited number of places. No definite connexion can be traced between the localities where it is known to occur and the present limits of sea and land, equally rich and equally scanty deposits being found in the hearts of continents and in the oceanic islands. Similarly, the tropics, the temperate and the polar circles are about equal in respect of their possession of bitumen, but it may be noted that the greater part of the known oil-bearing territory is north of the equator. Several writers have pointed out that the principal petroleum deposits of the world are intimately associated with the great mountain chains. It must not, however, be assumed that there is any necessary connexion between the origin of petroleum and the positions of the deposits in relation to the mountain ranges, the rational explanation of the intimate relation referred to being that it is usually in the neighbourhood of the mountains that the strata have, by the same changes as those which created the mountains and valleys, been thrown into a form suitable for the collection or concentration of the oil. The geographical distribution of petroleum affords most valuable evidence in relation to its origin. For a rare mineral special local conditions may be of paramount importance, but for a substance of almost world-wide occurrence, the theory of origin must harmonize with conditions that were either widespread simultaneously or of frequent recurrence in various places. We find that every one of the great divisions of geological time has produced some form of bitumen, and in the following table Mr W. H. Dalton has attempted to classify on this basis the various localities in which petroleum has been found in large or small quantities :—

Geological Periods.	Localities.
Quaternary .	Lancashire, Schleswig-Holstein, Red Sea, Mexico.
Pliocene .	Italy, Sumatra, Borneo, New Zealand.
Miocene .	Auvergne, Italy, Algeria, Egypt, Zante, Rumania, Austria, Caucasus, Persia, Turkestan, Assam, Burma, Eastern Archipelago (Java, Sumatra, Borneo, &c.), Japan, Alaska, California, Mexico, West Indies, New Zealand.
Oligocene .	Switzerland, Alsace, Galicia, Caucasus, Alaska, and other areas included under Eocene or Miocene by various authors.
Eocene .	Spain, Italy, Egypt, Turkey, Rumania, Austria, Caucasus, Baluchistan, Punjab, Assam, Burma, Eastern Archipelago, Utah, Texas, Mexico, New Zealand.
Cretaceous .	Switzerland, Hanover, Greece, California, Wyoming, Colorado, Athabasca, New Zealand.
Neocomian .	Spain, East France, Switzerland, Hanover, Austria, Rumania, Syria, Venezuela, West Indies, and other areas included under Cretaceous by various authors.
Jurassic .	England, Switzerland, Alsace, Hanover, Colorado, Mexico, Argentine Republic, and possibly other South American regions.
Triassic .	Alsace, Hanover, Punjab, China.
Permian .	Autun, Saxony.
Carboniferous .	Great Britain, South Russia, Central and Eastern United States, New Brunswick. Some of the deposits now assigned to the Carboniferous were formerly classified with the Devonian.
Devonian .	England, North Russia, Ontario.
Silurian .	East Canada, Central and Eastern United States, Newfoundland.
Cambrian .	British Columbia and Alberta (Kootenay Pass).
Archæan .	Sweden (bituminous gneiss of Nullaberg), East Canada (graphite).

It should be pointed out that the deposits which are of chief commercial importance occur in the older rocks (Carboniferous and Silurian) on the one hand, and in the comparatively new Tertiary formation on the other, the intermediate periods yielding but little, or at any rate far less abundantly.

Formation of Deposits.

The anticlinal or terrace structure which characterizes the principal oil-fields of the world is a most important factor in the accumulation of oil and gas. The anticlines, which have been formed by the slow contractile movements of the earth, usually occur as a series of broad low arches separated by synclines. They often extend for long distances, with great regularity, but are not infrequently crossed by subsidiary anticlines, which themselves play a not unimportant part in the aggregation of the oil. Owing to difference of density the oil and water present in the anticlines separate into two layers, the upper consisting of oil which fills the anticlines, while the water remains in the synclines. Any gas which may be present rises to the summits of the anticlines. When the slow folding of the strata is accompanied by a gradual local descent, a modified or "arrested" anticlinal structure, known as a "terrace," is produced, the upheaving action at that part being sufficient only to arrest the descent which would otherwise occur. The terraces may thus be regarded as flat and extended anticlines. They need not be horizontal, and sometimes have a dip of a few feet per mile, as in the case of the Ohio and Indiana oil-fields, where the dip varies from 1 to 10 feet. These slight differences in level, however, are found to have a most powerful effect in the direction already mentioned. Generally, it may be said that the strata from which the main supplies of oil and gas have been obtained in the United States are unusually unbroken, nearly horizontal, and but little disturbed. The importance of the anticlinal structure has been equally observed in the oil-fields of the Caucasus, the Carpathians, and elsewhere.

The formation of large deposits of petroleum is, however, dependent upon something more than we have yet considered. We may have the necessary deposit of organic matter, subjected to the requisite conditions to effect its conversion into petroleum, and we may have the anticlinal structure favouring the accumulation of the oil produced, but in addition we need a rock of sufficient porosity to serve as a reservoir for the oil, and above it an impervious stratum to preserve the oil from evaporation and oxidation, and from being displaced by water. The principal deposits which provide the necessary porosity for the storage of the oil are sandstones, conglomerates, and limestones. Shaly sandstones and slaty shales also serve as reservoir-rocks in a lesser degree. In the case of limestones, a natural porosity, such as is found in the coarsely crystalline varieties, or a certain amount of chemical change resulting in the formation of interspaces capable of receiving the oil, appears to be necessary for the formation of a true reservoir-rock. Such change is usually dolomitic, consisting in the conversion of the calcium carbonate forming the limestone into the double carbonate of calcium and magnesium known as "dolomite," which occupies less space than the unaltered limestone. It is therefore characterized by the production of such numerous spaces between the dolomite crystals that the rock becomes capable of retaining a large volume of oil. This dolomitic change appears to be capable of occurring only in the purer limestones. The Trenton limestone, for instance, is thus modified only where almost free from silica, the changed parts showing about 54 per cent. of calcium carbonate and 44 per cent. of magnesium carbonate. A large proportion of the Trenton limestone is too impure to permit of the change, and is destitute of oil and gas. Even in rich oil-fields the dolomite has only been formed in a small portion of the stratum. When followed northwards into Ohio and Indiana, the Trenton limestone is found to have become dolomitic through a small thickness only of its upper beds. The changed and unaltered portions occur at short intervals, but only the former contain the oil and gas. The change usually affects from 10 to 50, and in some cases 100 feet of the stratum, and has occurred along a line passing into Indiana through the principal oil and gas fields of Ohio. In addition to possessing a porous structure, the reservoir-rock must be entirely covered by an impervious layer, the commonest and most perfect cover being a fine-grained shale. The fractured character of the strata in central and eastern Pennsylvania may account for the absence of oil and gas in those districts. In oil-bearing territory the occurrence of a porous rock beneath a cover-rock usually results in the formation of an oil-field.

Oil and gas are often met with in drilled wells under great pressure, which is highest as a rule in the deepest wells. The closed pressure in the Trenton limestone in Ohio and Indiana is about 200–300 ℔ per square inch, although a much higher pressure has been registered in many wells. The gas wells of Pennsylvania indicate about double the pressure of those drilled in the Trenton limestone, 600–800 ℔ not being unusual, and even 1000 ℔ having been recorded. The extremely high pressure under which oil is met with in wells drilled in some parts of the Russian oil-fields is a matter of common knowledge, and a fountain or spouting well resulting therefrom is one of the "sights" of the country. A famous fountain in the Groznyi oil-field in the northern Caucasus, which began to flow in August 1895, was estimated to have thrown up during the first three days 1,200,000 poods (over 4,500,000 gallons, or about 18,500 tons) of oil a day. It flowed continuously, though in gradually diminishing quantity, for fifteen months, quickly destroying the derrick which had been erected; afterwards the flow became intermittent. In April 1897 there was still an occasional outburst of oil and gas.

The manner in which Nature created and put away in her storehouses the petroleum which is being lavishly poured out to-day is a subject of more than academic interest, since it is closely connected with the question of the permanence of the supplies. The various theories of origin may be broadly classified into two groups, one consisting of those which assign to the product an inorganic origin, and the other those which account for its production from animal or vegetable matter, or both. The latter group of theories are the more generally accepted, and the researches of Engler have furnished strong support to the view previously advanced by Höfer that the organic matter from which the petroleum was derived was, at any rate in many instances, animal rather than vegetable. To our knowledge of the chemical composition of petroleum no very striking or commercially important addition has been made within recent years, although from time to time interesting results have been announced which have thrown light upon the subject, and afforded confirmation of views previously based largely upon deduction.

Production of petroleum.

The "production" of petroleum by means of drilled wells in the United States was fully described in the article PETROLEUM in the ninth edition of the *Encyclopædia Britannica*. The system remains substantially unchanged to-day, but in consequence of the increased depth of the wells, extending in some districts to upwards of 3000 feet, heavier tools are commonly employed. In the method hitherto most largely adopted in drilling in the Russian oil-fields a percussion or "jumper" drill is also used, but the tools are suspended from the mechanism, which imparts to them a vertical reciprocating motion by means of screw-jointed iron rods instead of the manila cable which fulfils a similar purpose in the American system. Cable drilling is also practised to some extent in the Baku district, and as it is admittedly far more expeditious than drilling with rods, it is probable that it will be increasingly adopted, on account of the greater depth at which the oil has to be sought. Although the Russian oil wells are of less depth than most of those in the United States, they are of much greater diameter, and are therefore comparatively expensive, some of them costing as much as £5000. Owing to the high price of screwed artesian casing of large diameter, and the difficulty of handling it, riveted casing of iron plate is generally used, although it is not easy with such casing effectively to exclude water from the bore-hole. Recently, on some properties in the Russian oil-fields, artesian casing has been employed advantageously. The character of the strata and mode of occurrence of the oil necessitate the drilling of wells of large diameter in these fields; but even such wells frequently get choked when a fountain is struck, the soft sand and boulders of the oil-bearing formation being driven into the bore-hole by the immense pressure often exerted by the outflowing oil. The large diameter is also highly advantageous when the well has ceased to flow, for, owing to the great quantity of sand present in suspension, the oil cannot be raised with ordinary lift-pumps, as in the United States, and has to be brought to the surface by means of a baler (a long cylindrical vessel made of sheet iron, with a valve at the lower end): it is therefore obvious that the quantity of oil thus obtained in the course of a day would be but small unless the size of the well were such as to admit of the use of a baler of considerable diameter.

Some success has attended the trial in the Baku district of a method of raising the oil from the well by the use of compressed air. In this system, which has been for some time past employed in raising water, the compressed air is forced down a pipe of small diameter, fixed centrally in the well, and issues at the bottom through an outlet fitted with an inverted cone. The stream of air is thus made to impinge against the inner surface of the casing of the well, so as to fill the annular space, and in its upward rapid flow it carries the oil to the surface. It is found that oil can thus be raised far more rapidly than by baling, and as the air-lift system can be employed in a well of comparatively small diameter, it is possible that its general introduction may lead to a reduction in the diameter of the wells, especially in those parts of the territory in which fountains do not commonly occur. Electrical power has been substituted for steam power in both drilling and pumping by Messrs Nobel on their Russian petroleum properties, and by a Dutch company working in Rumania. This may prove to be one of the most important advances made in this branch of the industry. In Galicia, as in Russia, preference has, up to the present time, usually been given to the rod system of drilling, wooden rods, however, being in most instances employed. The rod system has also always been adopted in the Canadian oil-fields, and was, in fact, introduced into Galicia by Canadian drillers. Experts differ as to the relative merits of the cable and rod systems, and as very few drillers have had practical experience of both, it is difficult to get data for an effective comparison. It is asserted that the comparative rigidity of the rod is sometimes highly advantageous, but, on the other hand, it is admitted that the cable system is far more expeditious, especially in drilling at considerable depth, the disconnecting and reconnecting of the rods for the frequently recurring operation of "dressing" the bit and removing the detritus from the well involving much loss of time. In this connexion mention should be made of what is known as the water-flush system of drilling, which has been usefully employed on the Pechelbronn (Alsace) property and elsewhere. In this system tubular rods attached to a bit with a hollow shank and apertures above the cutting edge are used. The rods are connected with a force-pump by means of flexible tubing, and water is driven through them while the drilling is in progress. The water escapes through the orifices in the bit, and flows from the top of the casing, carrying away the detritus from the well. This method has been found successful where the strata are soft, and in such cases is inexpensive and rapid, but it is unsuitable for use in hard rock.

Attempts are being made to substitute a rotary "crown" borer for the percussion drill in sinking wells for petroleum. The instrument in question, which is known as the Calyx drill, is furnished with a steel-toothed cutter of annular form, by means of which the bulk of the rock to be removed is obtained in the form of a solid core, instead of being broken up. It is thus similar in action to the well-known diamond drill. With the Calyx drill good work has already been done in drilling for water; and as the study of the nature of the strata perforated by the drill is greatly facilitated by the preservation of a core, it is to be hoped that this form of drill may in the future find employment in the oil-field.

Refining.

The system of continuous distillation, to which brief reference has already been made as an important feature of the Russian petroleum refining business, was first adopted by Nobel Brothers. In the ordinary or intermittent system of distillation the crude oil is subjected in the still to gradually increased heat, with the object of separating or classifying the various hydrocarbons of which the crude oil is composed by taking advantage of their differences in volatility, and thus obtaining the desired commercial products. The crude oil, on being treated in this manner, first parts with the very volatile hydrocarbons forming the various descriptions of petroleum spirit (gasolene, benzene, &c.). As the temperature rises, the less volatile compounds, met with in commerce as kerosene, are removed, and at still higher temperatures lubricating oils and other products are obtained. The hydrocarbons, of course, leave the still in the form of vapour, but are brought back to the liquid state by being passed through a condenser. It will be evident that we have thus a means of effecting such division and subdivision of the crude oil as we may desire. In the continuous system of distillation, on the other hand, we have, instead of a single still with a progressive temperature, a series of stills heated to successively higher temperatures, which are carefully maintained, and the crude oil is caused to flow slowly and continuously through the whole series, being thus subjected to a steadily increasing heat while the temperature of the contents of each still remains practically constant. In this manner each still yields continuously a product of given volatility, corresponding with the temperature at which it is maintained, and from the series of stills a range of products is continuously obtained corresponding with that yielded by the intermittent system within the same limits of temperature. In this system the loss of time, waste of fuel, and injury to plant involved in the cooling down and re-heating of the stills and furnaces in the intermittent system are avoided. The continuous system is now employed at all the principal refineries in Russia, and is in use in Burma, Galicia, Java, and elsewhere. In the United States, on the other hand, it has not found favour, although considerable sums of money have been spent in attempts to introduce it.

For a second important improvement in refining, viz., the desulphurizing of oils containing sulphur compounds, the credit belongs to the Standard Oil Company. Two processes are employed, both based on the use of cupric oxide as a desulphurizer. In one of these the vapour passes from the still through a vessel containing cupric oxide, where the sulphur is separated as cuprous sulphide, and thence to the condenser. In this way the whole of the volatile constituents of the oil are subjected to the desulphurizing treatment. In the other method, which, in spite of its involving a double operation, is understood to be generally adopted, the petroleum spirit and kerosene distillates, obtained by the ordinary process of distillation, are redistilled with a large excess of finely divided cupric oxide in a still fitted with an agitator, by means of which the contents are kept actively stirred. From the cuprous sulphide the cupric oxide is recovered for further use by burning off the sulphur. The introduction of this process was of great commercial importance, since it rendered available, as a source of burning oil, the sulphuretted petroleum yielded by the prolific oil-fields of Ohio.

Transport and distribution.

In view of the large extent to which pipe lines are employed in the United States for the conveyance of crude petroleum, it has been a matter of surprise that, notwithstanding the admittedly inadequate transport facilities afforded by tank waggons on the Transcaucasian Railway, a pipe line has not been laid from Baku to Batum or some other port on the Black Sea. In the United States the refining business was many years ago largely transferred from the neighbourhood of the oil-fields to the Atlantic seaboard, the crude oil being pumped through pipe lines to the refineries in New York and Philadelphia, the guiding principle apparently being to refine the oil in a locality as near as possible to the point of shipment for export, or in a central position as regards consumption for the home trade. Two circumstances stood in the way of the adoption of a similar principle in Russia. One was that the revenue derived by the railway from the transport of petroleum products could not be spared, and the other that any considerable transference of the refining business from the shore of the Caspian Sea to that of the Black Sea would seriously diminish the value of the Baku refineries, many of which are establishments upon which very large sums of money have been expended. But now a pipe line for refined oil has been laid along a part of the 560 miles of railway from Baku to Batum, and this is to be extended so as to be available for the transport of refined oil from the Caspian to the Black Sea. The 8-inch pipe already completed extends from Michaelov to Batum, a distance of 140 miles, over the portion of the railway most subject to interruption of traffic by floods and snowstorms, and by employing it in conjunction with the railway tank waggons already in use, the carrying capacity of the railway will be largely increased.

The building of tank steamships for the marine transport of petroleum has steadily progressed, and every year sees important additions to a fleet of these vessels, which now number about 160, exclusive of the large number employed in the local trade in America and Russia. Increase in number has been accompanied by increase in tonnage of the individual vessels, some having a carrying capacity of as much as 10,000 tons. Concurrently there has been a corresponding increase in the number of tank barges, tank railway waggons, and tank road waggons employed in the distribution of the oil, as well as in the number and capacity of the tank storage installations.

Much difference of opinion exists as to what is a desirable minimum flash-point for oil intended to be burned in household lamps of the usual construction. Attention has been drawn to the number of deaths and cases of personal injury resulting from accidents with mineral oil lamps, and it has been contended that the remedy lies in a sufficient raising of the standard. Since the early days of the petroleum industry most civilized countries have prescribed by law a test of flashing-point or inflammability, designed in most cases primarily to afford a definition of oils for lighting purposes which may be safely stored without the adoption of special precautions. In the United Kingdom the limit has, for the purpose in question, been fixed by the legislature at 73° Fahr. by the present legal test (a form of "close test," devised by the late Sir Frederick Abel), which is the equivalent of the former standard of 100° Fahr. by the "open test." In Germany the law prescribes a close test of 21° C., equal to about 70° Fahr., whilst in Russia the standard is 28° C., equal to 84·4° Fahr., by the close test. In the United States various methods of testing and various minimum standards have been adopted. In Pennsylvania the prescribed limit is a "fire test" of 110° Fahr., equivalent to about 70° Fahr. close test, while in the state of New York it is 100° Fahr. close test. The subject of the testing of petroleum for legislative purposes, with which in later inquiries that of accidents with mineral oil lamps has been associated, has been investigated in Great Britain by committees of both branches of the legislature, and voluminous evidence has been taken. It has been strongly contended that the raising of the standard from 73° to 100° Fahr. would put an end to lamp accidents, but this view has been equally forcibly combated; and although the committee reported in 1898, by a narrow majority, in favour of such an alteration, no action has been taken upon the recommendation. The questions involved are in truth by no means simple. Obviously, the higher the flashing-point the "safer" the oil in one sense; but there are equally evident objections to a course which would to some extent reduce the available supply, and thus might lead to an increase in price or a deterioration in quality. Moreover, since lamp accidents have occurred with oil of a higher flash-point than 100° Fahr. Abel test, it cannot be held to be proved that the adoption of this standard would prevent such accidents. Apart from this, it does not appear to have been sufficiently borne in mind by the advocates of a high standard that the object of the Petroleum Acts passed in the United Kingdom has hitherto been to regulate storage. Petroleum spirit, "flashing" at zero Fahr., has always been obtainable for use as an illuminating agent, and, on the other hand, commercial enterprise has, without any legislative help, placed oils of high flashing-point at the disposal of those who prefer them. Moreover, if the legislature should, by putting difficulties in the way of the use in lamps of oil of the present legal test, lead to the creation of an impression that oil of, say, 100° Fahr. test can be safely used without the adoption of ordinary precautions, accidents with lamps would probably increase in number. It has been said by advocates of a higher test that with a safe oil any lamp is safe, but it may with equal truth be asserted that in a properly-constructed lamp used with reasonable care the ordinary oil of commerce is a safe illuminant.

Flash-point.

The report of the United States Geological Survey on the production of petroleum in the United States during the year 1899, compiled by Mr F. H. Oliphant, indicates that the most conspicuous features of the industry for the period in question were: (1) The total production was considerably in excess of that of the previous year; (2) there was a large increase in the number of wells completed in both the Appalachian and the Lima–Indiana oil-fields; (3) in south-eastern Ohio and in Texas there was a largely increased production; and (4) only about 7 per cent. of the total production was obtained outside the Appalachian and the Lima–Indiana fields. The Appalachian field embraces all the districts producing what is known as "Pennsylvania oil." It extends from Wellsville in New York state on the north-east, through western Pennsylvania into West Virginia, and includes a large portion of south-eastern Ohio. Its extension through Kentucky and Tennessee into northern Alabama has not been attended with any noteworthy developments. The total production in the Appalachian field for 1899 was 33,050,076 barrels, as compared with 31,711,857 barrels in 1898. The greatest increase was in south-eastern Ohio, where the output was more than doubled, and the greatest falling off was in Pennsylvania. The Lima–Indiana field includes the whole of Indiana and that portion of north-western Ohio in which Lima petroleum, found in the Trenton limestone, is produced. The production decreased from 20,321,323 barrels in 1898 to 20,225,356 barrels in 1899. The total production of crude petroleum in the United States during 1899 was 57,070,850 barrels (of 42 American gallons or about 35 imperial gallons), as compared with 55,364,233 barrels in 1898 and 60,475,516 barrels in 1897. The following is a tabular statement of the production in the various states for the years 1897, 1898, and 1899:—

American supply.

State.	Production.		
	Barrels.	Barrels.	Barrels.
	1897	1898	1899
New York	1,279,155	1,205,250	1,320,909
Pennsylvania	17,982,911	14,743,214	13,053,603
West Virginia	13,090,045	13,615,101	13,910,630
Ohio	21,560,515	18,738,708	21,142,108
Indiana	4,122,356	3,730,907	3,848,182
Kentucky	322	5,568	18,280
Missouri	19	10	132
Colorado	384,934	444,383	390,278
California	1,903,411	2,257,207	2,642,095
Texas	65,975	546,070	669,013
Indian Territory	625	0	0
Illinois	500	360	360
Wyoming	3,650	5,475	5,560
Kansas	81,098	71,980	69,700
	60,475,516	55,364,233	57,070,850

Much attention has been attracted by the rapid development of the Beaumont oil-field in Texas and the large yield of the "gushers" or spouting wells characteristic of what is known as the Spindle Top area. The oil, which will doubtless be used chiefly as fuel, is apparently obtainable in very large quantities at low cost, and having regard to the proximity of the field to the sea-board, the expense of transport is also small. The discovery of this new source of supply has led to renewed consideration of the advantages possessed by liquid fuel, and arrangements are being made on a large scale for the transport and distribution of the produce of the Beaumont field, principally with a view to its use as a substitute for coal. Oil-fields in various parts of the world which had been regarded as of minor importance have become more prominent, and much evidence has concurrently been furnished of the commercial value of other areas of petroliferous territory at present unworked.

The producing territory in the Baku district comprises the oil-fields of Balachani, Sabuntchi, Romany, Binagadi, and Bibi–Eibat, the aggregate area being under 10 square miles. The Balachani–Sabuntchi–Romany territory, and the adjacent district of Binagadi, are situated on the Apsheron Peninsula from 8 to 12 miles north-east and north of the town of Baku, while the Bibi–Eibat field lies 2 to 3 miles south of Baku. The production of these fields from 1897 to 1899 is shown in the following table:—

Russian supply.

District.	1897.	1898.	1899.
	Poods.[1]	Poods.	Poods.
Balachani . .	100,336,495	108,836,439	114,854,151
Sabuntchi . .	162,610,054	179,828,697	230,757,289
Romany . . .	96,266,133	100,523,699	98,581,782
Binagadi . .	197,462	227,730	213,386
Bibi-Eibat . .	62,514,479	96,526,783	80,840,807
	421,924,623	485,943,348	525,247,415

In the year 1893 attention was directed to the prolific character of the oil-bearing lands of Groznyi in the Terek district, about 300 miles north-east of Baku, and recent developments in this field point to the conclusion that the Groznyi oil-field will be a formidable rival to those at Baku. The production in the Groznyi district during the years 1897, 1898, and 1899 was as follows :—

1897	27,568,794 poods.
1898	17,716,899 ,,
1899	25,194,566 ,,

Petroleum also occurs in many other places in the Caucasus, in the Kuban district, in the Crimea, and at Petchora in the north of Russia, near the Ural Mountains.

Other sources of supply.

In Canada petroleum has been produced in large quantities for many years in the Enniskillen district in Lambton county, Ontario. The production for the year 1898 was 758,391 barrels (of 35 imperial gallons), and for 1899, 704,794. Petroleum is also reported to occur in the province of Quebec, near the extremity of the Gaspé Peninsula, and in the North-West Territories, in the district of Athabasca.

On the European continent there is a considerable production of petroleum in Galicia (Austria-Hungary), Rumania, and Alsace. The Galician oil-belt extends for a distance of about 220 miles along the northern slopes of the Carpathian Mountains, whilst the Rumanian deposits occupy the south-eastern and southern slopes of the southern Carpathians or Transylvanian Alps. The Galician oil-fields have been worked by means of drilled wells for many years, but it is only recently that those of Rumania have been similarly developed, petroleum having until within the past few years been obtained in the latter country by means of hand-dug wells. Owing to its favourable geographical position and to the successful results of recent borings, Rumania appears destined to assume a position of importance among petroleum-producing countries. The production of petroleum in Galicia during the year 1898 amounted to 330,451 metric tons, and in 1899 to 321,681 metric tons. In Rumania the production was about 240,000 tons in 1898 and about 300,000 tons in 1899. Much activity has been displayed in the drilling of wells in the Alsace oil-fields, and a profitable local industry has been created. In Italy the production of petroleum is small, but the oil, which is chiefly found in the Milan district, commands a high price.

The Eastern Archipelago (Java, Sumatra, Borneo, &c.) bids fair to rank before long among the chief sources of the oil-supply of the world. In Java there has been a large production for many years; in Sumatra the results which have attended the drilling operations in the Moeara Enim field and elsewhere have demonstrated the existence of a rich oil-bearing formation; and in Borneo the recent work of development, at Kotei, on the east coast of the island, on which much money has been expended, has already resulted in the discovery of abundant supplies of fuel oil, for the distribution of which arrangements are being made on a large scale. The petroleum industry of Japan exhibits steady growth, and has already reached considerable proportions, the output of crude oil, which for the year 1899 was reported to be 800,000 barrels, having increased so much that, according to estimate, it has almost doubled. Of this production the greater part was obtained in the province of Echigo. In Upper Burma British capital and energy have completely transformed the conditions which existed in the Yenangyaung oil-fields in the days of King Thibaw, when "Rangoon oil" (named after the port of shipment) was an unimportant article of commerce. The primitive hand-dug shafts have long been superseded by drilled wells, the produce of which is treated in a refinery provided with the most modern appliances, and an important industry has been created. In Assam an English company has met with similar success in boring operations, and has obtained a considerable production, for the treatment of which a refinery is in course of erection. Petroleum has been produced and refined in Peru in moderate quantities for many years, and has been found in Ecuador and Colombia. It also occurs in Algeria, on the Gold Coast, in Newfoundland, Alaska, the West Indies, New Zealand, and in other localities.

[1] 1 pood=36·1127 ℔ avoirdupois. In comparing the production of crude petroleum in Russia with the production of crude petroleum in the United States, 8 poods may be taken as the equivalent of the American "barrel" unit.

For further information see BOVERTON REDWOOD'S *Petroleum and its Products.* London, 1896 (2nd ed.) (B. R.)

II. MINERAL OIL AS LIQUID FUEL.

The use of petroleum as fuel had long been recognized as a scientific possibility, and some attempts had been made to adopt it in practice upon a commercial scale, but the insufficiency, and still more the irregularity, of the supplies prevented it from coming into practical use to any important extent until recent discoveries of oil specially adapted by chemical composition for fuel purposes changed the aspect of the situation. These discoveries of special oil were made first in Borneo and later in Texas, and experience in treating the oils from both localities has shown that while not less adapted to produce kerosene or illuminating oil, they are better adapted to produce fuel oil than either the Russian or the Pennsylvanian products.

With regard to the chemical properties of petroleum, it is not necessary to say more in the present place than that the lighter and more volatile constituents, known commercially as naphtha and benzene, must be removed by distillation in order to leave a residue composed principally of hydrocarbons which, while containing the necessary carbon for combustion, shall be sufficiently free from volatile qualities to avoid premature ignition and consequent danger of explosion. Attempts have been made to use crude oil for fuel purposes, and these have had some success in the neighbourhood of the oil wells and under boilers of unusually good ventilation both as regards their chimneys and the surroundings of their stokeholds; but for reasons both of commerce and of safety it is not desirable to use crude oil where some distillation is possible. The more complete the process of distillation, and the consequent removal of the volatile constituents, the higher the flash-point, and the more turgid and viscous is the fuel resulting; and if the process is carried to an extreme, the residue or fuel becomes difficult to ignite by the ordinary process of spraying or atomizing mechanically at the moment immediately preceding combustion. The proportions which have been found to work efficiently in practice are as follows :—

Carbon	88·00 per cent.
Hydrogen	10·75 ,,
Oxygen	1·25 ,,
Total . .	100

The standards of safety for liquid fuel as determined by flash-point are not yet finally settled, and are changing from time to time. The British Admiralty require a flash-point of 270° Fahr., and to this high standard, and the consequent viscosity of the fuel used by vessels in the British fleet, may partly be attributed the low rate of combustion that has been found possible in them. The German Admiralty have fixed a flash-point of 187° Fahr., and have used oil of this standard with perfect safety, and at the same time with much higher measure of evaporative duty than has been attained in British war-vessels. In the British mercantile marine Lloyd's Register has permitted fuel with a flash-point as low as 150° Fahr. as a minimum, and no harm has resulted. The Board of Trade, the department of the Government which controls the safety of passenger vessels, has fixed a higher standard upon the basis of a minimum of 185°. In the case of locomotives the flash-point as a standard of safety is of less importance than in the case of stationary or marine boilers, because the storage is more open, and the ventilation, both of the storage tanks and the boilers during combustion, much more perfect than in any other class of steam boilers.

The process of refining by distillation is also necessary to reduce two impurities which greatly retard storage and combustion, *i.e.*, water and sulphur. Water is found in all crude petroleum as it issues from the wells, and sulphur exists in important quantities in oil from the Texas wells. Its removal was at first found very expensive, but there no longer exists difficulty in this respect, and large quantities of petroleum fuel practically free from sulphur are now regularly exported from Texas to New York and to Europe.

Water mixed with fuel is in intimate mechanical relation, and frequently so remains in considerable quantities even after the process of distillation. It is in fact so thoroughly mixed as to form an emulsion. The effect of feeding such a mixture into a furnace is extremely injurious, because the water must be decomposed chemically into its constituents, hydrogen and oxygen, thus absorbing a large quantity of heat which would otherwise be utilized for evaporation. Water also directly delays combustion by producing from the jet a long, dull, red flame instead of a short bright, white flame, and the process of combustion, which should take place by vaporization of the oil near the furnace mouth, is postponed and transferred to the upper part of the combustion-box, the tubes, and even the base of the chimney, producing loss of heat and injury to the boiler structure. The most effective means of ridding the fuel of this dangerous impurity is by heat and settlement. The coefficients of expansion of water and oil by heat are substantially different, and a moderate rise of temperature therefore separates the particles and precipitates the water, which is easily drawn off—leaving the oil available for use. The heating and precipitation are usually performed upon a patented system of settling tanks and heating apparatus known as the Flannery-Boyd system, which has proved itself indispensable for the successful use at sea of petroleum fuel.

Progress of liquid fuel.

The laboratory and mechanical use of petroleum for fuel has already been referred to, but it was not until the year 1870 that petroleum was applied upon a wider and commercial scale. In the course of distillation of Russian crude petroleum for the production of kerosene or lamp oil, large quantities of refuse were produced—known by the Russian name of *astatki*—and these were found an incumbrance, and useless for any commercial purpose. To a Russian oil-refiner gifted with mechanical instinct and the genius for invention occurred the idea of utilizing the waste product as fuel by spraying or atomizing it with steam, so that, the thick and sluggish fluid being broken up into particles, the air necessary for combustion could have free access to it. The earliest apparatus for this purpose was a simple piece of gas-tube, into which the thick oil was fed; by another connexion steam at high pressure was admitted to an inner and smaller tube, and, the end of the tube nearest to the furnace being open, the pressure of the steam blew the oil into the furnace, and by its velocity broke it up into spray. The apparatus worked with success from the first. Experience pointed out the proper proportionate sizes for the inlets of steam and oil, the proper pressure for the steam, and the proportionate sizes for the orifices of admission to the furnaces, as well as the sizes of air-openings and best arrangements of fire-bricks in the furnaces themselves; and what had been a waste product now became a by-product of great value. Practically all the steam power in South Russia, both for factories and navigation of the inland seas and rivers, is now raised from *astatki* fuel.

In the Far East, including Burma and parts of China and Japan, the use of liquid fuel spread rapidly during the years 1899, 1900, and 1901, owing entirely to the development of the Borneo oil-fields by the enterprise of Sir Marcus Samuel and the large British corporation known as the Shell Transport and Trading Company, of which he is the head. In the United States of America liquid fuel is not only used for practically the whole of the manufacturing and locomotive purposes of the state of Texas, but factories in New York, and a still larger number in California, are now discarding the use of coal and adopting petroleum, because it is more economical in its consumption and also more easily handled in transit, and saves nearly all the labour of stoking. So far the supplies for China and Japan have been exported from Borneo, but the discoveries of new oil-fields in California, said to be of a character specially adapted for fuel, have encouraged the belief that it may be possible to supply Chile and Peru and other South American countries, where coal is extremely expensive, with Californian fuel; and there are some who believe that it will ultimately find its way across the Pacific to Japan. There are believed to be large deposits in West Africa, but in the meantime the only sources of supply to those parts of Africa where manufacture is progressing, *i.e.*, South Africa and Egypt, are the oil-fields of Borneo and Texas, from which the import has well begun, from Texas to Alexandria *viâ* the Mediterranean, and from Borneo to Cape Town *viâ* Singapore.

In England, notwithstanding the fact that there exist the finest coal-fields in the world, there has been a surprising development of the use of petroleum as fuel. The Great Eastern Railway have adapted 120 locomotive engines to its use, and these are running with regularity and success both on express passenger and goods trains. The London, Brighton, and South Coast Railway are also commencing the adaptation of some of their locomotive engines, and they have recently entered into a contract for the delivery of a large quantity of Texas oil fuel. Several large firms of contractors and cement manufacturers, chiefly on the banks of the Thames, have made large purchases for future delivery, extending over as many as three years in some cases. The facts that the depôt for the reception of Texas oil fuel is at Thames Haven, and that coal is necessarily dearer in the south of England than in the coal-bearing parts of the country, suggest that the development of liquid fuel is more likely to continue in the neighbourhood of London than elsewhere in England.

The chief factors of economy are the greater calorific value of oil than coal (about 16 ℔ of water per ℔ of oil fuel evaporated from a temperature of 212° Fahr.), not only in laboratory practice, but in actual use on a large scale, and the saving of labour both in transit from the source of supply to the place of use and in the act of stoking the furnaces. The use of cranes, hand labour with shovels, waggons and locomotives, horses and carts, is unavoidable for the transit of coal; and labour to trim the coal, to stoke it when under combustion, and to handle the residual ashes, are all indispensable to steam-raising by coal. On the other hand, a system of pipes and pumps, and a limited quantity of skilled labour to manage them, is all that is necessary for the transit and combustion of petroleum fuel; and it is certain that even in England petroleum will find places which, from topographical and other circumstances, will

Economy of liquid fuel.

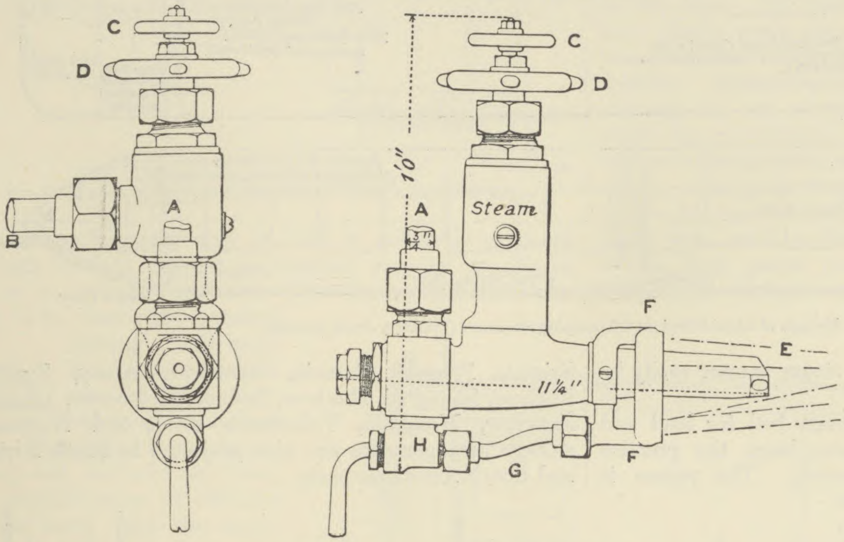

Fig. 1.—Holden Burner.

more economically use petroleum than coal as fuel for manufacturing purposes.

The theoretical calorific value of oil fuel is more nearly realized in practice than the theoretical calorific value of coal, because the facilities for complete combustion, due to the artificial admixture of the air by the atomizing process, are greater in the case of oil than coal, and for this reason, among others, the practical evaporative results are proportionately higher with liquid fuel. In some cases the work done in a steam engine by 2 tons of coal has been performed by 1 ton of oil fuel, but in others the proportions have been as 3 to 2, and these latter can be safely relied on in practice as a minimum. This saving, combined with the savings of labour and transit already explained, will in the near future make the use of liquid fuel compulsory, except in places so near to coal-fields that the cost of coal becomes sufficiently low to counterbalance the savings in weight of fuel consumed and in labour in handling it. In some locomotives on the Great Eastern Railway the consumption of oil and coal for the same development of horse-power has been as 17 ℔ oil is to 35 ℔ coal; all, however, have not realized so high a result.

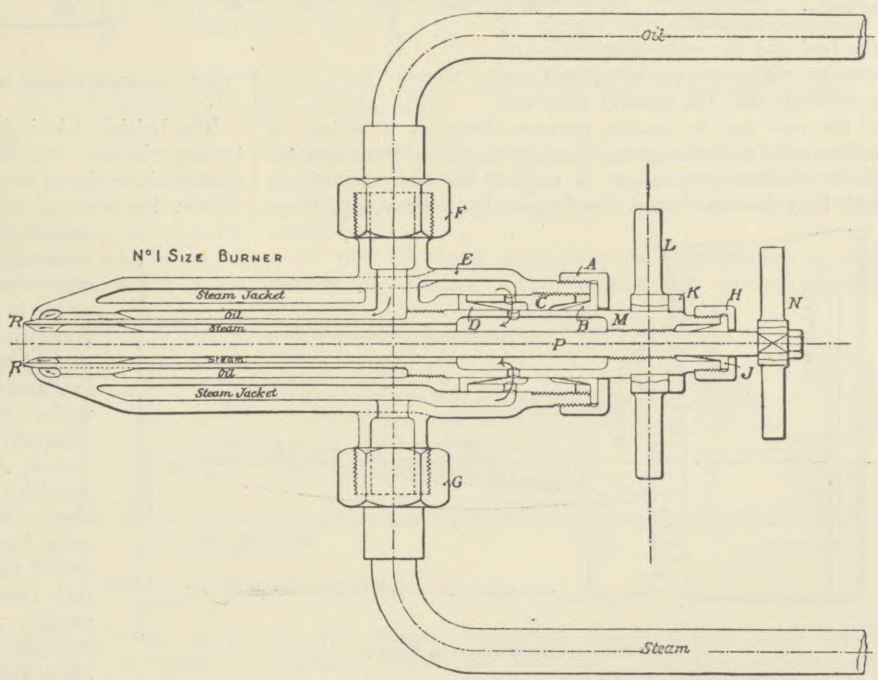

Fig. 2.—Rusden and Eeles Burner.

Liquid fuel in locomotives.

The mechanical apparatus for applying petroleum to steam-raising in locomotives is very simple. The space in the tender usually occupied by coal is closed up by steel-plating closely riveted and tested, so as to form a storage tank. From this tank a feed-pipe is led to a burner of the combined steam-and-oil type already indicated, and this burner is so arranged as to enter a short distance inside the furnace mouth. The ordinary fire-bars are covered with a thin layer of coal, which starts the ignition in the first place, and the whole apparatus is ready for work. The burner best adapted for locomotive practice is the Holden Burner shown in Fig. 1. The steam-pipe is connected at A, the oil-pipe at B, and the hand-wheels C and D are for the adjustment of the internal orifices according to the rate of combustion required. The nozzle E is directed towards the furnace, and the external ring FF, supplied by the small pipe G and the bye-pass valve H, projects a series of steam jets into the furnace, independent of the injections of atomized fuel, and so induces an artificial inrush of air for the promotion of combustion. This type of burner has also been tried on stationary boilers and on board ship. It works well, although the great consumption of steam by the supplementary ring is a difficulty at sea, where the

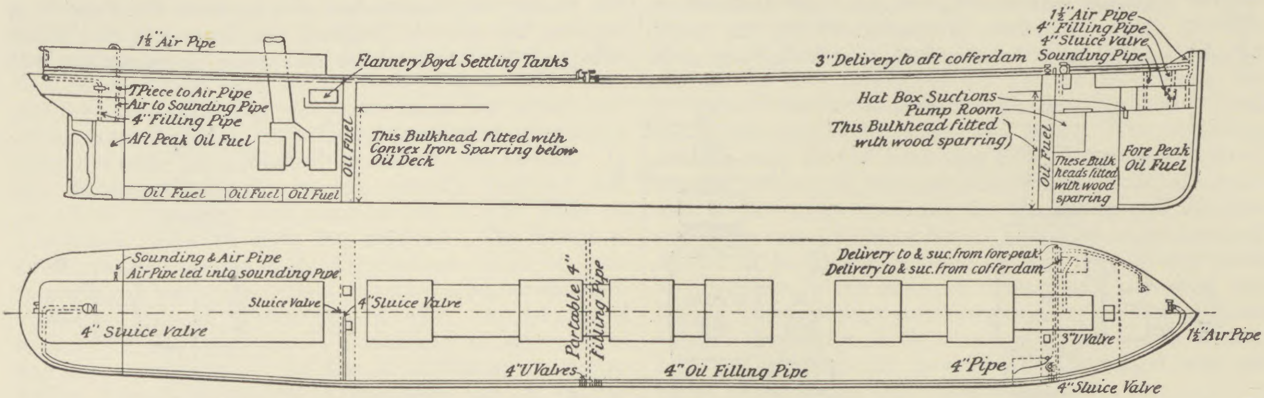

FIG. 3.—Storage of Liquid Fuel on Oil-carrying Steamers (Flannery-Boyd system).

water lost by the consumption of steam cannot easily be made up.

Although the application of the new fuel for land and locomotive boilers has already been large, the practice at sea has been far more extensive. The reason is chiefly to be found in the fact that although the sources of supply are at a distance from Great Britain, yet they are in countries to whose neighbourhood British steamships regularly trade, and in which British naval squadrons are regularly stationed, so that the advantages of adopting liquid fuel have been more immediate and the economy more direct. The certainty of continuous supply of the fuel and the wide distribution of storage stations have so altered the conditions that the general adoption of the new fuel for marine purposes becomes a matter of urgency for the statesman, the merchant, and the engineer. None of these can afford to neglect the new conditions, lest they be noted and acted upon by their competitors.

Liquid fuel at sea.

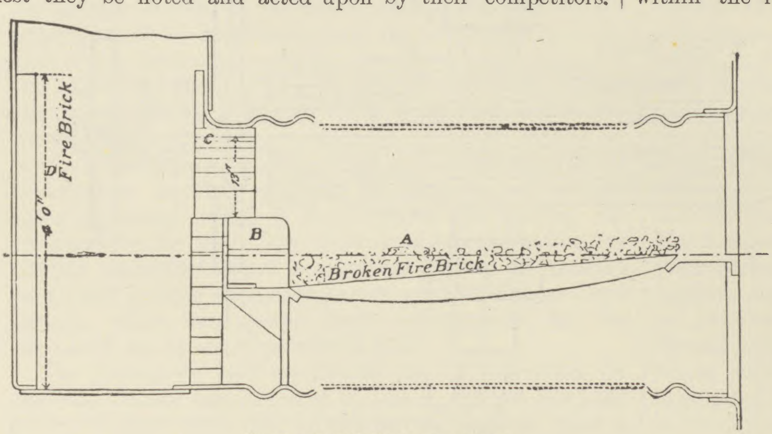

FIG. 4.—Installation on ss. *Trocas*.

Storage and supply now exist or will shortly be established in the following wide range of seaports :—London, Barrow, Southampton, Amsterdam, Copenhagen, New Orleans, Savannah, New York, Philadelphia, Singapore, Hong Kong, Madras, Colombo, Suez, Hamburg, Port Arthur, Texas, Rangoon, Calcutta, Bombay, Alexandria, Bangkok, Saigon, Penang, Batavia, Surabaya, Amoy, Swatow, Fuchow, Shanghai, Hankow, Sydney, Melbourne, Adelaide, Zanzibar, Mombasa, Yokohama, Kobe, and Nagasaki; storage arrangements are also projected in South African and South American ports.

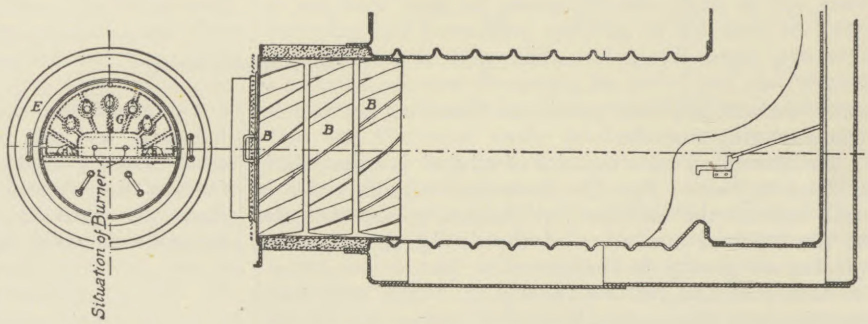

FIG. 5.—Details of Furnace, Meyer System.

The British Admiralty are proceeding with some vigour to experiment with liquid fuel at sea, and at the same time to investigate the possibility of supply from sources within the regions of the British Empire. There is an enormous supply of shale under the north-eastern counties of England, but no oil that can be pumped—still less oil with a pressure above it so as to "gush" like the wells in America—and the only source of liquid supply under the British flag appears to be in Burma. The Borneo fields are, however, under British control, and have been developed entirely by British capital. The Italian Admiralty have fitted several large warships with boiler apparatus to burn petroleum. The German Admiralty are regularly using liquid fuel on the China station. The Dutch navy have fitted coal fuel and liquid fuel furnaces in combination, so that the smaller powers required may be developed by coal alone, and the larger powers by supplementing coal fuel with oil fuel. The speeds of some vessels of the destroyer type have by this means been accelerated nearly two knots.

The questions which govern the use of fuel in warships are more largely those of strategy and fighting efficiency than economy of evaporation. Indeed, the cost of constructing and maintaining in fighting efficiency a modern warship is so great that the utmost use strategically must be obtained from the vessel, and in

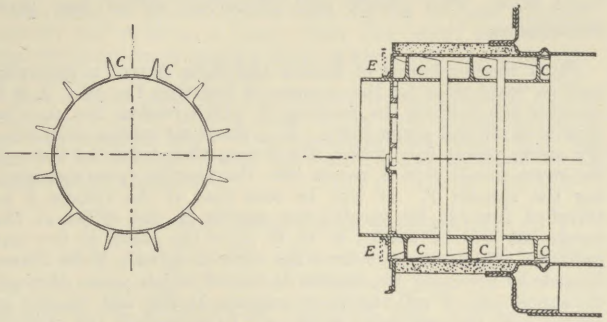

FIG. 6.—Details of Exterior Elongation of Furnace, Meyer System.

this comparison the cost of fuel is relatively so small an item that its increase or decrease may be considered almost a negligible quantity. The desideratum in a warship is to obtain the greatest fighting efficiency based on the thickest armour, the heaviest and most numerous guns, the highest maximum speed, and, last and not least, the greatest range of effective action based upon the maximum supplies of fuel, provisions, and other consumable stores that the ship can carry. Now, if by changing the type of fuel it be possible to reduce its weight by 30 per cent., and to abolish the stokers, who are usually more than half the ship's company, the weight saved will be represented not merely by the fuel, but by the consumable stores otherwise necessary for the stokers. Conversely, the radius of effective action of the ship will be doubled as regards consumable stores if the crew be halved, and will be increased by 50 per cent. if the same weight of fuel be carried in the form of liquid instead of coal. In space the gain by using oil fuel is still greater, and 36 cubic feet of oil as stored are equal in practical calorific value to 67 cubic feet of coal according to the allowance usual for ship's bunkering. On the other hand, coal has been relied upon, when placed in the side bunkers of unarmoured ships, as a protection against shot and shell, and this advantage, if it really exists, could not be claimed in regard to liquid fuel.

Advantages in warships.

Recent experiments in coaling warships at sea have not been very successful, as the least bad weather has prevented the safe transmission of coal bags from the collier to the ship. The same difficulty does not exist for oil fuel, which could be pumped through flexible tubing from one ship to the other even in comparatively rough weather. Smokelessness, so important a feature of sea strategy, has not always been attained by liquid fuel, but where the combustion is complete, by reason of suitable furnace arrangements and careful management, there is no smoke. The great drawback, however, to the use of liquid fuel in fast small vessels is the confined space allotted to the boilers, such confinement being unavoidable in view of the high power concentrated in a small hull. The British Admiralty's experiments, however, are gradually solving the problem, and the quantity of oil which can be consumed by forced draught in confined boilers now more nearly equals the quantity of coal consumed under similar conditions.

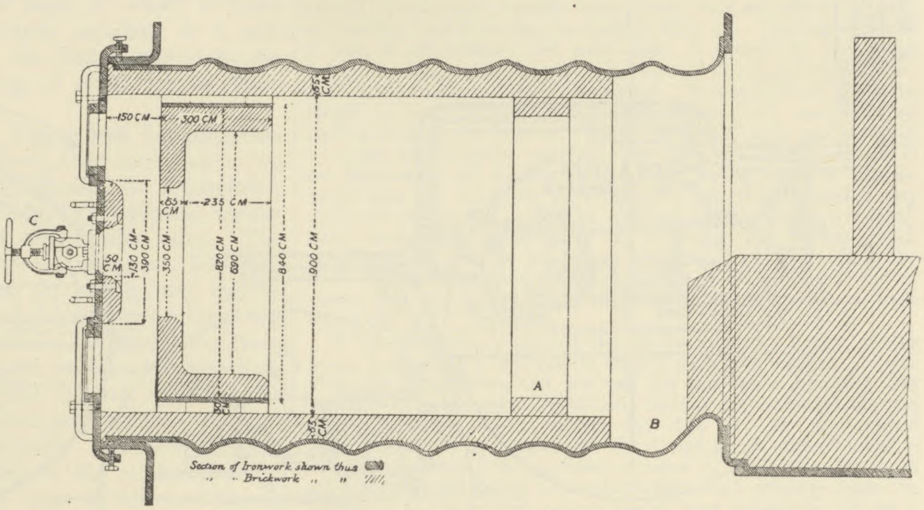

FIG. 7.—Furnace on ss. *Ferdinand Laeisz*. A, it is proposed to do away with this ring of brickwork as being useless; B, it is proposed to fill this space up, thus continuing lining of furnace to combustion chamber, and also to fit protection bricks in way of saddle plate.

In view of recent accusations of insufficiency of coal storage in foreign naval depots, by reason of the allegation that coal so stored quickly perishes, it is interesting to note that liquid fuel may be stored in tanks for an indefinite time without any deterioration whatever.

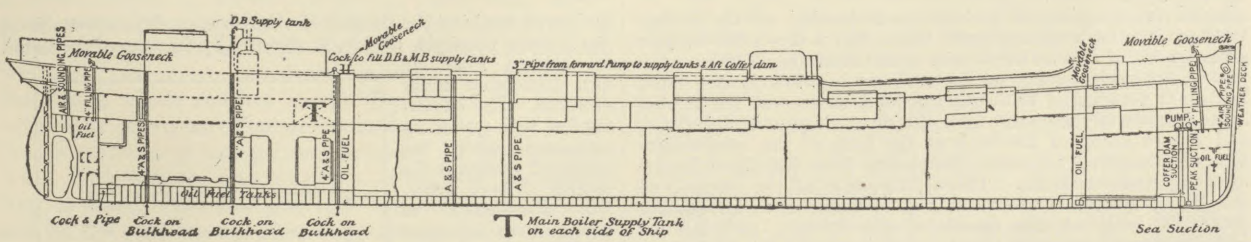

FIG. 8.—Fuel Tanks, &c., of ss. *Murex*.

In the case of merchant steamers large progress has also been made. The Shell Transport and Trading Company have twenty-one vessels successfully navigating in all parts of the world and using liquid fuel. The Hamburg-America Steam Navigation Co. have four large vessels similarly fitted for oil fuel, although differing in furnace arrangements, as will be hereafter described. One of the large American transatlantic lines is adopting liquid fuel, and French, German, Danish, and American mercantile vessels are also beginning to use it in considerable amounts.

Advantages in merchant ships.

In the case of very large passenger steamers, such as those of 20 knots and upwards in the Atlantic trade, the saving in cost of fuel is trifling compared with the advantage arising from the greater weight and space available for freight. Adopting a basis of 3 to 2 as between coal consumption and oil consumption, there is an increase of 1000 tons of dead weight cargo in a large Atlantic steamer, and a collateral gain of about 100,000 cubic feet of measurement cargo, by reason of the ordinary bunkers being left quite free, and the oil being stored in the double bottom spaces hitherto unutilized except for the purpose of water ballast. The cleanliness and saving of time from bunkering by the use of oil fuel is also an important factor in passenger ships, whilst considerable additional speed is obtainable. The cost of the installation, however, is very considerable, as it includes not only burners and pipes for the furnaces, but also the construction of oil-tight tanks, with pumps and numerous valves and pipe connexions.

Fig. 2 shows a burner of Rusden and Eeles' patent as generally used on board ships for the purpose of injecting the oil. A is a movable cap holding the packing B, which renders the annular spindle M oil and steam tight. E is the outer casing containing the steam jacket from which the steam, after being fed through the steam-supply pipe G, passes into the annular space surrounding the spindle P. It will be seen that if the spindle P be travelled inwards by turning the handle N, the orifice at the nozzle RR will be opened so as to allow the steam to flow out radially. If at the same time the annular spindle M be drawn inwards by revolving the handle L, the oil which passes through the supply pipe F will also have emission at RR, and, coming in contact with the outflowing steam, will be pulverized and sprayed into the furnace. Fig. 3 is a profile and plan of a steamer adapted for carrying oil in bulk, and showing all the storage arrangements for handling liquid fuel. Fig. 4 shows the interior arrangement of the boiler furnace of the steamship *Trocas*. A is broken fire-brick resting on the ordinary fire-bars, B is a brick bridge, C a casing of fire-brick intended to protect the riveted seam immediately above it from the direct impact of the flame, and D is a lining of fire-brick at the back of the combustion-box, also intended to protect the plating from the direct impact of the petroleum flame. The arrangement of the furnace on the Meyer system is shown in Fig. 5, where E is an annular projection built at the mouth of the furnace, and BB are spiral passages for heating the air before it passes into the furnace. Fig. 6 shows the rings CC and details of the casting which forms the projection or exterior elongation of the furnace. The brickwork arrangement adopted for the double-ended boilers on the Hamburg-America Steamship Company's *Ferdinand Laeisz* is represented in Fig. 7. The whole furnace is lined with fire-brick, and the burner is mounted upon a circular disc plate which covers the mouth of the furnace. The oil is injected not by steam pulverization, but by pressure due to a steam-pump. The oil is heated to about 60° C. before entering the pump, and further heated to 90° C. after leaving the pump. It is then filtered, and passes to the furnace injector C at about 30 pounds pressure; and its passage through this injector and the spiral passages of which it consists pulverizes the oil into spray, in which form it readily ignites on reaching the interior of the furnace. The injector is on the Körting principle, that is, it atomizes by fracture of the liquid oil arising from its own momentum under pressure. The advantage of this system as compared with the steam-jet system is the saving of fresh water, the abstraction of which is so injurious to the boiler by the formation of scale.

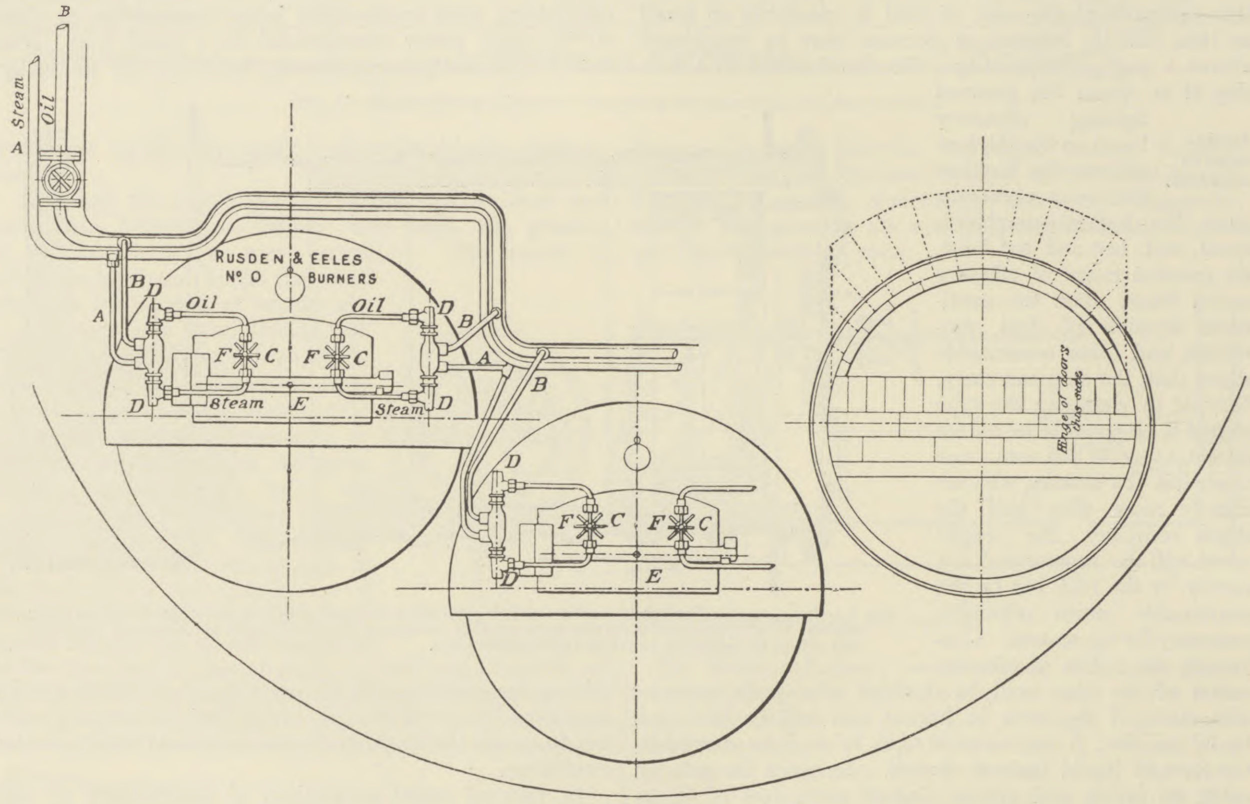

Fig. 9.—Furnace Gear of ss. *Murex*.

The general arrangement of the fuel tanks and filling pipes on the Shell Transport Company's ss. *Murex* is shown in Fig. 8; and Fig. 9 represents the furnace gear of the same vessel, A being the steam-pipe, B the oil-pipe, C the injector, D the swivel upon which the injector is hung so that it may be swung clear of the

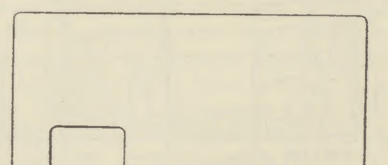

Fig. 10.—Section through Furnace of ss. *Murex*.

furnace, E the fire-door, and F the handle for adjusting the injector. In Fig 10, which represents a section of the furnace, H is a fire-brick pier, and K a fire-brick baffling bridge.

It is found in practice that to leave out the fire-bars ordinarily used for coal produces a better result with liquid fuel than the alternative system of keeping them in place and protecting them by a layer of broken fire-brick.

Boilers fitted upon all the above systems have been run for thousands of miles without trouble. In new construction it is desirable to give larger combustion chambers and longer and narrower boiler tubes than in the case of boilers intended for the combustion of coal alone. (F. F*.)

III. Mineral Oil as an Illuminant.

As early as 1781 the idea was mooted of burning naphtha, obtained by the distillation of coal at low temperatures, for illuminating purposes, and in 1820, when coal gas was struggling into prominence, light oils obtained by the distillation of coal tar were employed in the Holliday lamp, which is still to be found flourishing as the chief factor in illuminating the street barrow of the costermonger. In this lamp the coal naphtha is contained in a conical reservoir, from the apex of which it flows slowly down through a long metal capillary to a rose burner, which, heated up by the flame, vaporizes the naphtha, and thus feeds the ring of small jets of flame escaping from its circumference.

First use of petroleum as an illuminant.

It was in 1847 that James Young had his attention drawn to an exudation of petroleum that occurred in the Riddings Colliery at Alfreton, in Derbyshire, and found that he could by distillation obtain from it a lubricant of considerable value. The commercial success of this material, however, was accompanied by a failure of the supply, and, rightly imagining that as the oil had apparently come from the Coal Measure, it might be obtained by distillation from material of the same character, he commenced investigations in this direction, and in 1850 started distilling oils from a shale known as the "Bathgate mineral," in this way founding the Scotch oil industry. At first but little attention was paid to the fitness of the oil for burning purposes, although in the early days at Alfreton Young attempted to burn some of the lighter distillates in an Argand lamp, and later in a form of lamp which had been made many years before for the consumption of turpentine. About 1853, however, it was noticed that the lighter distillates were readily bought, and were being shipped to Hamburg and sent on to Germany, where lamps fitted for the consumption of the grades of oil now known as lamp oil were being made by Stohwasser of Berlin; and some of these lamps being imported, were afterwards manufactured in Great Britain by Messrs Laidlaw in Edinburgh, undergoing several improvements during the ensuing years.

In Pennsylvania in 1859 Colonel Drake's successful boring for petroleum caused the outbreak of oil fever in the States, which resulted in the flooding of the market with oil at prices never before deemed possible, and led to the introduction of lamps from Germany for its consumption. Although the first American patent for a petroleum lamp is dated 1859, that year saw forty other applications, and for the next twenty years they averaged about eighty a year.

The perfection of the mineral-oil lamp.

The English lamp-makers were not behind in their attempts to improve on the methods in use for producing the highest results from the various grades of oil, and in 1865 Messrs Hinks introduced the duplex burner, while later improvements made in various directions by Messrs Hinks, Silber, and Defries led to the high degree of perfection to be found in the lamps of to-day. Mineral oil for lamps as used in England at the present time may be defined as consisting of those portions of the distillate from shale oil or crude petroleum which have their flash-point above 73° F., and which are mobile enough to be fed by capillarity in sufficient quantity to the flame. The oil placed in the lamp reservoir is drawn up by the capillarity of the wick to the flame, and being there volatilized, is converted by the heat of the burning flame into a gaseous mixture of hydrogen and hydrocarbons, which is ultimately consumed by the oxygen of the air and converted into carbon dioxide and water vapour, the products of complete combustion.

In order to secure high illuminating power, together with a smokeless flame and only products of complete combustion, it is necessary to pay strict attention to several important factors. In the first place, the *wick* must be so arranged as to supply the right quantity of oil for gasification at the burner-head—the flame must be neither starved nor overfed: if the former is the case great loss of light is occasioned, while an excess of oil, by providing more hydrocarbons than the air-supply to the flame can completely burn, gives rise to smoke and products of incomplete combustion. The action of the wick depending on the capillary action of the microscopic tubes forming the cotton fibre, nothing but long-staple cotton of good quality should be employed; this should be spun into a coarse loose thread with as little twist in it as possible, and from this the wick is built up. Having obtained a wick of soft texture and loose plait, it should be well dried before the fire, and when put in position in the lamp must fill the wick-holder without being compressed. It should be of sufficient length to reach to the bottom of the oil reservoir and leave an inch or two on the bottom. Such a wick will suck up the oil in a regular and uniform way, provided that the level of the oil is not allowed to fall too low in the lamp, but it must be remembered that the wick acts as a filter for the oil, and that if any sediment be present it will be retained by and choke the capillaries upon which the action of the wick depends, so that a wick should not be used for too long a time. A good rule is that the wick should, when new, trail for 2 inches on the bottom of the oil vessel, and should be discarded when these 2 inches have been burnt off.

When the lamp is lighted the oil burns with a heavy, smoky flame, because it is not able to obtain sufficient oxygen to complete the combustion, and not only are soot flakes produced, but products of incomplete combustion, such as carbon monoxide and even petroleum vapour, escape into the air—the first-named highly injurious to health, and the second of an offensive odour. In order to supply the *necessary amount of air* to the flame, an artificial draught has to be created which shall impinge upon the bottom of the flame and sweep upwards over its surface, giving it rigidity, and by completing the combustion in a shorter period of time than could be done otherwise, increasing the calorific intensity and thus raising the carbon particles in the flame to a far higher incandescence so as to secure a greater illuminating power. This in practice has been done in two ways, first by drawing in the air by the up-suck of the heated and expanded products of combustion in a chimney fitted over the flame, and secondly by creating a draught from a small clockwork fan in the base of the lamp. It is necessary to break the initial rush of the draught: this is mostly effected by discs of perforated metal in the base of the burner, called *diffusers*, while the metal dome which surrounds and rises slightly above the wick-holder serves to deflect the air on to the flame. These arrangements also act to a certain extent as regenerators, the air passing over the heated metal surfaces being warmed before reaching the flame, whilst other contrivances, such as discs, cones, buttons, perforated tubes, inner air-tubes, &c., have from time to time been introduced with the object of increasing the illuminating power and completing the combustion.

The illuminating efficiency of modern oil lamps.

According to Dr Boverton Redwood, duplex burners which give a flame of 28 candle-power have an average oil consumption of 50 grains per candle per hour, while Argand flames of 38 candle-power consume about 45 grains of oil per candle per hour. These must, however, be regarded as the duties obtained from lamps of the best types, and in order to obtain information as to the efficiency of the lamps most extensively used in daily practice, a number of the most popular types were examined, using both American and Russian oil.

The results obtained are embodied in the table on the next page. The first thing that strikes one in this table is the apparent superiority of the American over Russian oil in the majority of the lamps employed, and there is no doubt that the bulk of the lamps on the market are constructed with the view of burning American or shale oil. A second interesting point is that with the flat-flame lamps the Russian oil is as good as the American. We have the authority of Dr Redwood, moreover, for the fact

Type.	Name.	Grains of Oil per candle-power per hour.		Total Candle-power.	
		American.	Russian.	American.	Russian.
Circular wick	Veritas, 60-line	64·5	112·5	122·5	78
	,, 30 ,,	42·5	50	60	60
	,, 20 ,,	43·75	58·5	40	35
	Ariel, 12-line centre draught	52·8	70·9	18	18
	Reading, 14-line	97·9	85·4	12	12
	Kosmos, 10-line	63·9	97·2	9	9
	Wizard, 15-line	56·9	51·3	18	19
Flat wick, single	Wanzer, no glass	42·6	48·3	17	17
	Solid slip, gauze and cone	84·4	84·4	8	8
	Old slip, fixed gauze	60·9	89·3	7	7
,, duplex	Feeder wick	56·2	55·7	20	22
	Ordinary	51·2	46·6	20	22

American oil—Sp. gr. 0·7904 ; flash-point, 110° F. Russian oil—Sp. gr. 0·823 ; flash-point, 83° F.

that after prolonged burning the Russian oil, even in lamps least suited to it, gives highly improved results. Although the average consumption with these various forms of lamps is close upon 60 grains per candle with American oil, yet some of the burners are so manifestly wasteful that 50 grains per candle-power per hour is clearly the fairest basis to take for any calculation as to cost.

Products of combustion of oil and other illuminants. Candles, oil, and coal gas all emit the same products of complete combustion, viz., carbon dioxide and water vapour. The quantities of these compounds emitted from the different illuminants for every candle of light per hour will be seen from the following table :—

Illuminant.	Cubic Feet per Candle. Carbon Dioxide.	Water Vapour.
Sperm candle	0·41	0·41
Oil lamp	0·24	0·18
Gas—Flat flame	0·26	0·67
Argand	0·17	0·45
Regenerative	0·07	0·19
Incandescent	0·03	0·08

From these data it appears that if the sanitary condition of the air of a dwelling-room be measured by the amount of carbon dioxide present, as is usually done, candles are the most prejudicial to health and comfort, oil lamps less so, and gas least, an assumption which practical experience does not bear out, the discomfort and oppression felt being distinctly less in a room lighted by candles or oil than in one lighted by any of the older forms of gas-burner. The explanation of this is to be found in these facts :—First, where we illuminate a room with candles or oil we are contented with a less intense and more local light than when we are using gas, and in a room of ordinary size would be more likely to use a lamp or two candles placed near our book or plate than the far higher illumination we should demand if gas were employed. Secondly, the amount of water vapour given off during the combustion of gas is greater than in the case of the other illuminants, and water vapour absorbing radiant heat from the burning gas becomes heated, and, diffusing itself about the room, causes great oppression. Also the air, being highly charged with moisture, is unable to take up so rapidly the water vapour which is always evaporating from the surface of our skin, and in this way the functions of the body receive a slight check, resulting in a feeling of depression.

The amount of heat emitted by our illuminants is a matter of importance upon which little has been said, and which places a distinct limit upon the size and illuminating power of oil lamps. ***Heat emitted by oil flames.*** Taking the composition of lamp oil to be 86 per cent. carbon and 14 per cent. hydrogen, the relative amount of heat evolved from gas flames and oil lamps for every candle-power of illumination per hour will be—

	British Thermal Units per Candle-power per hour.
Oil lamp	336
Gas—Flat flame	310
Argand	207
Regenerative	88
Incandescent mantle	36

A very successful form of oil lamp for use in engineering is that type of lamp represented by the "Lucigen," ***Oil-spray lamps.*** "Doty," and "Wells" lights, in which the oil is forced from a reservoir by air-pressure through a spiral heated by the flame of the lamp, and the heated oil being then ejected partly as vapour and partly as spray, burns with a large and highly luminous flame. The great drawback to these devices is that a certain proportion of the oil spray escapes combustion and is deposited in the vicinity of the light. This form of lamp is often used for heating as well as lighting, and any one who saw the wonderful engineering work at the Forth Bridge in progress will remember the effective way in which the rivets needed for that colossal undertaking were heated in trays by lamps of this type at the spot where they were required. The great advantage of these lamps was that oils of but very little value could be employed, and the light obtained approximated to 750 candles per gallon of oil consumed. They may to a certain extent be looked upon as the forerunners of perhaps the most successful form of incandescent oil-burner.

As early as 1885 Mr Arthur Kitson attempted to make a burner for heating purposes on the foregoing principle, that is, by injecting oil under pressure from a fine tube into a chamber where it would be heated by the waste heat escaping from the flame below, ***Oil applied to incandescent lighting.*** the vapour so produced being made to issue from a small jet under the pressure caused by the initial air-pressure and the expansion in the gasifying tube. This jet of gas was then led into what was practically an atmospheric burner, and drew in with it sufficient air to cause its combustion with a non-luminous blue flame of great heating power. At the time when this was first done the Welsbach mantle had not yet reached the period of commercial utility, and attempts were made to use this flame for the generation of light by consuming it in a mantle of fine platinum gauze, which, although giving a very fine illuminating effect during the first few hours, very soon shared the fate of all platinum mantles—that is, carbonization of the platinum surface took place, and destroyed its power of light emissivity. It was not until 1897 that the perfecting of the Welsbach mantle enabled this method of consuming the oil to be employed. The Kitson lamp has given results which certainly ought to ensure its future success, the only drawback to it being that it needs a certain amount of intelligent care to keep it in good working order, but where this has been forthcoming the lamp has more than fulfilled the high expectations formed of it.

In this lamp as used for outside street lighting the oil reservoir is in the base of the pillar, and is made of steel in order to withstand very high pressures, so as to be absolutely safe under the conditions of ordinary use. In this reservoir the oil is by means of a small pump put under an air-pressure of 50 or 60 ℔, which forces it up through a small capillary tube to the burner-head. Here it passes through a small cross-tube containing filtering material, for removing any solid particles in it, and is then ejected through a small aperture into a lower cross tube placed immediately above the top of the mantle, the heat from which passing upwards causes vaporization and partial gasification of the oil. The mixed gas and vapour rush out under considerable pressure from a small aperture in the under side of the tube down what is practically an inverted Bunsen tube, through the holes in the side of which it draws in a sufficient amount of air to render the flame at the burner-head not only non-luminous but sufficiently oxidizing in its character as to prevent any deposition of carbon on the mantle. By the time the burner-head is reached, the gas is practically down to atmospheric pressure again, so that the wear and tear to the mantle are not excessive. The performances of this lamp have been most carefully studied, and experiments show that with a large single burner it is perfectly easy to obtain illuminating values of from 1000 to over 1200 candles, and that 1000 candle-power could with a large installation be readily obtained for 1d. per hour, a figure which makes this method of illumination only one-third the cost of electric arc lighting. The cost, however, must vary with the number of lamps employed. Where the installation is large enough to keep a man constantly employed, the labour item becomes reduced to a very small figure, but rises to an excessive degree when the number of lamps decreases.

Incandescent table lamps.

Oil gas and oil vapours differ from coal gas merely in the larger proportion and greater complexity of the hydrocarbon molecules present, and to render the oil flame available for incandescent lighting it is only necessary to cause the oil gas or vapour to become mixed with a sufficient proportion of air before it arrives at the point of combustion. A simple statement of this kind, however, gives no idea of the great difficulties which exist in bringing about so simple an end, as with gases so rich in hydrocarbons as those developed from oil it is excessively difficult to get the necessary air intimately and evenly mixed with the gas in sufficient proportion to bring about the desired result. If even coal gas be taken and mixed with 2·27 volumes of air, its luminosity is destroyed, but such a flame would be useless with the incandescent mantle, as if the non-luminous flame be superheated a certain proportion of its luminosity will reappear. When such a flame is used with a mantle the superheating effect of the mantle itself very quickly leads to the decomposition of the hydrocarbons and blackening of the mantle, which not only robs it of its light-giving powers, but also rapidly brings its life to a close. If, however, the proportion of air be increased, the appearance of the flame becomes considerably altered, and the hydrocarbon molecules being burnt up and so destroyed before impact with the heated surface of the mantle, all chance of blackening is avoided.

As soon as attempts began to be made to construct a satisfactory oil lamp which could be used with the incandescent mantle, this trouble showed itself to be a most serious one, as although it was comparatively easy so to regulate a circular-wicked flame fed by an excess of air as to make it non-luminous, the moment the mantle was put upon this, blackening quickly appeared, while when methods for obtaining a further air supply were devised, the difficulty of producing a flame which would burn for a considerable time without constant necessity for regulation proved a serious drawback. This has been the trouble which has militated against most of the incandescent oil lamps placed upon the market.

It soon became evident that if a wick were employed the difficulty of getting it perfectly symmetrical was a serious matter, and that it could only be utilized in drawing the oil up to a heating chamber where it could be volatilized to produce the oil gas, which on then being mixed with air would give the non-luminous flame. In the earlier forms of incandescent oil lamps the general idea was to suck the oil up by the capillarity of a circular wick to a point a short distance below the opening of the burner at which the flame was formed, and here the oil was vaporized or gasified by the heat of the head of the burner. An air supply was then drawn up through a tube passing through the centre of the wick-tube, while a second air current was so arranged as to discharge itself almost horizontally upon the burning gas below the cap, in this way giving a non-luminous and very hot flame, which if kept very carefully adjusted afforded excellent results with an incandescent mantle. It was an arrangement somewhat of this character that was introduced by the Welsbach Company. The lamps, however, required such careful attention, and were moreover so irregular in their performance, that they have never proved very successful. Many other forms have been suggested and have reached a certain degree of perfection, but have not so far attained sufficient regularity of action to make them commercial successes. One of the most successful was one devised by Herr Altmann, in which an ingenious arrangement caused the vaporization of oil and water by the heat of a little oil lamp in a lower and separate chamber, and the mixture of oil gas and steam was then burnt in a burner-head with a special arrangement of air supply, heating a mantle suspended above the burner-head.

The perfect petroleum incandescent lamp on any of these systems, however, has not yet been made, but the results that have been obtained show that when the right system has been found a very great increase in the amount of light developed from the petroleum may be expected. In the case of one lamp which was experimented with for some time it was easy to obtain 3500 candle hours per gallon of oil, or three times the amount of light obtainable from the oil when burnt under ordinary conditions.

Comparative cost of oil as an illuminant.

The cost of obtaining illuminating power of equal intensity from the various illuminating agents has been calculated, the basis of calculation in each case being the figure which practice shows to represent the average duty obtained from each. The following table gives the results:—

Cost of 1000 Candles of Light per Hour.

	s.	d.
Electricity—3½d. per unit		
Incandescent lamp	1	2
Arc	0	3¾
Coal Gas—16 c.p. at 3s. per 1000 cubic feet.		
Flat flames	1	6
Argand	1	0
Incandescent	0	2¼
,, —pressure	0	1¾
Oil—		
Duplex lamp—oil, 8d. per gallon	0	7½
Oil gas—oil, 4d. per gallon	0	6
Incandescent—lamp oil, 8d. per gallon	0	2¼
,, air gas, gasolene, 10d.	0	2
,, Kitson	0	1

(V. B. L.)

Petrovsk, a district town and seaport of Russia, on the Caspian Sea, in the province of Daghestan, Transcaucasia, 180 miles by rail east of Vladikavkaz, and 235 miles from Baku. The fort has been abandoned, but the town has become a considerable seaport, the imports reaching 400,000 tons annually, and the exports 50,000 tons. There are naphtha wells, and the hot sulphur baths at Ah-Göl and Talga, close by, attract many visitors in summer. Population (1897), 9810.

Pettie, John (1839–1893), Scottish painter, was born at East Linton, Haddingtonshire, 17th March 1839, the son of Alexander and Alison Pettie. His first art work was done in the studio of Robert Frier, and while there he made several drawings for book illustration. At the age of seventeen he entered the Trustees' Academy in Edinburgh, working under Robert Scott Lauder with W. Q. Orchardson, J. MacWhirter, W. M'Taggart, Peter Graham, Tom Graham, and G. P. Chalmers. He first exhibited at the Royal Scottish Academy in 1858, the subject chosen being "The Prison Pet," following it in 1859 with a "Scene from the Fortunes of Nigel," and two portraits; and at the Royal Academy with "The Armourers" in 1860. The success of this work and of its successor, "What d'ye Lack, Madam?" in the following year, encouraged him to settle in London (1862), where he joined Orchardson. In 1866 he was elected an Associate of the Royal Academy, and in 1873 received full Academical honours in succession to Sir Edwin Landseer. His diploma picture was "Jacobites, 1745." Pettie was a hard and rapid worker, and, in his best days, a colourist of a high order and a brilliant executant. He was a successful portrait-painter, if not quite in the front rank; but he will always be better known for his subjects drawn from the romance of history, especially that of his native country. He was an accurate and charming draughtsman, with a capacity for the dramatic arrangement of a composition, and it is probable that his works of this class will always enjoy a very considerable popular vogue. In his early days he, along with many of his fellows, produced a certain amount of book illustration (see ILLUSTRATION). His connexion with *Good Words* began in 1861, and was continued during 1862 and 1863. In 1868 and 1869 wood-engravings after his drawings appeared in the *Sunday Magazine*. He also illustrated *The Postman's Bag* (with J. MacWhirter), Wordsworth's *Poetry for the Young* (Strahan, 1863); as well as contributing to *Pen and Pencil Pictures from the Poets* (Nimmo, 1866) and to *Touches of Nature by Eminent Artists* (Strahan, 1866). His principal paintings, in addition to those already mentioned, are "One of Cromwell's Divines" (1862); "The Trio," "The Tonsure," and "George Fox refusing to take the Oath" (1863); "The Drumhead Court-Martial" (1865); "An Arrest for Witchcraft" (1866); "Sir Hugh and Ralph in the Stocks," "A Visit to the Necromancer," "The Rehearsal," "John MacWhirter, Esq." (1871); "Terms to the Besieged" (1872); "The Flag of Truce" (1873); "A Scene in Hal o' the Wynd's Smithy" (1874); "The Sword and Dagger Fight" (1877, now belonging to the city of Aberdeen); "A Death Warrant" (1879); "Before his Peers" (1881); "Monmouth and James II." (1882); "The Vigil" (1884, in the Chantrey Collection at the National Gallery of British Art; see Plate); "Challenged" and "Sir Peter Teazle" (1885); "The Chieftain's Candlesticks" (1886); "The Traitor" (1889); and "The Ultimatum" (1892). Pettie died at Hastings on the 21st February 1893, at the age of fifty-four, and was buried in Paddington Cemetery. In 1894–95 a selection of his work was included in the Winter Exhibition of the Royal Academy.

See Sir WALTER ARMSTRONG's article in the *Dictionary of National Biography*.—W. MATTHEWS GILBERT in the *Art Journal*. (E. F. S.)

Pézenas, town and railway station, arrondissement of Béziers, department of Hérault, 26 miles in direct line west-south-west of Montpellier. The distilling of absinthe and other spirits, and the manufacture of distilling apparatus, casks, &c., are the principal industries. The commerce in cognac, spirits, and wines is so important that the prices current for these at the weekly sales are registered throughout the wine marts of France and Europe. A handsome monument of Molière, who lived here for several years, was erected in 1896. Population (1881), 6502; (1901), 6951.

Pfäffers. See RAGATZ.

Pfleiderer, Otto (1839–——), German Protestant theologian and philosopher, was born near Cannstadt in Würtemberg on 1st September 1839. From 1857 to 1861 he studied under Baur at Tübingen, and afterwards studied in England and Scotland. He then entered the Church, and for a short time held a pastorate at Heilbronn; but in 1875 he was called to the chair of systematic theology at Berlin, having made his name by a series of articles on New Testament criticism and Johannine and Pauline theology, which appeared in Hilgenfeld's *Zeitschrift für wissenschaftliche Theologie*, and by his *Paulinismus*, published in 1873. *Das Urchristentum* was published in 1887, and in 1890 *The Development of Theology since Kant, and its Progress in Great Britain since 1825*, which was written for publication in England. Kant's essay *Was ist Aufklärung?* is taken as the programme of the task to which German philosophy has devoted itself since his day. "The Influence of the Apostle Paul on Christianity" was the title of a course of Hibbert Lectures given in London in 1885. In 1894 he delivered the Gifford Lectures at Edinburgh, the subject being "The Philosophy and Development of Religion." In New Testament criticism Pfleiderer belongs to the critical school which has grown out of the impulse given by Baur. But, like other modern German theologians, he shows a greater disposition to compromise, and has none of the dogmatic narrowness that was at one time a characteristic of the German school. All his work shows a judicial tone of mind, and is remarkable for the charm of its style. Professor Pfleiderer's younger brother EDMUND (1842–1902) devoted himself to similar studies, and distinguished himself both in philosophy and theology. He too for a time held a post in the Church, and during the Franco-German war served as army chaplain, an experience described in his *Erlebnisse eines Feldgeistlichen* (1890). He was afterwards appointed professor of philosophy at Kiel, and in 1878 he was elected to the philosophical chair at Tübingen. He published works on Leibnitz, Empiricism and Scepticism in Hume's Philosophy, Modern Pessimism, Kantic Criticism, English Philosophy, Heraclitus of Ephesus, and many other subjects.

Pforzheim, a town of Germany, grand-duchy of Baden, on the outskirts of the Black Forest, 19 miles by rail south-east of Carlsruhe. It is a centre for the manufacture of gold and silver ornaments and jewellery. Amongst its public institutions may be mentioned a technical school, a hydropathic, a lunatic asylum, and a museum. Population (1885), 27,201; (1895), 33,345; (1900), 43,097.

Phaltan, a native state of India, in the Deccan division of Bombay, ranking as one of the Satara Jagirs. Area, 397 square miles; population (1891), 66,383; gross revenue (1897–98), Rs.2,29,425, of which Rs.14,810 was expended on public works; tribute, Rs.9600; number of police, 65; 33 schools, with 1355 pupils. The chief, whose title is desmukh, is a rajput by caste, tracing his descent to a grantee from a Delhi emperor in the 14th century. The town of PHALTAN is 37 miles north-east of Satara. Population (1891), 10,564; municipal revenue (1897–98), Rs.11,323.

Pharmacology.—Systematic writers on the subject differ considerably in the exact meaning which they attach to the term pharmacology (φάρμακον, a drug, λόγος, a discourse), some making it much more comprehensive than others. Binz, for instance, defines it as treating of the origin, nature, chemical and physical qualities, physiological actions, and therapeutical uses of drugs; in France and in Italy it is restricted to the mere description of medicines and their preparations, the action and uses of which as remedies are included in the term therapeutics. In the English-speaking countries of the world, and by the majority of German writers also, the meaning is now restricted to the study of the action of chemical substances (as apart from foods) on all kinds of animals, from bacteria up to man; it is, in fact, a comparative study of the action of chemical bodies on invertebrate and vertebrate animals, the ultimate aim being to obtain a wider and more accurate knowledge of remedial substances in relation to their practical

"THE VIGIL." By JOHN PETTIE.

(From a Photograph by W. A. Mansell and Co.)

application in the treatment of disease. This meaning of the word has now become fixed in the English language by use and wont. The term pharmaco-dynamics (φάρμακον, δύναμις, power), which is etymologically more correct, is often used as its equivalent, but it has never become widely adopted in the United Kingdom. Hitherto the study of pharmacological actions has been almost entirely confined to remedial agents, and especially to those in the different national pharmacopœias, but in many cases it has now been extended to substances which are not used for curative purposes. Being a comparatively recent development of medical science, it found, when it came into the field, numerous remedies of undoubted activity in general use, and for many years it contented itself with attempts to investigate and explain the actions of these, but latterly the introduction into practical use of many medicines, such as paraldehyde, antipyrin, and strophanthus, has followed the study of their actions on animals, and this tends to be more and more the case. Pharmacology is a branch of biology just as physiology is. It is also closely connected with pathology and bacteriology, for certain drugs produce structural as well as functional changes in the tissues, and in germ diseases the peculiar symptoms are caused by foreign substances (toxins) formed by the infective organisms present in the body. The effects of many of these toxins bear a close resemblance to the action of certain well-known drugs, as in the case of tetanus toxin and strychnine, and are studied by the same methods of observation and research. It is impossible also to dissociate pharmacology from clinical therapeutics; the former investigates the agents which are used in the treatment of disease, the latter is concerned with their remedial powers and the conditions under which they are to be used. Hence the word "pharmaco-therapy" has come largely into use, and most of the newer standard text-books combine together the consideration of pharmacology and therapeutics. Pharmacology is also related to toxicology, as many remedial and other agents are more or less poisonous when given in large doses, but it does not include the detection, tests, and the other strictly medico-legal aspects of poisoning.

History.

Medical writers in ancient and mediæval times had a very good idea of the general symptoms produced in man by certain important drugs, such as opium, belladonna, and alcohol, and of the effects of certain purgatives, emetics, and so on, but they were without any accurate conception of the why or wherefore of these effects, and of the special organs on which their actions were exerted. Pharmacology necessarily had to wait on the development of chemistry, physics, physiology, pathology, and medical diagnosis. Until physiological research had investigated and explained the structure, function, and mechanism of the tissues and organs of the body in their normal conditions, it was hopeless to expect that the effect of drugs on them could be profitably studied. Pharmacology therefore took origin as the result of the application of strictly experimental methods to physiology. The discovery (early in the 19th century) that plants owe their remedial and poisonous qualities to small quantities of definite active principles, such as alkaloids and neutral bodies, which can be extracted in a chemically pure condition, had also a very important effect on its development. We meet first with some early experiments made by investigators who perceived that observations on man and animals might lead to a better understanding of the action of drugs. In 1676 Wepfer and Conrad Brunner demonstrated on dogs the tetanizing action of nux vomica, and similar rough experiments were repeated from time to time with other substances by later investigators. In 1755 Menghini published an elaborate study of the action of camphor on a great variety of different kinds of animals. Albert von Haller (born 1708) sought to elucidate the action of remedies by observations on healthy men, and in 1767 William Alexander made experiments on himself with drugs, which were, however, brought to an abrupt termination by his nearly killing himself. In 1776 Daries, by observations on himself and on cats, established the mydriatic action of belladonna and other atropaceous plants. Hitherto no attempt had been made to determine what particular parts of the body were especially affected by drugs, but Fontana showed, in his great work (Florence, 1765) on the venom of the viper and on other poisons, that the general symptoms were brought about by an action on particular organs. In the course of his researches he performed more than six thousand experiments, more than four thousand of which were on animals, and he determined the effects on the heart and other isolated parts. These analytical methods of research were well known to the second Monro in Edinburgh, and to his pupils, one of whom, William Alexander, wrote a thesis in 1790 entitled "De partibus corporis animalis quae viribus opii parent." His methods were doubtless known also to the French physiologist Magendie, who improved upon them, and who in 1809 published a research on the Upas Tieuté and other strychnine-containing plants, in which he showed that their effects were due to an action on the spinal cord. The researches of his pupil, Claude Bernard, on curare, were equally exact and logical, and have served as the model for many subsequent investigations. In consequence, from the time of Magendie pharmacology may be said to have been put on a more exact basis. By the middle of the 19th century there were many workers on the subject, and the actions of such drugs as digitalis, morphine, alcohol, and many others had been frequently and minutely investigated. About this time Buchheim, professor of materia medica in Dorpat from 1846 to 1879, founded the first pharmacological laboratory on modern lines in Europe, and he performed a still greater service by introducing a more rational classification of drugs than had hitherto been in use, arranging them in groups according to their pharmacological actions. In the herbals and older treatises on materia medica and therapeutics, no explanation is usually offered of the action of medicines, and in such works as that of Cullen (1789) only a few of the more obvious actions are occasionally explained according to the current theories of physiology and pathology. In works such as Pareira's *Elements of Materia Medica and Therapeutics* (1842), the physiological effects of medicines are usually described, but very briefly as compared with the materia medica. At the present day most text-books dealing with medicinal agents and treatment devote a large part of their space to pharmacology, and a corresponding change has taken place in the teaching of the subject in our universities and medical schools. Since Magendie's time very numerous papers dealing with pharmacological subjects have appeared in such journals as the *Journal of Anatomy and Physiology*, the *Journal of Physiology*, Virchow's *Archiv*, and the principal medical periodicals of all countries. In 1873 the *Archiv für experimentelle Pathologie und Pharmakologie* first appeared, and in 1895 the *Archives Internationales de Pharmakodynamie*, both chiefly or entirely devoted to pharmacology.

The methods of research are essentially those employed by physiologists, the action of substances being studied in the usual way on bacteria, leucocytes, frogs, rabbits, and other animals. Not only are the general symptoms investigated, but it is necessary to carry out experiments on the nerves, muscles, circulation, secretions, &c., so as to get a more exact knowledge of the reasons of the general action. It is true that many of these animals react somewhat differently to drugs, both as regards each other and as regards man, but for the most part the differences are quantitative rather than qualitative. After carrying out a series of observations on animals, the drug can be assigned to its special group, and a good idea can be obtained of its possible practical value or the reverse; hence there is a saving of time and an avoidance of the necessity of testing its effects on man. The action of a drug may be called direct, when it acts on any part to which it is immediately applied, or which it may reach through the blood; and indirect, when one organ is affected secondarily to another, as, for instance, in strychnine poisoning when the muscles are violently contracted as the result of the action of the alkaloid upon the spinal cord. In a few cases the action is merely physical, but most frequently it is chemical in its nature, and is exerted on the living cell, the activity of which is either stimulated or depressed. In some cases the substances actually enter into a chemical combination with the protoplasm, which may be temporary or (much less frequently) permanent; in other cases they seem simply to modify or disturb the usual chemical activity of the cells. Prolonged or excessive stimulation invariably leads to depression or paralysis, the tissues becoming, in fact, fatigued, and from this condition they may recover or they may not. When we come to consider more in detail the results of these actions, we find that the various secretions of the body, such as the sweat, gastric juice, bile, milk, urine, &c., may be increased or diminished; that the heart may have its muscular or nervous apparatus stimulated or depressed; that the nerve-centres in the brain, medulla, and spinal cord may be rendered more sensitive or the reverse; and that the general metabolism of the body may be altered in various ways. In addition, the fluid constituents, such as the lymph and blood, may have their composition and bulk considerably altered, while the special senses, the temperature, and, in short, every function and tissue, may be more or less affected.

Action of drugs.

Some drugs given in excess are poisons to all forms of protoplasm, but when given in doses much short of the lethal they usually exhibit a distinct tendency to affect specially, and at an early period, certain organs or tissues, and hence result differences in action; others may act only on certain organs, leaving the others practically untouched. It is often possible by appropriate dosage to contrive that these special parts or organs may be affected and the rest of the body left practically intact, and it is by taking advantage of these selective actions that remedial or therapeutical effects are usually obtained. Some substances have a very wide range of action, and involve a great variety of structures, while others, such as purgatives, have a very limited sphere.[1] The most important of these circumstances is age, but speaking broadly this is really a question of bulk, the child being affected as the adult, but by smaller doses. There are exceptions to this, however, as children are more affected in proportion by opium and some other substances, and less by mercury and arsenic. In old age also the nervous system and the tissues generally do not react so readily as in youth. Habit, race, personal temperament, emotional conditions, disease, the time and circumstances of administration, and other accidental causes may also modify the action in man. Some species of animals are much more susceptible to the action of certain drugs than others, a condition which depends on obvious or unknown structural or metabolic differences. In the same way some individuals show a special tendency to poisoning by doses of certain drugs which are harmless to the great majority of mankind, and hence we get unexpected or unusual results, these arising from special susceptibility on the part of certain organs. These idiosyncrasies are not confined to drugs, but are seen with a few articles of food, such as eggs and shell-fish. It is well known that the habitual consumption of certain drugs, such as tobacco, Indian hemp, opium, arsenic, alcohol, and many others, gradually induces a condition of tolerance to their effects, so that large doses can be taken without causing symptoms of poisoning. In all cases, however, there is a limit, and after it is reached the ordinary effects of these substances are seen. Some individuals, however, never become tolerant, and show poisonous effects on each repetition of the dose. The degree of tolerance often differs in individuals at different times and in different circumstances, and may become quite lost by breaking off the habit for a short time. The explanation generally given is that the nerve and other cells become accustomed to the drug, so that they cease to react, or that an antitoxin is formed which antagonizes the poison, or that the poison is rapidly destroyed in the body. Recent researches on arsenic and atropine, however, point to the leucocytes as playing an important part in the production of tolerance, as these gradually become capable of ingesting large amounts of the foreign substances, and thus render them more or less harmless to the tissues, until they are gradually excreted from the body. But in the case of arsenic an antitoxin also forms in the blood. When the amount is too large to be dealt with by the leucocytes, poisoning seems to occur even in the most habituated. Tolerance is therefore analogous to the immunity which takes place with the toxins of infectious diseases and snake poison. Certain substances, notably digitalis, lead, mercury, and strychnine, exhibit what is called a cumulative action—that is to say, when small quantities have been taken over a period of time, poisoning or an excessive action suddenly ensues. The explanation in these cases is that the drug is absorbed more rapidly than it is excreted, hence there is a tendency to its accumulation in the body until a point is reached when the amount becomes poisonous.

Bodies which have a close resemblance in their chemical constitution exhibit a similar resemblance in their pharmacological action, and as the constitution of the substance becomes modified chemically so does its action pharmacologically. Numerous researches have demonstrated these points with regard to individual groups of substances, but hitherto we have not been able to formulate any fixed laws regarding the relationship between chemical constitution and physiological action.

When drugs are swallowed no absorption may take place from the alimentary canal; but, as a rule, they pass from there into the blood, in which they circulate, and thus exert their action on different organs. Absorption may also take place from the skin, from the rectum, from the respiratory passages, or from wounds, and from direct injection into the subcutaneous tissue or into a blood-vessel. Very rarely, as in the case of silver salts, excretion does not take place; but usually the drug is got rid of by the bowel, urine, bile, saliva, bronchial mucous membrane, or the other ordinary channels of elimination. Just as drugs act upon the tissues, so they themselves are in many cases reacted upon, and broken up or altered. While in the alimentary canal they are subjected to the action of the digestive fluids and the varied contents of the stomach and intestines, and after absorption they come under the influence of the constituents of the blood and lymph, and of the chemical action of the tissue cells. Inorganic bodies, such as metals, may enter into albuminous combinations which may greatly modify their effects, and organic substances may be split up into simpler compounds by

[1] The action of drugs is often modified by circumstances peculiar to the individuals or animals to whom they are administered.

oxidation or reduction, or may be rendered more complex by synthesis.

The antagonism between certain drugs has been much studied in relation to their use as antidotes in poisoning, but what is aimed at in these cases is to counteract the effects rather than to obtain a direct physiological antagonistic action. The substances which directly antagonize each other by acting on the same tissue are few in number, but there are numerous instances in which the effects or symptoms may be obviated by acting on another tissue. Thus curare may stop strychnine convulsions by paralysing the terminations of motor nerves, and chloroform may exercise the same effect by abolishing the irritability of the spinal cord. If two poisons act on the same tissue, one stimulating and the other paralysing it, the paralysing substance removes the action of the stimulant substance, not by bringing the tissue back to its normal state, but by abolishing its excitability; hence, although life may be saved by such an action, yet it can only be so within certain limits of dosage, because the antagonism is never complete at every point.

Speaking in the widest sense, every substance has an action on living protoplasm, but for convenience' sake pharmacological substances have come to be limited to those which are used as drugs, or which have a distinct action upon the animal organism, although they may not be put to any practical purpose. Such substances are derived from (1) the chemical elements and their compounds; (2) plants; and (3) animals. The first class includes such substances as iodine, mercury, iron, carbon, and their various compounds, and such bodies as alcohol, chloroform, and chloral, all of which are found in Nature or can be prepared by ordinary chemical processes of manufacture. From plants many substances are obtained which at the present time we are unable to make in the chemical laboratory, and of the constitution or composition of which we are in many cases ignorant. Some of these, such as resins, gums, essential oils and fats, are readily obtained as natural exudations or by very simple manipulations, while others, such as the alkaloids, glucosides, and vegetable acids, often require to be extracted by very complex processes. Substances obtained from animals include gland secretions, pepsin and other ferments, musk, cod-liver oil, &c., and to these may be added various antitoxins. The classification of substances having pharmacological actions presents so many difficulties that no satisfactory or universally adopted method has yet been proposed. As a matter of fact, our knowledge presents so many gaps, and the mode of action of many remedies is so obscure and imperfectly understood, that any arrangement adopted must be more or less tentative in character. The close alliance between pharmacology, therapeutics, and clinical medicine has induced many authors to treat the subject from a clinical point of view, while, on the other hand, its relationships to chemistry and physiology have been utilized to elaborate a chemical and physiological classification respectively as the basis for systematic description. Certain writers in despair have adopted an alphabetical arrangement of the subject, while others have divided it up into inorganic, vegetable, and animal substances, following the botanical natural orders and the divisions of the animal kingdom. These last-mentioned methods, however, are far behind our present state of knowledge, and need not be discussed here. The objection to a strictly chemical classification is, that while many substances closely allied chemically have a somewhat similar action in certain respects, yet in others they differ very widely—a striking example of which is given in the case of sodium and potassium. A physiological classification according to an action on the brain, heart, kidney, or other important organ becomes still more bewildering, as many substances produce the same effects by different agencies, as, for instance, the kidneys may be acted upon directly or through the circulation, while the heart may be affected either through its muscular substance or its nervous apparatus. A clinical or therapeutical classification into such divisions as anæsthetics, expectorants, bitters, and so on, according to their practical applications, also leads us into difficulties, as many drugs are employed for numerous purposes, and they cannot therefore be strictly classified in this way. The ideal method of grouping pharmacological substances would be in reference to their chemical action on living protoplasm, but as yet our knowledge is too scanty for this. At the present time the method adopted by Buchheim, or some modification of it, is the most scientific. As the result of painstaking investigations he grouped together all those substances having similar actions, giving to each group the name of its best-known or most thoroughly investigated member. Once the groups were more or less fixed any new substance could, when its action was determined, be referred to its own group, and thus be placed or classified. As few substances are absolutely identical in action, but only broadly similar, it is often difficult to divide sharply one group from another. In a *résumé* it is manifestly impossible to pass in review every pharmacological substance, and we shall therefore confine ourselves to those groups which are of practical importance. Many of the individual drugs have been already described, and detailed information regarding them may be obtained by reference to the particular headings in the earlier volumes (ninth edition) of this Encyclopædia.

Classification.

Group I.—*Acids.*—This includes sulphuric, hydrochloric, nitric, phosphoric, tartaric, citric, acetic, and lactic acids, all of which owe their action to their acidity. Many of the other acids, such as carbolic and salicylic, have specific effects which have no relationship to their acid reaction. The concentrated acids have an intense local action, varying from complete destruction of the tissues to more or less irritation. When considerably diluted they lose this, and are only slightly irritating; externally applied and in the stomach they have an antiseptic action; they increase the secretion of saliva, and thus assuage thirst. In the intestine they combine with ammonia and other alkalis present, and are absorbed into the blood as neutral salts, being excreted chiefly in the urine. In small doses they somewhat increase general metabolism. Boric acid only belongs partially to this group, as it and its compound borax have certain specific actions in addition.

Group II.—*Alkalis.*—This includes caustic potash, caustic soda, solution of ammonia, their carbonates and bicarbonates, borax, soaps, lithium carbonate and citrate, quick lime, slaked lime, chalk, magnesia, and magnesium carbonate. All these substances, apart from any other actions, exert a similar effect upon the body in virtue of their alkalinity. When they are taken internally in small amounts they neutralize the acids in the stomach and other parts of the alimentary canal, and at the same time they increase the normal acid secretion of the stomach. After absorption into the blood, which they make somewhat more alkaline, they are excreted chiefly in the urine, to which they impart an alkaline reaction if given in sufficient quantity. Some of them by stimulating the kidney cells act as diuretics, but others apparently lack this action. Caustic potash and caustic soda are locally very irritating, and destroy the tissues, but lose this quality when combined with acids as in the case of their carbonates, bicarbonates, and borax. Quick lime is also caustic, but magnesia is bland and unirritating. Weak solutions applied locally saponify fats, soften the epidermis, and thus act as slight stimulants and cleansers of the skin. Calcium salts form insoluble soaps with fats, and combine with albumen in a manner which makes them soothing and astringent rather than irritating locally. Apart from alkaline effects, these metals differ considerably pharmacologically. Potassium and lithium have a depressing action upon the nervous system, ammonium salts have a stimulating action, while sodium practically speaking is indifferent. Calcium and magnesium have actions somewhat similar to that of potassium. Most of these substances are normal constituents of the body, and indispensable for healthy existence. They are contained in sufficient amount in our ordinary dietary to supply the needs of the organism.

Group III.—*Easily absorbed Salts.*—Sodium chloride may be taken as the type of those salts which diffuse readily, and which are therefore easily absorbed. Sodium nitrate, potassium nitrate, potassium chloride, ammonium chloride, the alkaline iodides and bromides, also belong partly to this group, although most of them have specific actions in addition. Locally they cause considerable irritation, and when swallowed in concentrated solution may cause vomiting. From the stomach and intestines they are rapidly absorbed, and rapidly excreted from the blood, increasing all secretions and the general metabolism. These effects are apparently due to their irritating action upon individual cells.

Group IV.—*Salts absorbed with difficulty.*—This group includes the sulphates of sodium, potassium, and magnesium, the acetate and tartrate of potash, citrate of magnesium, sodium phosphate, sodium tartrate, and similar salts. Locally their action is slight, but when taken internally, dissolved in water, they are not absorbed from the alimentary canal except in very limited amount. They therefore remain for the most part in the intestine, and as they attract and retain large quantities of water, and at the same time slightly stimulate the mucous membrane, they come to have a purgative action and form the well-known group of saline cathartics. The small portion which is absorbed exerts a diuretic action.

Group V.—*Heavy Metals.*—These include iron, manganese, aluminium, chromium, zinc, copper, silver, gold, platinum, lead, mercury, and probably antimony, arsenic, and bismuth. Although some of these differ very greatly in their actions after absorption, still locally they have certain effects in common due chiefly to their chemical action on albumen. Their soluble salts precipitate albumen and preserve it, strong solutions being extremely irritant or caustic, while weaker ones are astringent simply, or even soothing. They are all antiseptics. Their insoluble compounds are much less active locally than the soluble, and in many cases are only effective to the extent to which they are dissolved by the secretions. Some metals are only absorbed from the alimentary canal to such a very limited amount that they exert no general action, while others readily pass into the blood and give rise to more or less marked effects. All of them injected into the blood in large doses act as muscle and nerve poisons, and during their excretion by the kidney usually irritate it severely, but only a few are absorbed in sufficient amount to produce similar effects when given by the mouth. When iron is injected directly into a vein it depresses the heart's action, the blood pressure, and the nervous system, and during its excretion greatly irritates the bowel and the kidneys. When taken by the mouth, however, no such actions are seen, owing to the fact that very minute quantities are absorbed, and that these become stored in the liver, where they are converted into organic compounds and ultimately go to form hæmoglobin. Soluble salts of manganese, aluminium, zinc, copper, gold, platinum, and bismuth have, when given by the mouth, little action beyond their local astringent or irritating effects; but when injected into a blood-vessel they all exert much the same depressing effect upon the heart and nervous system. Silver resembles them closely, but differs by the circumstance that it is deposited permanently in minute granules in the tissues, and, without affecting the general health, stains the skin of a bluish colour (argyria). Mercury and lead are absorbed from the bowel in considerable quantities, and are capable of inducing acute irritant poisoning as well as chronic poisoning. In the case of lead, the metal poisons the muscular and nervous systems, and gives rise to paralysis, wasting, colic, and other symptoms, while in the case of mercury, tremors, salivation, anæmia, and very marked cachexia are induced. Arsenic and antimony do not form combinations with albumen, but they both greatly depress the central nervous system and circulation; and, if their action be long continued in large doses, they cause fatty degeneration of the viscera and disappearance of glycogen from the liver. Locally they are both very irritating, and antimony has a special tendency to cause vomiting.

Group VI.—*Halogens.*—This group includes iodine, bromine, and chlorine, in their free state or as compounds. Locally they are all three strongly irritant or caustic, owing to their chemical action on albumen. They are in addition powerful germicides, and by splitting up water may act as oxidizing agents. Owing to their strong affinity for the hydrogen of organic compounds, they often act as bleachers and deodorizers. Iodine has a special interest, from the fact that it is a necessary constituent of our food, and is present in the secretion of the thyroid gland. Apart from certain conditions of ill-health, the iodides, as such, have no very marked influence on the healthy body beyond their saline action. Alkaline bromides, in addition to their saline action, have in sufficient doses a depressing effect upon the central nervous system, and less markedly upon the heart. Chlorine compounds are not known to exercise any action of a similar kind.

Group VII.—*Sulphur.*—Sulphur itself has no action, but when brought into contact with the secretions it forms sulphides, sulphites, and sulphuretted hydrogen, and thereby becomes more or less irritant and antiseptic. In the bowel its conversion into sulphides causes it to act as a mild laxative. Baths containing sulphuretted hydrogen or alkaline sulphides have a slightly irritating effect upon the skin, and stimulate the general metabolism.

Group VIII.—*Phosphorus.*—This includes phosphides, and, according to some authorities, hypophosphites. Phosphorus is present in all cells, in considerable quantity in the nervous tissue, and in the bones as phosphates. It is therefore, in some form or other, a necessary part of our dietary. When the element itself is taken by the mouth it is an irritant poison in large doses; in small doses the only effects which are noticeable consist in an increased formation of bony and connective tissue, although it is also supposed to exert a gently stimulating effect upon the nervous system.

Group IX.—*Oxygen.*—When pure oxygen is inhaled the only effect is a slight increase of the amount of the gas in the blood, but this has no particular physiological effect. The pharmacological action of hydrogen peroxide (H_2O_2), potassium permanganate, powdered charcoal, and some other oxidizing agents depends on the readiness with which they give up oxygen.

Group X.—*Carbonic Acid.*—Carbonic acid gas, carbonic oxide (CO), and some other irrespirable gases produce their effects practically by asphyxiation. When dissolved in water, however, carbonic acid gas is a gentle stimulant to the mouth, stomach, and bowel, the mixture being absorbed more rapidly than plain water; hence its greater value in assuaging thirst. Nitrous oxide (laughing gas) was at one time believed to act simply by cutting off the supply of oxygen to the tissues, but in addition to that it has certainly a specific effect in producing paralysis of certain parts of the central nervous system, and hence its value as an anæsthetic; when given in small amounts mixed with air it simply produces a condition of exhilaration.

Group XI.—*Water.*—Water acts directly as a diluent and solvent in the body. It therefore increases all the secretions, especially those of the skin and kidneys, while it also stimulates the general metabolism of the body and the excretion of nitrogenous products. Mineral waters act in the same way, but their effects are very much modified by, and depend largely upon, other constituents, such as alkaline salts, iron, arsenic, sulphides, carbonic acid, &c.

Group XII.—*Tannic Acid.*—Tannic acid is present in small quantities in the great majority of plants, but in notable quantity in gall-nuts, oak bark, bearberry leaves, rhatany root, catechu, kino, red gum, bel fruit, logwood, and witch hazel, all of which are largely used as medicines. In these the variety of tannic acid is not exactly the same, but although there are slight chemical differences, they all possess the power of tanning raw hides and of preserving albuminous tissues. The action of tannic acid is strictly local, and depends upon its power of precipitating albumen and of destroying germs. It thus acts as an astringent on all mucous membranes. After absorption into the blood it loses this effect, as it is partly broken up into gallic acid and partly combined with alkalis, both of which changes nullify its action upon albumen.

Group XIII.—*Local Irritants.*—Although some of the drugs already considered have a local irritant action, they produce other effects which throw this into the background, but the substances which are here ranged under this heading depend entirely for their action on their local irritant effects.

(*a*) Those which act upon the alimentary canal:—Simple bitters such as quassia wood, columbo root, taraxacum, gentian, chiretta, and many others, irritate gently the mucous membrane of the stomach and bowels, and by increasing the secretions improve the appetite and digestion. The aromatic bitters such as camomile flowers, cascarilla bark, hops, absinthe, orange peel, and others, contain in addition small quantities of essential oils which increase their local action and give them a pleasanter flavour. The active principles in some of these bitters have been isolated pure, and have been found to be alkaloids or neutral compounds. Substances like pepper, cayenne pepper, mustard, horse-radish, and ginger irritate the stomach and bowel much in the same way, but are more pungent, and are consequently used as condiments. Some of these have a similar but less marked effect upon the skin. The large number of vegetable substances which are used as purgatives owe their action to an irritating effect upon the mucous membrane and the neuro-muscular apparatus of the bowel, whereby the secretions and peristalsis are more or less increased, as the result of which diarrhœa ensues. Some of them cause so much irritation that the discharge is very watery (hydragogue cathartics), while others, for example aloes, by acting gently on the lower part of the bowel and on its muscular coat, produce simply a laxative effect. A few of them, such as aloin and colocynthin, are also purgative when injected subcutaneously or into the blood, probably owing to their being excreted into the intestinal canal.

(*b*) Those which act on the skin:—The best known of these is cantharides (Spanish fly), the active principle of which is a colourless crystalline body—cantharidin—which is extremely irritating. On a mucous membrane or a delicate skin it exerts an irritant action, which occurs more quickly than on a thickened epidermis, such as the scalp, and according to the strength and period of application there may result redness, a blister, or an ulcer. Many other substances, such as chrysarobin, mustard, pepper, &c., are also capable of irritating the skin, the effect produced varying from mere dilatation of the cutaneous vessels to destruction of tissue.

Group XIV.—*Male-fern.*—This includes the male-fern, santonin, cusso, pomegranate bark, pumpkin seeds, and a very considerable number of other substances, all of which contain active principles which have a specific poisonous action on intestinal parasitic worms. Apart from this their actions vary considerably, but are of little practical importance.

Group XV.—*Ethereal Oils.*—This includes a very large number of substances which owe their action to the fact that they contain ethereal or essential oils. The best known of these are cloves, pimento (allspice), myrtle, eucalyptus, caraway, fennel, dill, coriander, rosemary, lavender, peppermint, spearmint, nutmeg, cinnamon, sandal-wood, turpentine, juniper berries, valerian, sumbul, and many other substances. In this group may also be included the oleo-resins, such as copaiba, cubebs, and Canada balsam; the gum-resins, such as asafœtida, myrrh, ammoniacum, and galbanum; and the true balsams, such as benzoin, storax, balsam of Tolu, and balsam of Peru. The resins when taken internally have much the same action as essential oils, which are closely allied chemically, while the benzoic and cinnamic acids present in the balsams modify their actions very slightly. Although individual essential oils may differ somewhat in action, yet chemically and pharmacologically they are fundamentally similar. They all have a poisonous action on protoplasm, which makes them useful in medicine as antiseptics, disinfectants, germicides, anti-fermentatives, and parasiticides; when locally applied they are more or less irritating, and, when very dilute, astringent. When swallowed in small doses they slightly irritate the mouth and gastric mucous membrane, increasing the secretions and producing a feeling of warmth. At the same time they increase the movements of the stomach, and also in this way hasten digestion, an action which extends to the upper part of the bowel. They are readily absorbed into the blood, and they are excreted chiefly by the kidneys in a more or less altered form, and probably also by the different mucous membranes, and even by the skin. After absorption their action, speaking generally, is exerted on the brain and spinal cord, and is at first slightly stimulant and afterwards depressing, even to the causing of sleepiness and stupor. Locally applied they depress the terminations of sensory nerves, and may thereby lessen pain. On the heart and circulation the effects are stimulant unless large doses are given, when the pulse becomes slow and blood-pressure much lessened. During excretion they irritate the kidneys and the sweat glands, and thereby increase the excretion of urine and of sweat. They also have the effect of increasing the number of leucocytes in the blood, and the more irritating of them increase the flow of blood to the pelvic organs, and may thus stimulate the uterus, or in large doses cause abortion. The various camphors, such as laurel camphor, Borneo camphor, menthol, and cumarin, are oxidized derivatives of essential oils, and differ only superficially from them in their action.

Group XVI.—*Phenol.*—This includes a very large number of bodies chemically allied to benzol, such as carbolic acid, sulpho-carbolates, creosote, wood tar, coal tar, oil of cade, thymol, salicylic acid, benzoic acid, naphthol, hydrochinon, cresol, guaiacol, ichthyol, saccharin, and many others. These all resemble carbolic acid more or less closely, and may be described as general protoplasm poisons. Locally their destructive and irritating effects vary a good deal, but even when very dilute they all have a marked poisonous action on bacteria, white blood corpuscles, yeast, and similar organisms. After absorption most of them exercise a depressing effect upon the nervous system, and are capable of reducing high temperature. They are mostly excreted in the urine.

Group XVII.—*Alcohol.*—This group also includes a very large number of chemical bodies, only a few of which are mentioned here. Ethylic alcohol is taken as a type of the action of methyl alcohol, amyl alcohol, propyl alcohol, ether, acetic ether, amyl ether, paraldehyde, sulphonal, chloroform, methyl chloride, ethyl chloride, chloral hydrate, butylchloral hydrate, and almost any number of derivatives from these. Some of them are so volatile that they produce their effects when inhaled, others when sprayed upon the skin cause intense cold and then anæsthesia; but taken in the broadest sense the action of all of them after absorption into the blood is very similar, and is exerted upon the central nervous system, more especially the cerebrum. Their effects are said to be brought about by a slight coagulating action on the substance of the grey nerve-cells. In all cases there is a longer or shorter period of excitement, followed by intoxication or narcosis, and with large doses this passes into paralysis and death from depression of the respiratory centre or of the heart. Small doses of any of them dilate the blood-vessels from an action on the vaso-motor centre in the medulla oblongata, as a result of which the heart beats more rapidly and the blood circulates more freely in the body; but larger doses have a general depressing effect upon the circulatory system. Under their action more heat is lost from the body, the general metabolism is diminished, and the temperature falls. With some of them, such as chloral and chloroform, the stimulation period is short compared with the narcotic period, while with others, such as ether, the reverse is the case.

Group XVIII.—*Nitrites.*—This group contains amyl nitrite, ethyl nitrite, methyl nitrite, nitroglycerin, sodium and potassium nitrites, erythrol-tetranitrate, and many other compounds containing nitrous or nitric acid The latter becomes reduced to nitrous in the body, and thereby exercises its characteristic effects. These consist chiefly in an action upon non-striped muscle, vaso-motor centres, blood-vessels, and the blood. When they are given by inhalation or by the mouth their first effect is to produce marked dilatation of the small arteries, with a fall of blood-pressure and a greatly increased rapidity of the heart's action. At the same time the non-striped muscles slightly lose their tonicity, and when very large doses are given the hæmoglobin of the blood becomes converted into the chocolate-coloured methæmoglobin. The volatile members of the group act much more rapidly and more transiently than the others.

Group XIX.—*Alkaloids.*—This embraces a very large number of important pharmacological substances, which differ a good deal in the details of their action, but which have this in common, that they all act upon muscle and nerve tissue. Some of them affect only certain portions of the nervous system, others have a much wider range of action; they may act in either case as stimulants or as depressants, and hence the symptoms produced by them vary very greatly.

(1) Morphine and the other opium alkaloids (codeine, narcotine, laudanine, &c.) have two prominent actions—a narcotic followed by a tetanic action. In the case of morphine, on the higher animals at least, the narcotic action is very marked, the tetanizing action slightly so; while in the case of thebaine there is practically little narcotic effect, but a tetanizing action like that of strychnine. Morphine exercises its effects chiefly upon the cerebrum and the medulla oblongata in man. It has in addition a markedly depressing action upon the respiratory centre, it lessens all the secretions except the sweat, and diminishes bowel peristalsis and the size of the pupil. Men are much more affected by it than birds, rabbits, dogs, and most other animals. Cats, on the other hand, show marked symptoms of cerebral excitement and increase of the reflexes. Compared with morphine, codeine and the other alkaloids are only slightly narcotizing.

(2) Strychnine and brucine very closely resemble each other in action, and under this heading curarine may also be included. These bodies stimulate the grey matter in the spinal cord, and cause tetanic convulsions. In the case of curare these are masked almost at once by paralysis of the terminations of the motor nerves.

(3) Caffeine is the active principle in tea, coffee, kola, maté, and guarana; while theobromine, a body closely allied to it, is found in cocoa and chocolate. They both stimulate the grey nerve-cells in the brain and cord, this being the foundation of their dietetic value and their use as nervine stimulants. They also markedly increase the secretion of urine by stimulating the secreting cells of the kidneys.

(4) Cocaine is the active principle of the coca leaf, which is chewed as a stimulant-narcotic in Peru and Bolivia. Small doses have an exciting effect on the nervous system, while larger doses are depressing. The chief action of cocaine from a practical point of view is its power of paralysing the terminations of sensory nerves.

(5) Atropine, hyoscyamine, homatropine, duboisine, daturine, and some other bodies have a paralysing action upon the ends of the motor and secretory nerves. They therefore lessen all the secretions, and among other actions dilate the pupil and increase the rapidity of the heart by paralysing the vagus. Besides this they have a stimulating action on the central nervous system.

(6) Nicotine, piturine, and lobeline are the active principles of tobacco and other substances which are smoked as stimulant narcotics. In large doses they are powerful nerve poisons, but as usually taken they exercise a gently stimulant effect upon the nervous system. Pilocarpine has an action closely allied to that of nicotine, but as it is much less poisonous (the effects produced by small doses being chiefly excessive sweating and salivation), it is capable of being utilized in medicine. Muscarine has a very close resemblance in action to pilocarpine.

(7) Physostigmine, the active principle of the Calabar bean, acts chiefly as a stimulant to voluntary and involuntary muscles, and at the same time exercises a depressing effect upon the spinal cord. It contracts the pupil.

(8) Conine, gelseminine, and sparteine all exert a paralysing effect on the terminations of the motor nerves, to the implication of which the weakened gait and other symptoms are due.

(9) Aconitine, delphinine, and many of their derivatives have a very widespread action on muscle and nerve, which are both depressed from the beginning.

(10) Apomorphine is essentially a muscle poison, but owing to the fact that minute doses stimulate the vomiting centre and cause emesis before any other symptoms are observable, its emetic action is the most prominent effect in man.

(11) Emetine acts as a gradual depressant to the nervous system in animals. In man its chief effect is its emetic action, which seems to be due entirely to local irritation of the stomach.

(12) Quinine. Several of the other alkaloids found in cinchona bark act very much like quinine, while phenacetin, antipyrin, acetanilide, and many other artificially-made substances of the same nature resemble it and each other closely. They all depress the conducting power and the grey matter of the spinal cord, and to a much less extent that of the brain. They lessen the general metabolism and lower febrile temperature. The cinchona alkaloids have a specifically poisonous effect on the parasites of malaria when present in human blood, and are in addition poisonous to all low organisms.

Group XX.—*Digitalis.*—This group-name has been given to a large number of substances which have an action similar to that of the foxglove leaves, including the active principles of strophanthus, squill, Urechites suberecta, Convallaria majalis, Nerium Oleander, Helleborus niger, Antaris toxicaria (the upas tree), and several others. The active principles of these vary a good deal in chemical composition, but they are all non-nitrogenous neutral bodies. Their action is exerted upon muscle, but chiefly upon the muscle of the heart and blood-vessels. The individual muscle-fibres contract and expand more perfectly, and thus the diastole and systole of the heart are rendered more complete, the pulse is slowed, and the blood-pressure is raised. The slowing of the heart is partly brought about by an action on the vagus centre.

Group XXI.—*Picrotoxin.*—In large doses the action of picrotoxin is exerted chiefly on the medullary nerve centres, whereby irregular tonic-clonic convulsions are produced; in minute doses it stops the secretion of sweat.

Group XXII.—*Saponin.*—Saponin and allied bodies form an abundant soapy-looking froth when shaken up with water, and they are contained in a very large number of plants, the chief of which are the Quillaia saponaria, Polygala senega, sarsaparilla, and others, known collectively as soapworts. They all act as local irritants in the alimentary canal, and after absorption are more or less depressing to the muscular and nervous systems. They produce slight nausea and increased secretion of mucus.

Group XXIII.—*Cyanogen.*—This includes compounds of cyanogen such as hydrocyanic (prussic) acid, cyanides of potassium, sodium, &c., cherry-laurel water, amygdalin, bitter almonds, and other chemical and vegetable substances which readily yield hydrocyanic acid. Hydrocyanic acid is a general protoplasmic poison, all the lower organisms being very susceptible to its action, while in the higher animals it speedily depresses or paralyses all forms of nerve tissue. It enters into combination with hæmoglobin, forming a bright scarlet compound and interfering with respiration. It kills by its paralysing effect on the motor ganglia of the heart and on the respiratory centre.

Group XXIV.—*Ferments.*—These include such bodies as pepsin, diastase, the pancreatic ferments, papain, the pine-apple ferment, taka-diastase, and others, and serve to convert starch into saccharine substances, or albumen into peptone and albumoses.

Group XXV.—*Animal Glands and Secretions.*—Of these the thyroid gland, the suprarenal bodies, the spleen, the bile, the bone marrow, the ovaries, and some others have been investigated fully. Speaking generally, when given in small doses their action on the healthy organism is slight or *nil*, but in disease some of them are capable of acting as substitutes for deficient secretions.

Group XXVI. — *Antitoxins.* — These are substances which antagonize the toxins formed in the body by pathogenic organisms, the toxins of snake venom and other animal poisons, and vegetable toxins such as abrin, ricin, &c. A healthy person can be rendered insusceptible by gradually accustoming him to increasing doses of these poisons, and this immunity is due to antitoxins which are found in the blood serum and which are products of the body cells. The nature of these antitoxic subtances is not definitely known, but they are supposed to combine with and destroy the poisons. In specific germ diseases a similar antitoxin forms, and in cases which recover it counteracts the toxin, while the germs are destroyed by the tissues. Antitoxins can be prepared by immunizing a large animal, such as a horse, by injecting gradually increasing doses of specific toxins into its subcutaneous tissue. In due time the horse is bled, the serum is filtered free of blood corpuscles, and then constitutes the antitoxic serum, which can be standardized to a certain potency. Such serums are injected subcutaneously in diphtheria, tetanus, streptococcic infections, plague, snake-poisoning, cholera, and other similar diseases. They do not harm healthy men even in large quantities.

Group XXVII.—*Neutral Fats.*—This includes cod-liver oil, almond oil, olive oil, lard, &c., all of which act as foods when taken internally, and have a merely physical emollient action when applied externally. Lanolin, linseed oil, wax, spermaceti, &c., also belong to this group. The paraffins, glycerin, and vaseline, although not fats, have much the same effect when applied externally, but they are not nutritive.

Group XXVIII.—*Sugars, Starches, Gums, Gelatin, &c.* —Although these and allied bodies are used in various ways, as drugs their action is for the most part purely mechanical or dietetic.

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Phelps, Samuel (1804–1878), English actor, was born at Devonport, 13th February 1804. His parents dying when he was a boy, he was early thrown upon his own resources, and, after a short experience of work in various newspaper offices, took to the stage as an occupation in 1826. About the same time he married Sarah Cooper, a girl of sixteen. She bore him three sons and three daughters, and died in 1867. After playing a diversity of parts with touring companies in the north of England and in Scotland, he appeared in some south of England towns in a round of prominent tragic characters, and attracted sufficient attention to be spoken of as a rival to Kean. After a short season under Webster at the Haymarket, he joined Macready's company at Covent Garden, where he first appeared in October 1837. He was with Macready for about six years at Covent Garden, the Haymarket, and Drury Lane successively, and during this period was seen in a number of important parts. In 1844, having by this time firmly established his reputation, he became co-lessee of Sadler's Wells Theatre with Thomas Greenwood and Mrs Warner. Greenwood supplied the business capacity, Phelps was the theatrical manager, and Mrs Warner his leading lady. In this position Phelps remained for twenty years, during which time he raised the Sadler's Wells house to an important position, and himself appeared in a very extensive and varied repertory of characters. Thirty-four of Shakespeare's plays were presented there under his direction. In 1861 Greenwood retired from the partnership, and Phelps, finding himself unable to cope with the business responsibilities of the management, retired from it in the following year. For the next fifteen or sixteen years he acted under various managements, his last appearance being in 1878 as Wolsey in *Henry VIII.*, under Miss Litton at the Imperial Theatre. After this his health began to fail, and he died at Coopersale, near Epping, on 6th November 1878. He was essentially a sound and capable actor, rather than one of any marked genius; and, in spite of his predilection for tragedy, was most successful in such characters of comedy as called for dry humour. Perhaps Sir Pertinax Macsycophant in Charles Macklin's *The Man of the World* was his finest impersonation. He published an annotated edition of Shakespeare's plays, in 2 vols., 1852–54. (R. F. S.)

Philadelphia, the chief city of Pennsylvania and the third city in size in the United States, is situated on the west bank of the Delaware river, 96 miles from the Atlantic Ocean and 125 miles in a direct line north-north-east of Washington, D.C., and 85 miles south-west of the city of New York. It covers an area of 129·58 square miles, and the Schuylkill river, running north and south, divides the city. The length of river front on the Delaware is 18·8 miles, and the length of wharves 6·5 miles. On both sides of the Schuylkill the river front is 14·6 miles, and the length of wharves 3 miles. The channel of the Delaware river has been deepened to 26 feet below mean low water for the distance of 5·4 miles, giving a channel of this depth for 20 miles below the Philadelphia harbour, and it is being further deepened to 30 feet. The channel of the Schuylkill river has been deepened to 22 feet for a distance of 3 miles, and to 20 feet for a distance, above, of 17·1 miles. These improvements were begun in 1895 and completed in 1899. At the confluence of these two rivers is situated the United States Naval Station at League Island, covering an area of 997 acres and having a water front of 7 miles. This is the largest fresh-water naval station in America. Windmill or Smith's Island, in the Delaware river, lying between Philadelphia and Camden, New Jersey, which is on the east bank of the river, has been removed, giving clear navigation between the two cities by constantly-crossing ferry boats.

The city is divided into 42 wards, and there are plotted upon the city plans 955,165 separate town lots. There are laid down on these plans upwards of 3000 miles of streets, but only 1542 miles are at present opened. Of these, 413 miles are unpaved, 301 miles are laid with improved sheet asphalt pavements, 362 miles with granite blocks, 134 miles with vitrified brick, 226 miles with macadam, 61 miles with cobble or rubble stone, and 29 miles with blocks. Market or High Street and Broad or 14th Street are the most important thoroughfares. The former, running east and west, is 6 miles long, and Broad Street, running north and south, has a length of 13 miles, 10 of which are paved with sheet asphalt, making it the longest street so paved in the world. There are 1850 miles of pavement, 311 bridges, and 919 miles of sewers. There are 65 lines of electric street railway, covering 175,000 miles daily, and carrying an average of 1,000,000 passengers each day. The city has 9083 electric street lamps, at a cost of 30·17 cents per night, 20,373 gas lamps, and 14,355 gasoline lamps. There were, 31st December 1901, 5,045,977 feet of electric conduit, representing an aggregate of 26,288,119 feet of duct. At the same period there were 104 miles of telegraph and telephone cable, containing 4121 miles of wire; 14,135 miles of overhead wire and 99,550 miles of underground wire. There are 1379 miles of water mains, through which in 1901 there were distributed 102,191,040,693 gallons of water, or 279,975,453 gallons a day, being 211 gallons per day for each man, woman, and child, figures which seem to show an enormous wastage. A system of slow sand filtration was being constructed in 1902 at a cost of nearly $20,000,000, and by the end of that year 300,000,000 gallons of filtered water will be furnished to the citizens daily. There are 19 reservoirs or water basins, with a capacity of 1,417,860,400 gallons, into which there were pumped, in 1901, 101,836,624,094 gallons, at a cost of $871,886. The receipts of the water department for the same period were $3,331,437, showing a profit to the city of $1,807,236.

The city has 47 small public parks or air spaces, aggregating 627 acres, besides Fairmount Park, the area of which has been increased to 3341·328 acres. The total cost of the latter, to 1st May 1902, was $6,430,000, and there had been expended on improvements $3,559,000. The Schuylkill river runs through the park for 4·2 miles, and Wissahickon creek for 6·8 miles. The commissioners of Fairmount Park are the custodians of Willstack bequest of about $800,000 for a public art gallery which has been established in the park. A large number of statues and monuments have been placed in the park, the most important for size and cost being that erected by the Pennsylvania State Society of the Cincinnati to the memory of Washington.

Municipal Government.—By the governor's approval, 1st June 1885, of a legislative enactment known as "The Bullitt Bill," the government was radically changed. The Bill was drafted and passed in the interest of good government and economy, but this utopian purpose has sadly miscarried. The law went into effect 4th April 1887, and for the year prior thereto the cost of maintaining the city was $9,434,507. The first year of the new government cost the city $13,273,893, and from this it steadily rose until in 1901 the cost reached $24,522,804. By the Bullitt Bill extraordinary powers are conferred upon the mayor of the city as its chief executive officer, who holds office for four years, and serves until his successor is duly qualified, but is ineligible for re-election for the next succeeding term. He appoints, with the plenary power of removal, the Directors of the Departments of Public Works and of Public Safety, and the presidents and directors of the Department of Public Charities and Corrections, and of the Board of Health. The heads of departments form a cabinet, with whom the mayor must consult at least once a month; and he is *ex officio* a member of all boards, with the right to vote. The salary of the mayor is $12,000 per annum, and of the two directors $10,000 each. Under the Department of Public Safety is the administration of police affairs, matters pertaining to the public health, and to the fire and police force, while under the Department of Public Works are the supply and distribution of water and gas, the care of the public highways, sewerage system, &c. The city hall or municipal building, at the intersection of Market and Broad Streets, begun in 1871, is now completed, so far as construction is concerned, and the commission for its erection went out of existence 31st December 1900. There was expended on its construction to 30th June 1900, $17,868,067. In addition there was spent, on maintenance during construction and fittings, upwards of $5,000,000. The building contains 634 rooms, with an area of 14·5 acres. The height of the main tower is 548 feet above the pavement.

Fire and Police.—The records of the fire insurance patrol show that the year 1901 was Philadelphia's least disastrous year for fires in a decade. There were 3049. The loss was $2,657,099, of which $600,736 was on buildings and $2,056,363 on personal property. This loss was protected by insurance amounting to $37,071,305. To protect the city against fire there is a force of 844 men, 50 steam fire-engines, 44 combination waggons and chemical engines, 5 chemical engines, 11 hook and ladder trucks, 5 water towers, and 13,000 street fire-hydrants. The cost of the department for 1901 was $1,072,379.

The bureau of police deals with 34 districts, and the force in 1901 was 2890, of which 2427 were patrolmen. This is obviously a wholly inadequate force to protect properly an area of nearly 130 square miles and a population of over a million and a quarter. There are 620 patrol boxes, with telephone connexion with station-houses, and in 1901 there were 61,189 arrests, of which 40 per cent. were for intoxication. There were 5135 commitments to the House of Correction, of which 956 were women and 1455 foreign-born.

Finances.—On 1st January 1902 the funded debt was $59,932,895, maturing at different periods extending over 30 years, and bearing rates of interest varying from 3 to 6 per cent. Additional loans have been authorized by a vote of the citizens to the extent of $7,800,000, at a rate of interest not exceeding 3½ per cent. To provide for the payment of the debt at maturity there is a sinking fund, which amounted at the above date to $13,642,714. There was also a floating indebtedness of $1,441,606. To meet its expenses the city has almost unlimited power of taxation of real estate, which is assessed at $901,009,664 as subject to city tax for 1902. The tax rate for the last 15 years has been $1.85 per $100. In 1901 the receipts from all sources for municipal purposes were $36,922,333, of which $15,059,783 was from taxation of real estate. The city owns real estate assessed at $62,313,924. There are 37 trust funds of the city under control of a Board of City Trusts, which amounted, 1st January 1902, to $17,880,651, of which $15,902,235 is the residuary estate of Stephen Girard for the maintenance of the college for orphan boys that bears his name.

There are 35 national banks in Philadelphia, with an aggregate capital of $21,405,000, and for the week ending 30th April 1902 their loans were $146,378,183, reserve $59,192,000, deposits $226,109,602, and circulation $9,606,737. In addition to the national banks there were, on 25th November 1901, 4 banks chartered by the state, with a capital of $250,434 and $727,578 deposits; 42 trust companies receiving deposits upon which interest is paid, subject to check, with a capital of $31,757,661, a surplus of $21,810,867, and deposits of $139,192,677; and 8 mutual benefit saving funds, with assets of $99,095,813. On 1st January 1902 there were 16 joint-stock fire insurance companies, with a capital of $8,102,875, having in force policies to the amount of $2,237,158,865, of which $365,810,371 are perpetual risks; 4 joint-stock fire and marine insurance companies, with $4,202,875 capital and $5,252,027 marine risks; and 11 mutual fire insurance companies, with outstanding risks of $106,233,582. There are also 6 life insurance companies, with 178,624 policies in force amounting to $446,206,264; 2 surety companies, with $750,000 capital and $79,778,875 risks; 1 accident company, with a capital of $100,000 and $17,466,670 risks; 5 land title insurance companies, and 1 plate-glass insurance company.

Commerce.—Though the commerce is increasing, it has not kept pace with the progress made in other branches of industry. The total imports at this port during the year ending 31st December 1901 were $47,787,361, and the total exports were $79,354,025, in which there were 50,530,408 bushels of cereals, 309,208,841 barrels of petroleum, 43,827 head of cattle, 687,274 tons of coal, 35,176,536 pounds of glucose and grape sugar, and 100,936,062 pounds of linseed oil cake. In 1901, 159 American and 961 foreign vessels entered from foreign ports, and 152 American and 976 foreign vessels cleared for foreign ports. In the same period 4403 coastwise vessels entered and 4425 cleared. Regular lines of steamers run as heretofore, and the railway lines in the city are unchanged, except in the passenger terminals of the Pennsylvania and the Philadelphia and Reading roads. By a system of elevated tracks these two lines have been brought, one to 15th and the other to 12th and Market Streets, where large and imposing stations have been erected which accommodate also the general business offices of the corporations. The gross receipts for 1901 of the Pennsylvania Railway from all lines owned or operated by it, connecting directly with the city, were $101,329,795, and the gross expenses were $65,259,543. The total tonnage was 110,226,729 tons, an increase of 5·16 per cent. over 1900; and the number of passengers carried 43,136,511, an increase of 6·16 per cent. Its capital stock, 31st December 1901, was $203,272,100, and its funded debt $88,893,323. The gross receipts of the Philadelphia and Reading Company for the year ending 30th June 1901 were $62,143,470, and the gross expenses $46,621,006. It carried in the year 22,697,295 passengers. Its capital stock is $168,000,000, and its funded debt $116,117,143.

Industries.—Philadelphia is one of the great manufacturing centres of America, with the largest locomotive works in the world and the largest shipyard in the country. Here, too, are made a greater number of yards of carpet and of oilcloth per annum than in any other place. According to the census of 1900, there were in this city 15,887 manufacturing establishments, employing 246,445 wage-earners and engaging $476,529,407 of capital. The Cramp shipyard, founded in 1830, has a worldwide reputation, as has also the Baldwin locomotive works, founded the next year. To 30th April 1902 the Baldwins had built 20,391 locomotives, of which 1275 were turned out in 1901 and 498 in the first four months of 1902, which is at the rate of 1494 for the year. The number of men employed is 11,500, the horse-power used is 7000, and the works cover an area of 16 acres. The immense works of the Cramp yard cannot be shown so satisfactorily by mere figures. It may be stated, however, that the Cramps employ 7000 men, and that the weekly pay-roll reaches $84,000. The plant represents an investment of $10,000,000, and covers more than 52·4 acres, with a water front on the Delaware river of 1229 feet. On 1st May 1902 they had 10 vessels in all stages of construction, the contract price of which was upwards of $24,000,000. These include one first-class battleship and two large armoured cruisers for the U.S. navy, and one protected cruiser for the Turkish navy. The Russian battleship *Retvizan* was launched 23rd October 1900, and is the largest battleship ever built in America. During the last twelve years this yard has supplied the U.S. navy with seventeen modern warships, beginning with the double-turreted monitor *Terror*, and including the first-class battleship *Maine* and the great armoured cruisers *Colorado* and *Pennsylvania*; to the Japanese navy one first-class protected cruiser, and to the Russian navy one battleship and one protected cruiser. Philadelphia has always been noted for its shipbuilding, and has led America in this industry from colonial days. She is the birthplace of steam navigation in the United States. John Fitch in 1785, at Philadelphia, made the first attempt, which two years later was successful. Up to the year 1902, 105 vessels had been built at Philadelphia for the U.S. navy, beginning in 1776 with the frigate *Randolph* and ending with the first-class battleship *Maine*, which was launched 27th July 1901. There were in 1902 five being built, including the armoured cruiser *Pennsylvania*, which was to be launched during the year.

According to the census of 1900, the following were the principal industries of the city, with the capital invested and value of the product:—

Industries.	Capital.	Value of Product.
Foundry and machine-shop products	$45,935,567	$38,372,971
Sugar and molasses refining	23,992,552	36,163,817
Clothing	11,526,030	28,254,896
Carpets and rugs	16,866,764	21,986,062
Leather	9,932,990	19,956,125
Woollen goods	12,874,265	18,340,012
Worsted goods	14,079,859	16,242,250
Cotton goods	12,541,083	15,723,654
Hosiery	10,024,606	13,040,905
Liquors	27,636,289	12,606,551

Population.—According to the census of 1900, Philadelphia had a population of 1,293,697, an increase of 246,733 over the census of 1890, a gain of 23·6 per cent. By the census of 1890 the city had 511,112 males and 535,842 females, of which numbers 25·74 per cent. were foreign-born, and 44·59 per cent. were engaged in gainful occupations. In 1900 the males numbered 634,485, the females 659,212, the native-born 998,357, and the foreign-born 295,340. There were 62,613 negroes. Out of 257,575 adult native-born males, 3695 were illiterate (unable to write); out of 129,378 adult foreign-born males, 13,893 were illiterate; and out of 20,095 adult negro males, 2190 were illiterate. In 1901 there were 9912 marriages, 28,215 births, and 24,137 deaths registered. In 1901 the death-rate was 18·26 per thousand. The immigration has materially decreased, only 13,304 immigrants having been landed in the year 1902, of whom 8056 were males, and 2195 came from Ireland, 2921 from Russia, 1594 from Hungary, 823 from Italy, and 1986 from Great Britain.

Domestic Life.—Philadelphia is emphatically the city of homes, a name which is now applied to it more frequently than that of Brotherly Love. According to the census of 1890, there were 187,052 dwelling-houses occupied by 205,135 families, which, taking the population as given by that census, 1,046,964, gave 5·60 persons to each house; at the same time New York had 18·52 persons to a house, and Chicago 8·60. There were in 1900 upwards of 245,000 dwelling-houses in the city, of which about 70 per cent. were owned by the occupants. This result is largely due to building societies, a form of investment which has had great influence in developing Philadelphia, where it had its origin in 1831. There were 467 of these societies in operation in Philadelphia at the beginning of 1900, with assets of $43,401,384, loans to members of $36,603,702, and undivided profits of $3,977,702.

Education.—There are 328 school-houses in Philadelphia, valued at $10,000,000, with 152,889 pupils and 3650 teachers, only 209 of whom are men. The cost of public education for 1901 was $4,223,278, or $23.15 for each child. On 10th September 1900 a new building for the Central High School for boys was opened, with 1400 pupils and 54 professors and instructors. The building was begun in 1894, and cost, with ground and equipment, $1,533,000. It has accommodation for 2000 pupils. A recent bequest to the city, by Dr Thomas W. Evans of Paris, of about $3,000,000 is for the endowment of a college and museum of dentistry in Philadelphia. The University of Pennsylvania has within the last decade jumped from a merely local institution to a national one, taking an important part in university education. The list for 1901–02 gives the number of students at 2573, and the professors and tutors at 272. The property of the university amounts to upwards of $9,000,000, and the buildings, 29 in number, are situated on property covering an area of 56 acres.

Free Library.—In 1887 the state legislature enacted its first laws tending to the formation of free libraries, and on 18th February 1891 a private body was incorporated called The Free Library of Philadelphia. In October 1892 its first branch was started, and on 12th March 1894 the main library was opened. At the close of 1894 the city councils created a public board of trustees for establishing a free library, superseding the private body, and in 1896 appropriated to it $60,000. The appropriation for 1902 is $125,000. There is a central library on Chestnut

Street, with a children's department and one for the blind, and 14 branch libraries in remote sections of the city. In 1901 it had 101 travelling libraries in active operation. The central and branch libraries on 31st December 1901 contained 239,103 books, and the circulation in 1901 was 1,915,687 books, against 632,536 in 1894. The library has already received many important gifts, among them a special collection of 500 volumes printed before 1501.

Changes and Improvements.—The business centre has moved from its original locality at the eastern end of the city to the vicinity of Broad and Market Streets, the centre of the original city. This change has been brought about by the removal of the courts of law and of all departments of the city government from the old State House or Independence Hall to the new City Hall, and the removal of the business offices of the Pennsylvania Railroad to its passenger station at 15th and Market Streets. Large office buildings have been erected in the immediate vicinity, and are occupied by banks, trust companies, corporations, lawyers, and other business people, leaving 3rd Street, the old Threadneedle Street of Philadelphia, deserted and dead. Some of the new buildings are "sky-scrapers," one of them being 20 storeys in height. To prevent the extension of this style of building, recent legislation gives power to the city to limit the height of such erections. A great change has taken place within the last few years in the conduct of retail business, and there are now five immense retail department stores, where every article for domestic or personal use can be purchased, excepting food and drink (which, however, may be obtained for consumption on the premises). Among noted improvements are the successful restoration of Independence Hall to its original state, thus preserving this fine example of pure colonial architecture as it was in historic days; the widening of Delaware Avenue along the river front, for one mile between South and Vine Streets, from between 50 and 60 feet to a minimum width of 150 feet; the building of a subway under Pennsylvania Avenue for a distance of 11,000 feet, at a cost of $5,400,000, to do away with the passage of the Philadelphia and Reading Railway trains along the street. This work was begun in November 1896, and was ready for use 20th May 1900. It required the excavation of 1,083,422 cubic yards of earth and rocks, and the laying of 183,114 cubic yards of masonry. The new United States Mint, in the northern section of the city, has a frontage of 316 feet and cost $2,000,000. Two new theatres have also been constructed on Chestnut Street, one opened in 1901 and the other in 1902. (C. H. H*.)

Philippeville, the fourth seaport of Algeria, 54 miles north by east of Constantine, on the Bay of Stora. It is connected by railway with Constantine, Batna, and Biskra. The surrounding country is laid out in vines, and its forests of cork trees yield valuable products. The town possesses an archæological museum and a Roman theatre. The harbour works having been destroyed by a storm in 1878, a new and magnificent harbour was completed in 1882. From Cape Stora on the east a mole or breakwater projects 4592 feet in a west-north-westerly direction, while from Chateau Vert on the west another mole runs out in a northern direction 1312 feet, leaving an entrance to the port about 656 feet wide. The protected area comprises an outer and an inner basin. The works begun in 1870 are not yet completed, but will ultimately provide a harbour of 1200 acres area. The tonnage, 195,000 in 1893, had grown to 400,000 in 1898. Population (1886), 17,653; (1896), 19,615; (1900), 20,450.

Philippine Islands, The.—The boundary of the Philippine Islands, fixed by the Treaty of Paris, is a line running from W. to E. along or near 20° N. and through the middle of the navigable channel of Bachi from 118° to 127° E., thence along 127° E. to 4° 45′ N., thence along 4° 45′ N. to its intersection with 119° 35′ E., thence along 119° 35′ E. to 7° 40′ N., thence along 7° 40′ N. to its intersection with 116° E, thence by a direct line to the intersection of 10° N. with 118° E., and thence along 118° E. to the point of beginning. In the description of the northern limits the line through the navigable channel of Bachi governs, as against the statement that it shall follow along or near 20° N. The cathedral in Manila is in 14° 35′ 31″ N. and in 120° 58′ 03″ E., or $10^h\ 27^m\ 55{\cdot}6^s$ W. of Washington. Spanish maps, as a rule, reckon the longitude from the meridian of San Fernando, which is 6° 12′ 20″ W. of Greenwich. The date reckoning now conforms to European usage. Prior to 1845, however, there was a difference of one day. The change was made by suppressing the date following 30th December 1844, which would have been Tuesday, and calling it Wednesday, 1st January 1845. A careful recount of the islands, made in 1889 by the United States Coast and Geodetic Survey, fixed the number at 1725; and a remeasurement of the land surface gave a total area of 119,542 square miles. The following islands have an area of more than 100 square miles: Luzon, 47,238; Mindanao, 36,237; Samar, 5040; Negros, 4854; Panay, 4708; Mindoro, 3972; Palawan, or Paragua, 3937; Leyte (Leite), 2713; Cebú, 1742; Bohol, 1439; Masbate, 1290; Catanduanes, 680; Basilan, 350; Busuanga, 328; Marinduque, 287; Dinagat, 259; Tablas, 250; Sulu, or Jolo, 241; Polillo, 231; Tawi Tawi group, 183; Guimaras, 176; Burias, 163; Siargao, 134; Sibuyan, 131; Culion, 117; Samal, 105. The coast-line of the Philippines measures approximately 11,444 miles.

Volcanoes.

There are twenty-three volcanoes in the islands, of which the following are more or less active: in the Babuyanes Islands, Babuyan, Camiguin (2415 feet), and Diplicia; in Luzon, Mayon (8978 feet), Taal (1050 feet), Bacon (4592 feet), and Bulusan; in Negros, Canloon or Malaspina (4592 feet); in the island of Camiguin, Camiguin (10,824 feet); and in Mindanao, Apo (10,824 feet) and Macaturin. Those considered to be extinct are: Caua (3920 feet), Arayat (3506 feet), Maquiling (3723 feet), Banajao (7315 feet), and Isarog (6448 feet), in Luzon; Acudining, in Leyte; Magaso, in Negros; Dinata, Calayo, Matutun, and Butulan, in Mindanao; and Sarangani (3050 feet), on Balut Grande Island, south-west of Davao. Mayon still continues very active. After its long-continued eruption in 1881 and 1882 there were minor disturbances in 1885, 1886, 1887, 1888, 1890, and 1891, none of which occasioned more harm than the crushing in of roofs in neighbouring villages by falling ashes. In the eruption of 1892 the top of the volcano was lowered by about 100 metres. A similar eruption occurred in 1893, covering the ground thickly with ashes at a distance of 8½ miles from the base of the volcano. There followed slight eruptions in 1895 and 1896. In 1897 occurred the most violent outbreak since the famous one of 1814 which destroyed 1200 lives. The eruption of 1897 began practically without warning on 23rd June, became alarming on the 24th, and destructive on the 25th, ending on the 30th. Streams of lava completely destroyed the villages of San Antonio, San Roque, Santa Misericordia, Santo Niño, and San Isidro, and injured Bigaa, Libog, and the town of San Fernando. The lava flow extended more than 7 miles from the volcano to the east, one-fourth south-east. Highways were destroyed, and much valuable agricultural land was ruined. Two hundred and twenty-six dead were recovered. The total number of victims will never be known, as the village of San Antonio was completely buried. A rain of ashes extended 100 miles to the east and 75 to the west.

Earthquakes.

The Philippines are noted for the frequency and violence of their earthquakes. A seismic observatory has been established by the Jesuits at Manila, and the systematic work carried on there and at other points in the archipelago has greatly increased our knowledge of the seismic phenomena. Palawan and the Calamianes Islands seem to enjoy almost complete immunity from earthquakes, while on the other hand seismic foci, or centres of disturbance, have been shown to exist in the north-western mountains of Luzon; in Nueva Vizcaya; in the Babuyanes Islands; in the vicinity of Taal volcano; in the vicinity of Mayon volcano; in the vicinity of Canloon volcano; in Surigao province, Mindanao; in the vicinity of Mount Apo; in the valley of the river Agusan; in the vicinity of the volcano Macaturin; and in the neighbourhood of Camiguin. In March 1892 one of the severest earthquakes ever felt in Luzon wrought havoc in the provinces of Pangasinan, Union, and Benguet, ruining Binalenon, Mangaldan, San Jacinto, Pozorrubio, Santo Tomas, and Agoo, and more or less seriously damaging sixteen other towns. Other destructive earthquakes occurred on 10th February 1894 in the district of Davao in Mindanao; on 21st June 1893 and 29th June 1894 in the valley of the Agusan river in Mindanao, ruining many towns; on the 11th of December 1895, the 8th of September 1896, and the 8th of April 1897, in the same region; and at Dapitan in 1885. In 1897 a very destructive series of shocks ruined the town of Zamboanga. Considerable loss of life was caused by falling buildings and by immense sea-waves, which swept away structures along the shore. Serious damage was done throughout the entire province of Zamboanga, the south-western coast of Mindanao in general, and the Sulu Archipelago. A new island appeared at this time off the coast of Borneo, near Labuan.

Minerals.

Although there have been no recent additions to our knowledge of the geological formation of the Philippines, much prospecting has been done since the American occupation, and extensive and rich deposits of copper and gold have been located. The provinces of Benguet, Lepanto, Abra, and Bontoc, in Luzon, have been found to constitute a mineral district of exceptional richness. Present indications are that copper, coal, and gold will yield the largest returns, ranking in the order named. The coals thus far discovered in the Philippines are highly carbonized lignites. They burn with little smoke, leaving a clear, white ash, free from clinker. Recent analyses have resulted as follows:—

Place.	Fixed Carbon.	Volatile Matter.	Water.	Ash.	Caloric Volatile Matter.	Caloric Fixed Carbon.	Fuel.
Santa Rosa .	57·94	31·75	9·23	1·08	674	5353	89·69
Caridad .	54·56	34·53	9·60	1·31	1369	5643	89·09
Esperanza .	51·96	37·56	7·80	2·68	1632	5829	89·52

None of the deposits has as yet been worked to any considerable depth. Several of the coal-fields are very extensive. Valuable minerals are known to be distributed as follows: Luzon, coal, gold, copper, lead, iron, sulphur, marble, kaolin; Catanduanes, gold; Marinduque, lead, silver; Mindoro, coal, gold, copper; Cararay, coal; Batan, coal; Raparapa, coal; Masbate, copper; Romblon, marble; Samar, coal, gold; Sibuyan, gold; Semirara, coal; Panay, coal, oil, gas, gold, copper, iron; Biliran, sulphur; Leyte, coal, oil, sulphur; Cebú, coal, oil, gas; gold, lead, silver, iron; Negros, coal, copper; Bohol, gold; Panaon, gold; Mindanao, coal, gold, copper, platinum. Cinnabar has been reported in Panay and Leyte, but its existence there is doubtful.

Climate.

A meteorological observatory was established at Manila by the Jesuits in 1865. From small beginnings it has grown into a thoroughly equipped and admirably conducted institution. The following figures are taken from its records:—

1883–1898.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
Mean temperature . . .	77°·0	77°·7	80°·4	82°·9	83°·3	82°·0	80°·8	80°·8	80°·4	80°·4	79°·0	77°·4	80°·2
Absolute maximum temperature	93·0	95·7	95·9	99·0	100·0	97·0	94·8	94·3	93·7	94·8	92·1	91·9	...
Absolute minimum temperature	65·1	61·0	63·3	66·0	71·1	70·9	70·0	69·1	70·5	68·7	64·9	60·3	...
Mean relative humidity . .	77·7	74·1	71·7	70·9	76·9	81·5	84·9	84·4	85·6	82·6	81·6	80·7	79·4
Mean rainfall (inches) . .	1·193	0·413	0·736	1·42	4·197	9·622	14·567	13·866	14·925	7·536	5·126	2·134	75·457

Absolute maximum temperature for the sixteen years, 100·0.
,, minimum ,, ,, ,, ,, 60·3.

There are three seasons: the hot and dry, the hot and wet, and the cool and dry. At Manila the hot and dry includes March, April, May, and often the first half of June; the hot and wet, the last half of June, July, August, September, and October; and the cool and dry, November, December, January, and February. On the Pacific coasts of Luzon, Samar, Leyte, and Mindanao the seasons are reversed, the rains beginning with the north-east monsoon. While the observations as to temperature, humidity, and amount of rainfall obtained at Manila may be considered as fairly typical of conditions throughout the lowland regions of the archipelago, it should be remembered that there is great individual difference between the islands. Zamboanga is some 425 miles farther south than Manila, yet it has a cooler climate. The rainfall in Mindoro is known to be much heavier than in Luzon. In the provinces of Benguet, Lepanto, Bontoc, and Abra there are extensive highlands with an elevation of 4000 to 5000 feet, having a maximum temperature of 77° Fahr. and a minimum of 45°. Observations at Baguio, Benguet, show a mean monthly temperature of 65·9° in August, 66·94° in September, and 67·4° in October. The mean daily variation for a period of ninety days was only 7·87°. The relative humidity and rainfall are somewhat less than at Manila. A highway affording connexion with this temperate highland region is in process of construction, and the preliminary survey for a railway has been completed. The Philippines are often swept by the violent cyclonic storms known as typhoons, which not infrequently cause heavy loss of life and property. Since 1880 no less than 397 typhoons have been felt at the Manila observatory. Twenty per cent. of these have occurred in September. During December, January, February, March, and April they are very rarely felt. In May, June, and July they become increasingly common. In August there is a falling off in the number, which reaches its maximum in September, gradually decreasing in October and November. In the famous typhoon of 1881, the vortex of which passed over Manila, an immense amount of damage was done in the city. Two thousand persons lost their lives in Samar and Leyte during the great storm of 1897. The typhoon warnings sent out from the Manila observatory annually save heavy loss of life and property.

Fauna.

Extensive additions to our knowledge of the Philippine fauna have been made by Everett, Platen, Whitehead, Keay, the Steere expedition (1887–88), and the Menage expedition (1890–93). The Philippines, politically speaking, and the Philippines, zoologically speaking, are not identical areas, Balabac, Palawan, and the Calamianes being characterized by the occurrence of numerous Bornean forms which are conspicuously absent from the remaining islands. While the Philippines are commonly held to form an eastern extension of the Indo-Malayan sub-region, there is nevertheless a large amount of specialization in the fauna of the islands to the eastward of the Palawan group.

Mammals are scarce. No marsupials occur. The edentates are represented by the pangolin (*Manis* sp. ?) of the Palawan group. In the seas are found the dolphin, cachalot, and dugong. Wild hogs of at least two species occur, and in some of the islands are abundant enough to do considerable damage to growing crops. The beautiful axis deer of Sulu has apparently been brought there by man. Red or brown deer occur in Basilan, Mindanao, Leyte, Samar, and the Calamianes Islands. The number of species and their respective ranges have not been satisfactorily determined. In Masbate, Panay, Guimaras, and Negros there is a dark-coloured species marked with buff spots. Deer are absent in Palawan, Tawi Tawi, Tablas, Romblon, Sibuyan, and Siquijor. Domestic goats are abundant, and do well. Sheep do not thrive in the lowlands, but are said to flourish in the highlands of Benguet. Humped cattle are raised on most of the islands. They are killed for their flesh, hides, and horns, and little attention is paid to their milk-giving properties. The Philippine horses are small, but well formed and tough. The water-buffalo, or caraboa, is the most important of the domesticated mammals. It occurs in a wild state in Luzon, Mindoro, the Calamianes group, Masbate, Negros, and Mindanao, but the wild herds are believed to have originated from domesticated animals. The domesticated water-buffalo is sluggish in its movements, and will not work through the heat of the day, but it is a wonderful swimmer, and makes its way through the worst quagmire with ease. It is universally used as a draught animal and beast of burden. The most interesting of the ruminants is the timarau (*Bubalus mindorensis*, Heude), peculiar to Mindoro. Unlike the water-buffalo, it does not bathe in water or wallow in mud. It is extremely wild, feeding by night and sleeping by day in the densest jungle. It sometimes charges the hunter without provocation, and is very dangerous when wounded. It attacks and kills the much larger wild buffalo. All attempts to domesticate it have failed. A chevrotain is found in Balabac. The house rat, which has been introduced by man, is a common nuisance, while mice occasionally become so numerous as seriously to damage sugar-cane and rice. Squirrels are confined to the eastern chain of islands from Basilan to Samar, and to the Palawan–Calamianes group. In the southern islands there is a tiny species the size of a mouse. Very large flying squirrels are found in Palawan and Mindanao. Squirrel-shrews occur in the Palawan–Calamianes group, and true shrews at various points in the Archipelago. Among the Carnivores may be mentioned the binturong and an otter, both found in the Palawan–Calamianes group; two civet cats, which range throughout the archipelago, and a wild cat of small size, which has been found in Palawan, Panay, Negros, and Luzon. Bats are very numerous, and a number of the species are peculiar to the Philippines. *Galeopithecus* and *Tarsius* range from Basilan to Samar, and the former occurs also in Bohol. In spite of all that has been said to the contrary, but one species of monkey (*Macacus philippinensis*, Geoff.) has been discovered in the Philippines. It occurs on every island of any importance. Its flesh is occasionally eaten by the natives. While albino specimens of this monkey are not uncommon, the pure white monkeys, not albinos, said to inhabit Mindanao, are mythical. The large fruit bats (*Pteropus*) occur in immense colonies, and are sometimes eaten by the natives. Especial importance attaches to the unexpected discovery by Whitehead of a new and peculiar mammalian fauna inhabiting a small plateau on the top of Monte Data in northern Luzon, at an altitude of 7000 to 8000 feet. Specimens of 15 species were obtained, embracing 5 new genera (Calæmomys, Chrotomys, Rhynchomys, Batomys, and Carpomys). Eight of the species were new and strikingly peculiar. Their zoological relationships are probably with Celebes and with Australia. Other discoveries include a few new squirrels and bats, and the occurrence of a lemur (*Nycticebus tardigradus*) in Tawi Tawi.

Birds.—The islands are as rich in birds as they are poor in mammals, the total number of species recorded up to 1897 being 590, of which 325 are peculiar to the Philippines. A study of their geographical distribution has demonstrated that the islands may be divided into a number of fairly well-marked groups, in each of which the birds show a degree of specialization closely correlated with diversity of environment and completeness and probable duration of separation from adjacent groups. Balabac, Palawan, and the Calamianes show a very strong Bornean element. Mindoro stands by itself. Luzon and the small neighbouring islands have 51 peculiar forms. A close relationship exists between the birds of the entire eastern chain of islands. Numerous genera and some families which are absent from the central islands range from Luzon to Basilan. These genera usually have distinct representative species in Luzon, Samar and Leyte, Mindoana, and in some cases in Basilan also. The greatest differences occur between Luzon and Samar and Leyte. The latter islands have 22 peculiar species.

Sulu and Tawi Tawi belong zoologically to the Philippines, but have 12 well-marked peculiar species, and many of the characteristic Mindanao–Basilan forms are lacking. Panay, Guimaras, Negros, and Masbate constitute a sharply-defined area, characterized not only by the occurrence of 30 peculiar species, but by the absence of important genera and even whole families represented in the eastern islands. Most of the mammals characteristic of the latter region are lacking. It is a curious fact that Cebú stands quite by itself, although the width of the deep channel separating it from Negros narrows at one point to about four miles. Cebú possesses 9 striking species of birds not known to exist elsewhere, and lacks many of the characteristic forms of the central and eastern islands. The zoological position of Bohol has never been satisfactorily determined, but all existing evidence indicates that it must be grouped with Samar and Leyte.

Among the more interesting birds may be mentioned the "mound-builder" (*Megapodius cumingi*, Dillwyn), which buries its large eggs in the soft sand along the sea-beach, or under great mounds of earth and dead leaves, often at a depth of three or more feet below the surface. The young are forced to dig their way out and shift for themselves. The eggs are highly prized by the natives. The jungle-fowl abounds. There are 35 species of pigeons and doves, many of them most beautifully coloured and all edible. Snipe, plover, turnstones, and other shore birds are abundant during the cool season, and herons, bitterns, and ducks at all times. The birds of prey number 45 species, of which 22 are peculiar to the group. They vary in size from a tiny falcon, not larger than a sparrow (*Microhierax*), to an immense monkey-catching eagle (*Pithecophaga jefferyi*, Grant), which is strong and active enough to seize monkeys in the air as they leap from tree to tree. But two specimens of this remarkable eagle have thus far been secured. There are 21 species of kingfishers, 15 being peculiar. Of the 12 species of hornbills, not one occurs outside of the Philippines. Frog-mouths, bee-birds, night-hawks, and swifts are found in considerable variety. One of the last (*Collocalia troglodytes*, Gray) is of some commercial importance, constructing the edible nests so highly prized by the Chinese. The best nests are obtained on the precipitous sides of the Peñon de Coron, between Culion and Busuanga.

There may also be mentioned 21 cuckoos, 1 cockatoo, 19 parrots and parroquets, 19 woodpeckers, barbets, broadbills, starlings, orioles, weaver-finches, larks, nuthatches, 24 beautifully coloured sun-birds, and 23 flowerpeckers, titmice, shrikes, swallow-shrikes, tailor-birds, thrushes, fruit-thrushes, fairy bluebirds, fire-birds, 42 fly-catchers, 4 swallows, and 5 species of most beautifully coloured ant-thrushes, as well as a large number of birds for which English names cannot be readily supplied.

Reptiles and batrachians are abundant, but have been little studied. Pythons occur throughout the group, and sometimes attain enormous size. There are numerous venomous serpents, but the mortality from snake-bite is low. Geckoes may be seen on the walls and ceilings of any house. Flying lizards abound in the forests. Large iguanas are numerous. Their eggs are prized by the natives, and the flesh of one species, known as ibit or pelubid, is highly esteemed. Crocodiles are extremely numerous in many of the streams, and are occasionally found in the sea along the coasts. Specimens have been obtained measuring 18 feet in length. Land turtles of small size are common. Very large sea turtles are often captured by the fishermen, and their flesh is highly appreciated as an article of food. A considerable business is done in tortoise-shell. Frogs occur in great variety. One small species appears in immense numbers with the oncoming of the rainy season, and at night the noise of its outcry almost deadens other sounds.

Fishes.—Marine fishes constitute an important source of food supply. Some of the fresh-water species are also largely used by the natives, notably the "dalag," which is found in the paddy-fields during the wet season. Fishes are more numerous and more varied and less well known than are any others of the vertebrates.

Molluscs.—The Philippines are famous for the variety, beauty, and abundance of their land molluscs. Fresh-water and marine molluscs are also very numerous. While most of the species are of interest chiefly to the conchologist, there are a number of edible forms which help to supply the natives with food. The shells of *Placuna placenta*, L., split into thin flat plates and cut into small squares, are almost universally used in place of window-glass.

The valves of the giant clam (*Tridachna*) sometimes attain a length of 5 feet and weigh hundreds of pounds. Pearl-oysters are abundant in the southern waters of the archipelago. Pearl-fishing is an important industry in the Sulu Islands. The shells of the pearly nautilus are commonly used by the Visayans for drinking-cups. From the great opercula of certain marine forms bracelets and other ornaments are carved, while the hard serrated edges of other species are sometimes employed in place of knives for harvesting rice. The land molluscs have been quite thoroughly classified, but much still remains to be done with the marine species.

Arthropoda are very abundant and as yet little known. Shrimps, crabs, and lobsters form an important source of food supply. Mosquitoes are numerous and troublesome in the wet lowlands. Bees are abundant, and wild honey and wax are gathered in considerable quantities. The number of species of ants is very large. Some of them infest dwelling-houses and swarm over the food. The termites, or so-called "white ants," inflict great damage on wooden buildings, often causing serious loss. Plagues of locusts occasionally ruin growing crops. An insect pest recently almost completely destroyed the coffee plantations of Batangas.

The remaining branches of the animal kingdom are abundantly represented in the Philippines, but have as yet been little studied. Land-leeches swarm in the damp lowland forests, to the serious annoyance of foot passengers. The coral beds of Mindanao and the Sulu Archipelago are of unsurpassed beauty, and Guimaras, Cebú, and Siquijor are completely covered with a thick cap of coral limestone, proving the important part that coral polyps have played during bygone centuries.

Flora and vegetable products.

There have been no important recent contributions to our knowledge of the Philippine flora, and the epoch-making work of Father Blanco continues to be the standard authority. Some progress has been made in the study of the woods. The number of species is known to exceed 450, of which 385 have been classified. Included in this list are numerous very valuable woods suitable for structural purposes, inside finishing, cabinet work, and carriage-making. The largest forests are in Mindoro, Palawan, and Mindanao, although there are immense tracts in many of the other islands. Timber forms one of the great natural sources of wealth in the archipelago, and the exploitation of the forests bids fair to become an important industry. Tobacco continues to be one of the most important products. Greater care in growing and curing would vastly improve the quality. Since the abolition of the Government monopoly in 1881, large companies have sprung up, which at present control the trade. Among these may be mentioned the Compañia General de Tabacos, with a capital of $750,000. This concern has 100,000 hectares of land under cultivation, and handles annually 500,000 quintals of tobacco. Its Manila factory turns out 100,000,000 cigars annually, and employs 10,000 labourers. In 1900 a company called the Cagayana, with a capital of $500,000, was formed for the purpose of purchasing the product of the Cagayan valley. The output of abacá, or Manila hemp, increased steadily up to the outbreak of the insurrection in 1896. The coffee plantations have been ruined by a borer which attacked the canes. A small quantity of coffee is still produced in Benguet, where the borer has not appeared.

Exports of sugar also increased steadily up to 1896. This industry was in 1902 still in its infancy in the Philippines. The introduction of modern machinery and methods of cultivation will enormously increase production. Although there are a number of small steam crushers in Negros and Luzon, much of the cane is still ground between wooden or stone rollers turned by draught animals. The methods of obtaining sugar from the juice are often equally primitive. Only a small part of the good sugar land is yet under cultivation.

Rice and sweet potatoes are the staple foods of the natives, although Indian corn is now extensively raised in Negros, Cebú, and parts of Luzon. Cacao does admirably, and properly conducted plantations are profitable. There is a steadily growing trade in copra and cocoanut oil. Peanuts flourish, but are not raised to any considerable extent. The trade in indigo has been ruined by the Chinese, who adulterated the Philippine product so that it earned a bad name. A red dye obtained from sibucao (*Cæsalpinia Sappan*, L.) constitutes an important article of export to China and England. There are eleven other woods furnishing dyes of more or less value. Sago-palms grow abundantly in some parts of the archipelago.

The distillation of alcohol from fermented sap obtained from the nipa palm has become a flourishing industry. The nutmeg grows naturally in Cebú and in Laguna province, but is not an article of commerce. Cinnamon, of rather poor quality, is abundant in the forests. The cultivation of pepper is diminishing. Valuable essential oils are obtained from the flowers of the ilangilang, sampaguita, and champaca. There are eleven resins of domestic or commercial value. Extensive deposits of almaciga (damar) exist in Palawan, Sibuyan, and Mindanao. There are also eleven valuable gum-resins, of which gutta-percha is the most important. At one time a considerable quantity of gutta-percha was exported from the southern islands, but adulteration by Chinese merchants has nearly destroyed the trade.

Manufactures.

Cigars and cigarettes are the only manufactured articles exported in any quantity. Except for the cigar factories, cotton mills, rope walks, carriage and furniture factories, brick kilns, pottery ovens, and sugar refineries of Manila and vicinity, the Philippines have no manufactories of importance, although some articles are produced in considerable quantity by the natives at their homes. Among manufactures of this class may be mentioned dyed cotton stuffs; beautiful fabrics called "piña" and "jusi," the former woven of pineapple-leaf fibre and the latter of this fibre mixed with silk; mattings, bags, hats (those of bamboo being extremely light and durable); patates, or sleeping-mats; shoes, leather, soap, and other small household articles. A considerable amount of salt is also made from sea-water. There is much fine water-power in the islands, but none of it is at present in use.

Communications.

The only railway extends from Manila to Dagupan, a distance of 122 miles. Elsewhere land transportation is by means of carts or sledges drawn by water-buffaloes or bullocks. Highways are bad at the best, and in many of the islands there are none. Water transportation is therefore employed when possible. There are 61 steamers, with a tonnage of 21,300, 49 sailing vessels, with a tonnage of 5863, and numerous small native vessels engaged in the coasting trade.

There is cable communication with Europe by way of Hong Kong; also with Panay, Negros, and Cebú. The line is in process of extension to Mindanao, Basilan, and Sulu. Military land lines extend throughout Luzon and connect the most important towns of Panay, Negros, Cebú, Samar, and Leyte.

Trade.

Exports increased steadily up to the year 1897, as will appear from the following table:—

Year.	Abacá.	Copra.	Sugar.	Tobacco.
	Piculs.	Piculs.	Piculs.	Quintals.
1890	1,012,310	74,447	2,360,422	179,054
1891	1,271,094	245,309	2,672,259	207,166
1892	1,581,106	259,539	3,955,263	253,850
1893	1,282,938	183,404	4,186,982	230,686
1894	1,591,162	532,233	3,110,202	190,904
1895	1,664,590	593,671	3,697,332	207,771
1896	1,551,786	607,529	3,671,024	219,729
1897	1,804,756	811,437	3,332,010	316,712
1898	1,585,212	263,402	2,859,661	175,170
1899	1,201,476	291,322	1,488,854	114,261

The total value of exports for 1894 was $3,237,760; for 1895, $3,333,095; for 1896, $3,440,800; for 1897, $3,721,450; for 1898, $3,409,605; for 1899, $3,161,284. The restrictive Spanish tariff on imports remained in force, with slight modifications, up to the close of 1900. Since the American occupation, the increase in imports, not including Government supplies, has been extraordinary, in view of the disturbed conditions which have prevailed. The largest annual collection of import duties at Manila under the Spanish régime was $4,055,696 in 1896. Collections fell to $3,536,788 in 1897. For the fiscal year ending 30th June 1900 there was collected $8,174,084. The total value of the imports for the year was $20,878,666. Of vessels engaged in the foreign trade there entered during this year 566, with a tonnage of 665,913, and cleared 501, with a tonnage of 641,975. The entries of vessels engaged in the coasting trade were 3346, tonnage 459,075; clearances, 3666 vessels, tonnage 480,992. During the year ending 30th June 1901 the imports from the United States amounted to $4,014,180, and the exports, of which vegetable and manila fibres were valued at $4,254,416, to $4,420,289. The ports of entry are Manila, Iloilo, Cebú, Zamboanga, Sulu or Joló, and Siassi.

Government.

The purely military government established shortly after American occupation was gradually replaced by a civil administration. The re-establishment of civil courts began on 29th May 1899, and the organization of civil municipal governments in July of the same year. There was no direct intervention in the affairs of the central government by civilians until 1st September 1900, when, by order of the President of the United States, the legislative power and the power to appoint and remove civil officers were taken from the military governor and vested in a civil commission of five members. This commission was further charged with the duty of completing the organization of civil government, beginning with the pueblos, provinces, and departments, eventually recommending a suitable form of central civil government, and suggesting the time when it should go into effect. Benguet was the first province in which civil government was established by the commission.

Population.

The total number of inhabitants is not accurately known. It has been placed as low as 6,000,000, and as high as 12,000,000. The study of the Philippine tribes is in a far from satisfactory state. Blumentritt, who has written more accurately concerning them than has any other author, had never visited the islands. There are three distinct races—Negrito, Indonesian, and Malayan. The Negritos are almost universally conceded to be the disappearing remnants of a people which once populated the entire archipelago. They are physical weaklings, of low stature, with very dark skins, closely curling hair, flat noses, thick lips, and large, clumsy feet. In intelligence they stand near the bottom of the human species, and they are apparently incapable of any considerable degree of civilization or advancement. As a rule, they are to be met with only on the forest-clad sides of the higher mountains of Luzon, Panay, Negros, and Mindanao, although in north-eastern Luzon they are found in the lowland forests near the coasts. They live a nomadic life, wandering almost naked through the forests, and subsisting on fruits, tubers, and such game as they can kill. They are divided into twenty-one tribes, variously known as Negritos, Aetas, Buquiles, and Manguyanes. The Philippine representatives of the Indonesian race are confined to the island of Mindanao. They are physically superior both to the Negritos and to the Malayan peoples, being tall and well developed, with high foreheads and aquiline noses, and with wavy hair; often, also, with abundant beards. The colour of their skin is quite light. Many of them are very intelligent. They are divided into sixteen tribes. All of these are pagan, and several are very warlike. The great majority of the inhabitants of the Philippines are of Malayan origin, although the Malayan race is not found pure in any of the islands, but is everywhere modified through intermarriage with other peoples. The number of Malayan tribes is forty-seven. The individuals comprising them are of medium size, with straight black hair. As a rule the men are beardless. The skin is brown, and distinctly darker than that of the Indonesians, though much lighter than that of the Negritos. The nose is short and considerably flattened. The various tribes show every degree of social advancement, from abject savagery to a relatively high degree of civilization. Seven of them are Christianized, seven are Mahommedan, and the remainder pagan. Although there are far more pagan tribes in the Philippines, the seven Christian tribes with the Mahommedans include the bulk of the population, as will appear from the following table:—

Tribe.	Approximate Number of Individuals.	Territory occupied (square miles).
Visayans	2,601,600	28,100
Tagalogs	1,663,900	15,380
Bicols	518,111	6,900
Ilocanos	441,780	6,170
Pangasinans . . .	365,500	1,950
Pampangas . . .	337,900	1,950
Cagayans	166,300	11,050
Mahommedans . . .	268,000	12,860
	6,363,091	84,360

These figures are only approximate. The number of inhabitants composing the wild tribes is still more a matter of conjecture, but can hardly exceed 2,500,000. Of these latter peoples it may be said that, while many of them are pacific and harmless when well treated, not a few are vicious. Head-hunting is practised by several of the North Luzon tribes, some of which are even accused of occasionally indulging in cannibalism. Several of the tribes practise polygamy, and the taking and keeping of slaves is not uncommon. Human sacrifices are practised by at least two of the Indonesian tribes in Mindanao. The number of Americans in the islands was estimated at 66,700 in December 1900, including an army of 2219 officers and 60,480 men. The Chinese at this time were estimated at 70,000, Spanish at 3000, British at 250, Japanese at 175, Germans at 125, Swiss at 90, French at 60, Portuguese at 30, Belgians at 25, Italians at 20; other nationalities, 30. (D. C. W.)

History.—The history of the Philippine Islands shows that nearly the whole period of the 327 years of Spanish dominion (1571–1898) was one of continual strife and discord between the clergy, the military and civil power, and the natives. The perpetual struggle for supremacy between the Crown officers and the monastic orders, the immorality of the clergy, the feud between their respective communities, the constant inflow of penniless Spanish adventurers and the venality of the officials, brought both laymen and ecclesiastics into lasting contempt among the natives. The government of the islands was inspired by the monks, and was based on the theory that the natives should for ever be regarded as minors. Education was entirely in the hands of the friars. In the course of time many natives acquired comparative wealth, the best education which the colony afforded, and a taste for European comforts. The natural consequence was a desire to throw off the absolutely dominant tutelage of Spain, and participate in the administration. To this end there were frequent risings, suppressed by the Spaniards with a severity the remembrance of which was preserved from generation to generation. In 1812, during the enforced absence from Spain of King Ferdinand VII., the famous Cortes de Cadiz was established. This parliament, extremely democratic in its composition, resolved to impose a constitution on the king when he should return. The constitution was to include direct representation of the colonies—indeed, delegates from each dependency (including the Philippines) were invited to Cadiz and took part in the deliberations. This ray of political sunshine for the Filipinos lasted, however, but a short while, for, on King Ferdinand's return, reaction set in, and the proceedings of the Cadiz parliament were annulled. But the desire for liberty lived on. On the other hand, the tyranny of the Spanish clergy increased as they found themselves face to face with an ever-growing body of enemies. Each parish had, in its friar incumbent, a secret Government agent, through whom men were suddenly wrested from their homes and deported to distant islands without trial.

Early conflicts.

The deposition of Queen Isabella II. in 1868 brought again into power the democratic political element in Madrid, and in 1869 it was decreed that a certain measure of participation in the civil government should be accorded to the Filipinos, by the formation of a native council to co-operate with the governor-general. The councillors were indeed nominated; but the hopes thus raised were once more thwarted by ultra-conservative influences, and the disappointment served only to fan the flame of discontent. The Filipinos then conceived a new plan. According to those decrees of the Council of Trent which define the status of the regular clergy, the services of a monk in any colony were limited to mission work. His duty ended when there were no more converts to be made, and he could only temporarily act as incumbent when there was no secular clergyman available. In 1871—three centuries after the conquest—the only unconverted natives were the aboriginal mountain tribes and the Mussulman inhabitants of Mindanao. Therefore the natives, championed by a certain Father Burgos, agitated for the fulfilment of the Council of Trent decrees whereby the incumbencies in Christianized villages should be held by the secular clergy. Filipinos had for generations been ordained in the priesthood, and parish curacies were actually held by them. The real aim of the natives was to diminish the power of the regular clergy, whose communities were, in fact, strongly organized secret societies, each one extremely jealous of the other, but ever ready to join issue against any Filipino movement. In 1872 the friars took the initiative in bringing matters to a crisis.

Through their secret agents a pretended plot was concocted, and the native garrison at Cavite was induced to mutiny. The priests immediately presented a bill of indictment against the richest, best educated, and most influential Philippine-born families in Manila. The proscribed persons, accused of treason, were the leaders of that class which aspired to national manhood. It was the object of the friars to banish this class, and to secure to themselves the incumbencies in perpetuity. They succeeded temporarily, for the flower of the Philippine-born population was deported to the Ladrone Islands, whilst Father Burgos and three other native priests were publicly garrotted, and the native clergy were formally declared to be thenceforth incompetent to have the cure of souls.

Steamer and telegraphic communication, both opened about the same time, may be said to have marked a new era in the Philippines, by bringing them more into harmony with the conditions of neighbouring colonies. The improved travelling facilities came at the time when intelligent natives were most anxious to flee from monastic tyranny. Some crossed over to Hong Kong; others travelled to Spain, where, under the republic, they found sympathetic listeners. The tragedy of 1872 gave birth to revolutionary notions, and Philippine committees were founded at Madrid and Barcelona. Steamers brought the Madrid newspapers to natives who hitherto had but a vague notion of European affairs. Filipinos, too, began to return with new ideas from Europe. The most distinguished of these returned native scholars was the late Dr Rizal. Born in Calainha and educated in Manila, he was sent to Europe at an early age to complete his studies. After gaining the degrees of Doctor of Medicine and of Philosophy, he published, among other works, his *Noli me tangere*—a sarcastic exposition of the immorality of the friars, written in the form of a romance. He returned to the islands, and disputed the Dominican order's title to lands actually in their possession in Laguna province. He became the arch-foe of the friars and the idol of his own countrymen. To escape the monks' vengeance he returned to Europe; but in 1892 he received assurances from Governor-General Despujols that he might enter the islands and remain there at liberty. On his arrival at Manila his enemies produced certain seditious leaflets, alleging that they were found in his luggage. He was therefore arrested on a charge of treason. The friars importuned the governor-general for his life, but the general persistently refused their demand, and met the case half-way by banishing Rizal to Dapitan in Mindanao. Incensed by the failure of their plot, the friars' relations with the general became so strained that, in accordance with precedent, the procurators of the religious communities in Madrid forthwith obtained the recall of Governor-General Despujols after only eight months' service. Meanwhile a reform party, initiated by Dr Rizal, was organized under the title of Liga Filipina. Its object was to procure, by pacific means, several reforms in the government of the islands, the chief of which were (1) the expulsion of the friars, and (2) the withdrawal of the governor-general's arbitrary power to deport Filipinos on his sole authority. The new governor-general, Ramon Blanco, was, like Despujols and many of his other predecessors, a humane man at heart, but he could do no more for the Filipinos than hold in check the most tyrannical schemes of the clergy. The banishment of Rizal convinced the reform party that peaceful endeavour to procure reforms was futile. A secret organization known as the Katipunan was therefore started to secure reforms by force of arms. Each member enrolled was bound by the ancient "blood compact." An incision was made in the arm, and with the blood which flowed therefrom the roll of membership was signed. In 1895 the friars suspected some movement, and consequently between the autumn of 1895 and August 1896 many hundreds of natives were banished.

The Katipunan leaders were completing their plans for open warfare, when the whole conspiracy came prematurely to light through a traitor. This man divulged the secret to his wife, who (in August 1896) went to Father Mariano Gil, parish priest of Tondo, and revealed the whole plot. The next day about 300 of the most prominent Filipinos were lodged in prison. The drawbridges of the walled city were put in working order, and troops were stationed along the approaches. News came shortly that the insurgents had attacked the civil guard about three miles outside the city. Native cavalry was sent there at once, and the insurgents fled. A week later some hundreds of insurgents suddenly attacked the powder magazine at San Juan del Monte, about three miles from the city. Troops were quickly on the spot; the insurgents, who were completely routed, left about eighty dead on the field, and fled in confusion towards the Pasig river. Many were shot dead in attempting to cross the river, whilst the rest were pursued for miles. Four chiefs were taken prisoners, and subsequently executed in Manila. This was the first of the numerous executions which took place all over the colony. Pandacan, Pasig, and several other parishes in the neighbourhood of the capital were unsuccessfully attacked by the insurgents during the following days. Ten days after the plot was discovered Manila and five other provinces were officially proclaimed in a state of siege. Insurgents were assembling in great numbers near Mariquina; Europeans, Chinese, and natives flocked into the city. News came that the whole province of Cavite was in revolt; San Roque was in insurgent hands. The insurgents concentrated all their energies upon Cavite province. They dug a trench about a mile south of the neck of land on which Cavite arsenal is situated. To defend the arsenal the Spaniards established a camp at Dalahican, which was held by the 72nd Visaya (native) regiment and Spanish volunteers under General Rios. From this camp the Spanish forces made a sortie, but were driven back with great slaughter. There was a general call to arms, and volunteers were enrolled. Several villages were in the hands of the insurgents, and, emboldened by their success at Dalahican, they seized a convent in the centre of Cavite province, fortified and provisioned it, and for several weeks repulsed the attack of the Spanish troops, until at length artillery was brought into action, when most of the besieged effected their escape. It was now that Emilio Aguinaldo came to be known as the insurgent commander-in-chief.

Revolt of 1896.

The difficult position of the Government was taken advantage of by the revolutionary chiefs. General Blanco had extremely few European troops at his disposal, and many of these were in Mindanao. Transports were at once despatched to bring them to the capital. It was doubtful how far native troops could be trusted against their own countrymen. Reinforcements were soon on the way from Spain, but the demands of Cuba had already depleted the Peninsula of the best fighting material. Most of the troops sent out to Manila were of weak physique and without military training. By those who understood least the true position Blanco was blamed for his apparent lethargy. There was constant friction between him and Archbishop Nozaleda, who urged the immediate adoption of bloodthirsty measures; but as Blanco declined to be led by the archbishop, he was recalled, and in December 1896 General Polavieja arrived as his successor, with General Lachambre as chief of staff. Before General Blanco left he released Dr Rizal and allowed him to go to Spain, but the friars caused a cablegram to be sent to arrest him. Rizal was therefore sent back, a prisoner, to Manila, where he was executed by Polavieja's orders in December 1896.

The reinforcements now numbered about 16,000 men, and Lachambre took the field in Cavite with energy, whilst Polavieja held in check the insurgents north of Manila. After repeated encounters in Cavite province, with great slaughter to the insurgents and no inconsiderable losses on the part of the Spaniards, General Lachambre succeeded in practically quelling the rebellion in that province, whilst General Jaramillo rendered effective service in Batangas province. Lachambre was then despatched north, where the insurgents were in arms all over the provinces of Bulacan, Pampanga, and Nueva Ecija. Numerous small battles were fought, those of any importance being Aliaga and Cabanatuan. The insurgents, routed everywhere, quietly reappeared in other places. An attack was made on Bolinao, and the cable station was threatened, but troops arrived just in time. Aguinaldo personally operated in the province of Bulacan, making frequent raids on the Spaniards and then retiring to his mountain fastness. No definite progress towards a finish was being made by either party. Polavieja's demand for more troops having been refused, he tendered his resignation on the ground of ill-health, and was succeeded (spring of 1897) by General Primo de Rivera, who had been governor-general of the colony sixteen years previously. Rivera was already personally acquainted with the leading Filipinos. A rising in Cebu city had been quelled by a gunboat; hostilities continued elsewhere in an indecisive manner, and the wet season (middle of the year) had fully set in, making operations extremely difficult. A certain Paterno volunteered his services to Primo de Rivera to negotiate peace, with the result that Aguinaldo agreed to quit the islands with thirty-five of his chiefs on the understanding that the Spanish Government would pay them an indemnity of $1,200,000 and introduce certain reforms. Consequently, on the 23rd December 1897, Aguinaldo and his colleagues left for Hong Kong. The "Treaty of Biacnabatò" in which it is said these conditions are set forth is of doubtful existence. However, according to agreement (verbal or written), a first instalment of $400,000 was paid to Aguinaldo. The Madrid Government having refused to confirm the terms of peace, further payment was suspended. As soon as Aguinaldo and his party were safely out of the colony, the peace rejoicings in Manila were followed by the persecution of all those who were known to have sympathized with the movement. The prospect of reform was as remote as ever, and other chiefs took the field in northern Luzon.

Spanish-American war.

When hostilities between America and Spain broke out, on the 23rd April 1898, there was already an American fleet in Far Eastern waters, which, under the command of Commodore (afterwards Admiral) Dewey, arrived in the Bay of Manila on the 1st of May, and totally destroyed or disabled the Spanish fleet. Dewey demanded the surrender of the city, which was refused. Cavite was at once occupied by the Americans, and Dewey awaited reinforcements of troops before attacking Manila. Shortly afterwards Aguinaldo and his party, at their request, were brought to Cavite in an American transport by Dewey's permission.

With the approval of Dewey, who allowed arms to be supplied to him, the rebel chief at once set to work to collect his forces, and with 30,000 men renewed the campaign against the Spaniards, harassing them on all sides, until practically all Luzon, excepting the city of Manila and the suburbs, was at his mercy. About 11,000 Spanish prisoners (soldiers and civilians) fell into the rebels' hands. At the same time rebel emissaries were despatched to the southern islands of Panay, Negros, and Mindanao to raise rebellion against the Spanish forces commanded by General Rios. Many encounters took place, but the Spaniards held possession until the treaty of peace was signed in Paris. The American reinforcements had already arrived, and on the 13th August, after a show of resistance, General Augusti (the successor of Primo de Rivera) surrendered the city of Manila. The capture of Manila coincided with the signing of the peace protocol at Washington.

Aguinaldo chafed at the refusal of the American commander, General Otis, to allow his troops to enter the city, and still more so when he was ordered to remove his camp farther away from the Manila suburbs. The fate of the islands was in suspense from August 1898 to February 1899, and during this period of abeyance the Filipino army remained quietly under arms, repudiated as a factor by the Americans. During this interval Aguinaldo went to Malolos, proclaimed the Philippine Republic, formed a ministry, presided over a parliament of deputies, and issued a new constitution. The American authorities were invited to attend, but did not do so.

The treaty of peace between America and Spain, by which the Philippine Islands passed into the hands of the Americans, had been signed in Paris on the 10th December 1898, but it was not until 6th February of the following year that the treaty was confirmed by the American Senate. On 4th February, however, hostilities had broken out between the American troops and the Filipino army. The next day the contending forces met at Paco, a Manila suburb, where the Filipinos were defeated with heavy loss. The American troops, following up the retreating enemy, drove them out of Malolos and San Fernando into Nueva Ecija, and then withdrew to Manila. A call for troops brought the total American army of occupation up to about 60,000 men.

Revolt against the Americans.

It is unnecessary to trace in detail the gradual conquest of the islands, or the hundreds of engagements, often small, between the rebels and the Americans, especially in the islands of Luzon, Panay, Leyte, Negros, Samar, and Mindanao. Owing to the nature of the country, the climate, the want of roads, and the fact that large parts of the islands had never really been subjected by the Spaniards, the war was prolonged for from two to three years. The Filipino forces were gradually disorganized and dispersed, and with the capture of Aguinaldo, 23rd of March 1901, and later of his successor as commander-in-chief, Malvar, the resistance became little more than that of guerilla bands, and by July 1902 these bands seemed to have been largely captured or crushed. During all this time the islands were under military government, but civil government was gradually introduced as fast as the different islands or provinces were conquered.

Civil government.

During the first year of the war a civil commission, under the presidency of Dr Schurman, was despatched to Manila by President McKinley to inquire into and report on the state of affairs. In February 1900 a second commission for perfecting the civil government was appointed, consisting of Judge W. H. Taft, Professor D. C. Worcester, General L. E. Wright, Mr H. E. Ide, and Professor Bernard Moses. According to the instructions of the President, "that part of the power of government in the Philippine Islands which is of a legislative nature is to be transferred from the military governor of the islands to this commission, to be thereafter exercised by them in the place and stead of the military governor. Exercise of this legislative authority will include the making of rules and orders, having the effect of law, for the raising of revenue by taxes, customs duties and imposts; the appropriation and expenditure of public funds of the islands; the establishment of an educational system throughout the islands; the establishment of a system to secure an efficient civil service; the organization and establishment of courts; the organization and establishment of municipal and departmental governments; and all other matters of a civil nature for which the military governor is now competent to provide by rules or orders of a legislative character." On the 1st of September the commission assumed its legislative powers. Its first Act was to appropriate one million dollars for the construction and improvement of roads. Another early Act provided for the improvement of Manila harbour at an expense of three million dollars. It was hoped that the harbour work would be completed in two years. Other legislation enacted by the commission provided for the organization of bureaus and departments of the central Government; the creation of municipal and provincial governments (of the latter, thirty-four were established between February and September 1901); the passage of a general school law, under which 1000 American teachers were brought to the Philippines, who, with the help of a much larger number of Filipino teachers, started schools in 500 different towns, attended by over 100,000 pupils; the organization of a judiciary, with courts culminating in a Supreme Court of seven members, four Americans and three Filipinos; the establishment of a provincial constabulary of 5000 men, which led to the rapid disappearance of ladronism; the adoption of a new tariff; the extension of the postal system; the enactment of a code of civil procedure; the establishment of a bureau of forestry, a health department, and an agricultural bureau; and the enactment of what were known as treason and sedition laws.

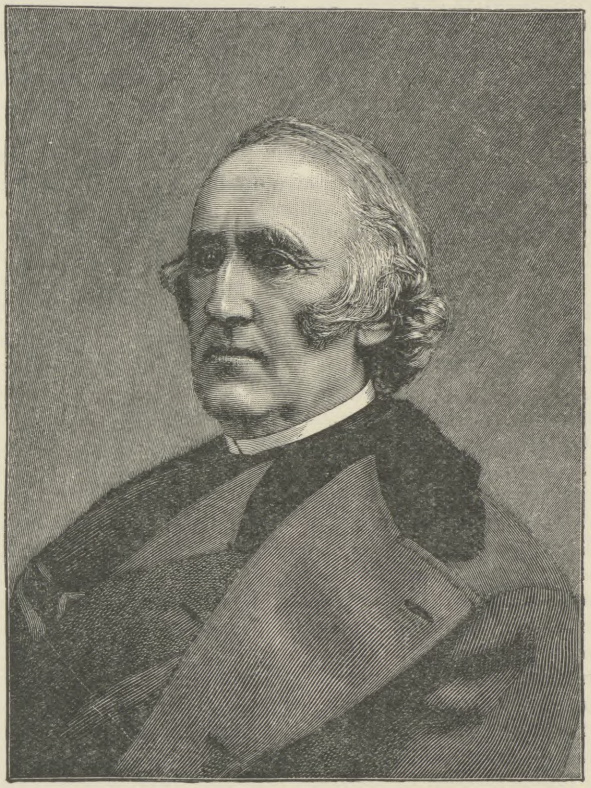
On the 1st of July 1902 President Roosevelt signed a new and important Bill for the civil government of the Philippines. Under this Bill a census was to be taken at an early date, and two years thereafter, should peace prevail, a legislative congress or assembly was to be authorized. The upper house of this assembly was to consist of the present commission of five Americans, with three Filipino members added, large powers being given to it through its control over appointments and salaries. As the majority was composed of Americans, no legislation hostile to the United States was possible. The lower house was to consist of members elected by property owners or persons who can speak English or Spanish. The Bill authorized the sale of the public domain in not larger lots than 2500 acres to any one person, and also the purchase of the land belonging to the hated friars. On the 4th of July President Roosevelt abolished the office of military governor, the military forces being largely recalled, and the part remaining being made henceforth subordinate to the civil authorities. He also granted a general amnesty to all rebels and political prisoners who would take the oath of allegiance to the United States. The most important question remaining was that connected with the ownership of land by the friars. The four orders—the Dominicans, the Augustinians, the Recoletos, and the Franciscans, none of which admit the natives to membership—were the owners of 400,000 acres of land, largely the best land in the islands, half of which are near Manila. No rents had been collected on these lands between 1896 and 1902. Through all the years of Spanish government the friars were the real rulers, and it was opposition to them that caused the rebellion of 1896. It was the object of the commission to buy out the friars as landowners, and to substitute for them as spiritual leaders American secular priests. With this object in view, Judge Taft proceeded to Rome in July 1902, and negotiations were in August 1902 progressing on the subject, the belief of the members of the American commission, as well as that of all other authorities, being that the removal of the friars was of the utmost importance for the peace and progress of the islands. (J. F*.)

Philippopolis, the capital of eastern Rumelia, principality of Bulgaria, finely situated in the midst of picturesque granite eminences on the Maritza, 96 miles east-south-east of Sofia and 97 west-north-west of Adrianople. Having communication by rail both with the port of Sedéaghatch on the Mediterranean and that of Bourgas on the Black Sea, and being situated in a remarkably fertile country, it has now become the chief commercial centre of southern Bulgaria, and is the seat of both a Greek and a Bulgarian archbishopric. The residences of the richer Greeks and Bulgarians occupy the slopes of the largest eminence, the Djambaz-tépé, in the centre of the town; between it and the Nobet-tépé, from the summit of which there is a magnificent view of the town, is the Armenian quarter; near the bridge over the Maritza is the poorer Turkish quarter; and south-west of the Djambaz-tépé there is a suburb of villas. On the Bounardji-tépé a monument has been erected by the Russians in commemoration of the war of 1877, and near this is the new palace of the prince of Bulgaria. The Sahub-tépé is crowned by a clock-tower. Not far from it are the beautiful Exhibition Park laid out in 1892, and the fine Djournaia-djami Mosque. Near the Maritza are the remains of the ancient Konak of the Turkish pashas, the public park formed by the Russians in 1877, the gymnasium, and the new Greek cathedral. The town has a large commerce in rice, attar of roses, and cocoons; other exports being corn, wine, tobacco, alcohol, and hides. Population (1892), 36,033, of whom the bulk were Bulgarians, Turks numbering about one-sixth and Greeks about one-ninth, the remainder being Armenians, Jews, Tziganes, and Bohemians; (1900), 42,849.

Phillimore, Sir Robert Joseph, (1810–1885), British judge, was the third son of the well-known ecclesiastical lawyer, Dr Joseph Phillimore, and was born at Whitehall, 5th November 1810. Educated at Westminster and Christ Church, Oxford, where a lifelong friendship with Mr Gladstone commenced, his first appointment was to a clerkship in the Board of Control, where he remained from 1832 to 1835. Admitted as an advocate at Doctors' Commons in 1839, he was called to the Bar at the Middle Temple in 1841, and rose very rapidly in his profession. He was engaged as counsel in almost every case of importance that came before the Admiralty, Probate, or Divorce Courts, and became successively Master of Faculties, Commissary of the Deans and Chapters of St Paul's and Westminster, Official of the archdeaconries of Middlesex and London, and Chancellor of the dioceses of Chichester and Salisbury. In 1853 he entered Parliament as member for Tavistock. A moderate in politics, his energies were devoted to non-party measures, and in 1854 he introduced the Bill for allowing *vivâ voce* evidence in the Ecclesiastical Courts. He sat for Tavistock until 1857, when he offered himself as a candidate for Coventry, but was defeated. He was appointed Judge of the Cinque Ports in 1855, Q.C. in 1858, and Advocate-General in Admiralty in 1862, succeeding Dr Lushington as Judge or Dean of the Court of Arches five years later. Here his care, patience, and courtesy, combined with unusual lucidity of expression, won general respect. In 1875, in accordance with the Public Worship Regulation Act, he resigned, and was succeeded by Lord Penzance as Dean of Arches. When the Judicature Act came into force, the powers of the Admiralty Court were transferred to the High Court of Justice, and Sir Robert Phillimore was therefore the last judge of the historic Court of the Lord High Admiral of England. He continued, however, to sit as judge for the new Admiralty, Probate, and Divorce Division until 1883, when he resigned. In literature Sir Robert will be remembered for his *Ecclesiastical Law of the Church of England*, a book which still holds its ground, for his *Commentaries on International Law*, and for his translation of Lessing's *Laocoon.* He married in 1844 Charlotte Anne, daughter of John Denison of Ossington Hall, Newark. He was knighted in 1862, and created a baronet in 1881. He died at Shiplake, near Henley-on-Thames, 4th February 1885. His eldest son, Sir Walter G. F. Phillimore (b. 1845), also distinguished as an ecclesiastical and admiralty lawyer, became in 1897 a judge of the High Court.

Phillipolis. See Orange River Colony.

Phillips, Wendell (1811–1884), American orator and reformer, was born in Boston, 29th November 1811. His father, John Phillips, a man of wealth and influence, was a graduate of Harvard College in 1788, and became successively "town advocate and public prosecutor," and in 1822 first mayor of Boston, then recently made into a city. Wendell Phillips himself attended the public Latin school, entered Harvard College before he was sixteen, and graduated in 1831 in the same class with the historian Motley. Both of them belonged emphatically to the aristocracy of Boston, and it is recorded that Phillips was the only man for whom the family carriage was habitually sent out from Boston to Cambridge on Saturday morning that he might spend Sunday at home. He graduated at the Harvard Law School in 1834, and was admitted to the Bar in Boston. He soon came under the influence of the anti-slavery movement, witnessing in 1835 the mobbing of Garrison. In 1837 a meeting was called at Faneuil Hall, to express the sentiments of the people on the murder of Elijah P. Lovejoy, at Alton, Illinois, for defending his press from a pro-slavery mob. In the course of the meeting a speech was made in opposition to its general current by James T. Austin, Attorney-General of the state, who said that Lovejoy had died "as the fool dieth," and compared his murderers to the men who threw the tea into Boston harbour during the American Revolution. The speech seemed likely to divide the audience, when Wendell Phillips took the platform. "When I heard," he said, "the gentleman lay down principles which placed the murderers of Alton side by side with Otis and Hancock, with Quincy and Adams, I thought these pictured lips [pointing to their portraits] would have broken into voice to rebuke the recreant American, the slanderer of the dead." This appeal not merely determined the sentiment of the meeting, but it gave Wendell Phillips his first fame and determined his career. Although loving his profession, and this especially for the opening it gave in the direction of public life, he practically stepped outside the sphere dearest to young Americans, and lived henceforth the life of an agitator, or, like his father, that of a "public prosecutor." Accepting unhesitatingly the leadership of Garrison, and becoming like him gradually a disunionist, he lived essentially a platform life, interested in a variety of subjects, but first and chiefly an abolitionist. He was not, however, like his great leader, a non-resistant, nor was he, on the other hand, like John Brown, borne on by irresistible necessity to overt action. Nor did he find, like his fellow-worker, Theodore Parker, the time to keep up his scholarship and lead in part the life of a student. Early study and travel had indeed furnished him with abundant material for rhetorical illustration; and he was also a great reader of newspapers, but he used to say that he knew in his whole life but one thing thoroughly, namely, the history of the English Revolution, and there were few occasions when he could not draw from it the needful illustration. His style of eloquence was direct and brilliant, but eminently self-controlled. He often surprised his hearers by the quietness of his beginnings, and these were very often the speeches which turned out most brilliant and most irresistible ere the close. He may be said to have introduced the direct and colloquial manner upon the American public platform, as distinct from the highly elaborated and often ornate style which had been established by Edward Everett; nor has there ever been a reversion since his day to the more artificial method. He was capable at times, nevertheless, of highly sonorous periods with superb climaxes, yet his favourite style was the conversational. His logic, while never obtruded, was rarely at fault; but he loved the flash of the rapier, and was never happier than when he had to face down a mob and utterly foil it by sheer superiority in fencing. The two volumes of his speeches, as edited by Mr Redpath, were fortunately made from verbatim reports, and they wisely enclose in parentheses those indications of favour or dissent from the audience which transformed so many of his speeches into exhibitions of gladiatorial skill. He was a tribune of the people, associated unflinchingly not merely with the unpopular, but—which is sometimes more difficult—with the unpolished; always carrying about him not merely a certain Roman look, but a patrician air. After slavery had fallen Phillips associated himself freely with reformers occupied in other paths, herein separating himself from the other patrician of the movement, Edmund Quincy, who always frankly said that after slavery was abolished there was nothing else worth fighting for. Phillips was not always the best judge of character, and was sometimes allied in these movements with men who were little more than demagogues. But the proof he gave by his transfer of energies that the work of reform was never quite finished—this was something of peculiar value, and worth the risk of some indiscretions. The life of a reformer did not in



Wendell Phillips.
(*From a photograph by Sarony, New York.*)

itself make him thoroughly happy; he chafed more and more under its fatigues, and he always felt that his natural place would have been among senators or ambassadors; but he belonged essentially to the heroic type, and it may well have been of him that Emerson was thinking when he wrote those fine words: "What forests of laurel we bring and the tears of mankind, to him who stands firm against the opinion of his contemporaries." His domestic life was most happy, though his wife was a confirmed invalid, seldom quitting her room. She was a woman of heroic nature and very strong convictions. Her husband used to say that she first made him an abolitionist. They had no children, but adopted an orphaned daughter of a friend, Mrs Eliza Garnaut, and this young girl brought much light and joy into the household. Their worldly circumstances were easy, except that they were always ready to impoverish themselves for the sake of others. Wendell Phillips died at Boston on the 2nd February 1884. (T. W. H.)

Phillipsburg, a city of Warren county, New Jersey, U.S.A., on the east side of the Delaware river, opposite the mouth of the Lehigh and the city of Easton, Pennsylvania, in the western part of the state, at an altitude of 221 feet. Its site is hilly and the street plan irregular. It is on five railways—the Central of New Jersey, the Lehigh Valley, the Delaware, Lackawanna, and Western, the Lehigh and Hudson River, and the Pennsylvania, which afford ample facilities for communication. The city has large manufactures of iron and steel goods. Population (1880), 7181; (1890), 8644; (1900), 10,052, of whom 990 were foreign-born.

Philo.—Since the appearance of the article in the ninth edition of the *Encyclopædia Britannica* (vol. xviii. pp. 759–764; see especially p. 763) much valuable work has been done, the effect of which has been to establish, or at least to uphold, the genuineness of writings ascribed to Philo, but then held to be spurious. The works there impugned are the following: (1) Περὶ βίου θεωρητικοῦ ἢ ἱκετῶν ἀρετῶν (*De Vita Contemplativa*). This is both the shortest and historically the most important of the impugned writings, since it contains the sole original account of an ascetic community known as the Therapeutæ having their home on the shores of Lake Mareotis. These were held by Eusebius and many other Christian writers to be the earliest Christian monks, which of course could not be the case if it was a genuine work of Philo. On this account, amongst others, it was held to be spurious by Graetz and P. E. Lucius; and this view gradually received the assent of most modern scholars. Latterly, however, the tables have been turned. L. Massebieau has shown with great thoroughness that in language and thought alike it is essentially Philonic, and the genuineness of the book has also been affirmed by P. Wendland, and especially by F. C. Conybeare. Massebieau first conjectured that it was part of the Ἀπολογία ὑπὲρ Ἰουδαίων of Philo mentioned by Eusebius, and Conybeare has shown almost to demonstration that it formed the fourth part of his treatise in five books entitled Περὶ ἀρετῶν, which was probably the work referred to by Eusebius. In any case, whether it be held that the Therapeutæ actually existed in Philo's day, or that they are a utopian dream, it can no longer be doubted that the idea was Jewish, not Christian. (2) Περὶ ἀφθαρσίας κόσμου (*De Incorruptibilitate Mundi*), which has been declared unauthentic by Z. Frankel and J. Bernays. It has, however, been successfully defended by its latest editor, F. Cumont. (3) Περὶ κόσμου (*De Mundo*). It is generally agreed that, in L. Cohn's words, this is "nothing but a compilation from various portions of the περὶ ἀφθαρσίας κόσμου and other Philonic works." (4) Two discourses, *De Sampsone* and *De Iona*, extant only in Armenian, and certain other writings of the same kind. These appear only to been imputed to Philo by chance, and certainly cannot claim to be his work. In addition to these, two other tracts have been attacked: (1) Περὶ τοῦ πάντα σπουδαῖον εἶναι ἐλεύθερον (*Quod Omnis Probus Liber sit*) has been questioned by Z. Frankel and R. Ansfeld; but their arguments would rather point to its being an early work of Philo, which P. Wendland believes to be the case. (2) Περὶ προνοίας (*De Providentia*), which we possess as a whole only in an Armenian version: it consists of two books, the first of which appears to be in a Christian recension, but there is no reason for denying its Philonic origin. In a word, the effect of modern work upon the text has been to vindicate in a remarkable degree the genuineness of the works ascribed to Philo; and these results are accepted by Dr Leopold Cohn and Dr Paul Wendland, the editors of the critical edition.

AUTHORITIES.—L. COHN and P. WENDLAND. *Philonis Alexandrini opera quae supersunt.* Berlin, 1896 f.—P. WENDLAND. *Philo's Schrift über die Vorsehung.* Berlin, 1892.—F. C. CONYBEARE. *Philo about the Contemplative Life.* Oxford, 1895.—*Revue de l'Histoire des Religions*, vol. xvi., Paris, 1887, art. "Le Traité de la Vie Contemplative," by L. MASSEBIEAU.—*Jahrbücher für Philologie und Paedagogik*, Supplementband xxii., Leipzig, 1896, art. "Die Therapeuten und die philonische Schrift vom beschaulichen Leben," by P. WENDLAND.—*Jewish Quarterly Review*, vol. v., London, 1893, art. "The Latest Researches on Philo of Alexandria," by L. COHN; and vol. vii., 1894, art. "Florilegium Philonis," by C. G. MONTEFIORE.—*Dictionary of Christian Biography*, vol. iv., London, 1887, art. "Philo," by A. EDERSHEIM. (W. E. CO.)

Philology.—The history of philology since 1885 has been one of steady progress. In that period no discovery has been made equal to those that were made in the decade after 1870. As in previous periods of the history of the study of language, an era of discovery has been followed by an era of organization. The results of such discoveries as Verner's law have been far-reaching. It has taken time to grasp them in all their bearings and to tabulate the results. The working hypotheses which were furnished by the generalizations propounded in the 'seventies have been justified by their successful application to the multitudes of facts relating to language which had been collected before, or which have in even greater numbers been collected since. This very success has led discussion back to those principles which, first definitely propounded by Leskien in 1876, by Osthoff and Brugmann in 1878, led to an animated controversy culminating in a war of pamphlets in 1885. This controversy had no definite termination. The older school led by Georg Curtius practically came to an end with his death in 1885. Curtius's successor at Leipzig was Brugmann, the foremost exponent of the new principles. The school of Berlin represented by Johannes Schmidt, and that of Göttingen represented by Fick and by younger men like Bechtel and Collitz, though denying the originality of the new principles, and though deviating to some extent in terminology, have nevertheless been equally active in the employment of these principles as an engine of discovery. These principles were: (1) phonetic change proceeds according to laws which admit of no exceptions; (2) apparent exceptions are produced by the cross-action of a psychological influence-analogy. Besides the discussion of first principles attached to these two formulas, much has been done in investigating the effects of accent, though the results are still in too inchoate a condition to be treated here, while two practically new fields of investigation have been opened up. These are (*a*) Comparative Syntax, (*b*) the study of Semantics or the principles according to which the meanings of words develop and change.

In the study of phonetic laws several stages are traceable, and the meaning attached to the phrase *phonetic law* has varied at each of these stages. Moreover, the sweeping nature of the original generalizations has become so hedged in and contracted by limitations that a recent writer has been compelled once more to formulate the question whether phonetic laws actually exist. It must be admitted in the first place that the word *law* has been ill chosen for use in this connexion. In phonetic laws there is no element which can be identified as coming under the definition of a law as propounded by a jurist like John Austin. There is no authority which enunciates the law, there is no penalty for the breach of it. But the philologists who first used the term were not thinking of law in its strict signification, but of its use in such metaphorical expressions as scientific laws, for Schleicher and his followers in the middle of the 19th century had taken a keen interest in the development of the natural sciences, and had to some extent assimilated their terminology to that employed in those sciences. It was, however, soon recognized that the laws of language and those of natural science were not really alike or akin. A scientific "law" is only a brief method of expressing the fact that universal experience shows that certain causes universally produce certain effects. In chemistry two atoms of hydrogen and one of oxygen will make water, and they will make nothing else at any time or at any place the world over. Phonetic laws, however, do not hold true universally. They are often curiously limited in the area to which they apply. In ancient Greek, for example, the sound *-s-* between two vowels, which had been handed down from the original language whence Greek and the sister languages are derived, regularly disappears; in Latin, on the other hand, it changes into *-r-*; thus an original genitive of a neuter substantive we find represented in Greek by γένε-ος, a form which comparison with other languages shows to be traceable to an earlier **genes-os*, preceding the separation of the languages, while the same original stem with a different vowel in the ending appears in Latin as *gener-is*. Similarly an early **euso* appears in Greek as εὕω, in Latin as *uro*. This disappearance of original intervocalic *s* pervades all Greek dialects —the apparent exceptions come under the heading of analogical change; with a very few exceptions similarly explicable Latin intervocalic *s* has become *r*. But Latin was originally limited to a very small part even of Italy, and the next neighbours of the Latins on the east and south—the Sabines, Campanians, and Samnites—retained this intervocalic *s* without changing it into *r*. On the other hand, the neighbours to the north-east—the Umbrians in and beyond the Apennines—shared in this rhotacism. Yet the Kelts, who bordered on the Umbrians along the Po, and who spoke a language in many respects very closely akin to the dialects of Italy, in this regard agree rather with Greek than the Italic languages. In Latin, again, the period of action of the law which changed intervocalic *s* into *r* did not in all probability exceed the century from 450 B.C. to 350 B.C. So unlike, indeed, are phonetic laws to the laws of natural science in universality that an opponent of the dogma which declares that phonetic laws have no exceptions has compared them with the laws of fashion. The comparison is not so outrageous as it may seem at first sight. For in language there are two kinds of sound change, that which is unconscious, universal at a given time and within a given area, and, on the other hand, that which belongs only to a particular class or clique, deviates consciously from the pronunciation of the majority, is therefore not universal, and exercises no permanent influence on the language. The second kind of sound change corresponds exactly to the laws of fashion; it is in fact one of them. Such sound changes are the pronunciation of the English ending *-ing* as *-in'*, which was fashionable in the middle of the 19th century. This had, though probably without the knowledge of those who used it, a historical justification in the earlier forms from which most of the English words now ending in *-ing* are descended, and which survive in numerous local dialects. A similar conventional mispronunciation was the lisp affected by some would-be artistic persons at a somewhat later period. Belonging to an entirely different social stratum, and now equally obsolete, was the London pronunciation of the first half of the 19th century typified in Tony and Sam Weller's treatment of *v* and *w* in the *Pickwick Papers*. This, however, made a much nearer approach to being a genuine dialect peculiarity. It undoubtedly pervaded the pronunciation of the lower classes in London at one time; had it survived it might conceivably have spread over a wider and wider area until it embraced the whole population of England. A later change, that of the diphthong *ai* into *ei* (so that *day*, *daily* are pronounced *dy*, *dyly*), has spread from Essex and the East End of London over a large part of London and of the adjacent counties, and is still widening its range both geographically and socially. The history of these sound changes has not yet been investigated in detail with the thoroughness which it deserves.

There is, then, a part of sound change which is a matter of fashion and which is conscious. This sound change appears frequently in the pronunciation of individuals who have migrated from one part of a country to another. In many parts of Scotland, for example, the prepositions *with* and *of* appear in dialect only in the forms *wi'* and *o'*, which were originally the unaccented forms. In the conscious attempt to pronounce them as they appear in literary English, the educated Scotsman, if he remains in his native place, as a rule pronounces them as *with* (with the final sound unvoiced as it appears in the Scottish legal preposition *outwith*) and as *off*, the final sound here also being unvoiced. If he migrates to England or to Australia he will probably in course of time adopt the pronunciation with a voiced final sound. In the course of years habit will become second nature, and in this respect the speaker's pronunciation will become identical with that of his neighbours. It is clear, however, that changes of this nature cannot take place on a large scale. If a large number of persons migrate in a body and continue to live in close intercourse with one another and but little in contact with the outside world, changes such as take place in the pronunciation of the individual emigrant do not occur. There can be no imitation of alien sounds, for there are none; no greater effort to be intelligible is required, for the audience has not changed. Hence it has been often remarked that a population which history shows to have remained undisturbed for very long periods in the same geographical situation manifests but little change in its language. Thus in Arabia and Lithuania the population has remained practically unmixed in the same habitat for thousands of years, with the result that the languages spoken there remain at the present day the most archaic members of the linguistic families to which they respectively belong.

From what has been said it will be obvious that a phonetic law is only an observed uniformity in the treatment of a sound or a combination of sounds within a linguistic area at a given time. In the definition the term *linguistic area* is a very variable quantity. Thus it is a phonetic law that a sound of the original Aryan language, the precise pronunciation of which cannot be determined, but which was at any rate a palatal sound ($\hat{k}$), appears in the Aryan group (Sanskrit, Zend, Old Persian, with their descendants), in Armenian, in Balto-Slavonic and Albanian, in the form of a sibilant, while in

Greek, the Italic dialects, Germanic and Keltic, it appears as a *k*-sound. Here the linguistic area is extremely wide, and it is clear that the difference between the two groups of languages must be dated back to a very early period. Again, it is a phonetic law of Greek that the original combination *st-* at the beginning of words is retained in Greek. How then are we to explain the existence side by side of στέγος and τέγος? The former apparently complies with the law, the latter does not. The former has by its side the verb στέγω, while τέγος is supported only by the rare τέγη. Yet the forms of the verb and substantive found in the Germanic languages leave no doubt that the forms without *s-* represent an extremely old form, for the English *thatch* could not have changed its original *t-* into *th-* if it had been preceded by *s-*, the law being as strict for English as for Greek that initial *st-* remains unchanged. On the other hand, a phonetic law may be limited to a very small area. Thus in the dialect of Eretria, and nowhere else within the area of the Ionic dialect of Greek, do we find the change of the sound which appears elsewhere in Greek as -σ- between vowels into -ρ-: σίτηριν for σίτησιν (acc. sing.), παραβαίνωριν for παραβαίνωσιν (3rd pl. subjunctive). Why this change should take place here and nowhere else we do not know, although it may be conjectured that the cause was a mixture with immigrants speaking a different dialect, a mixture which ancient tradition supported. Undoubtedly such mixtures are the chief conditions of phonetic change, the effect of which is universal. The manner in which the change takes place is that the basis of articulation, the method in which the sound is produced, becomes changed. Thus along the "Highland line" in Scotland, where the English and Gaelic speaking populations had their linguistic frontier for centuries, the *wh-* of English, the Anglo-Saxon *hw-*, becomes universally *f-*, *wha?* becoming *fa?* *white*, *fite*, &c., *f* being the sound which it was most easy to substitute for the difficult *hw-*. The history of Spanish in the different communities of South America excellently illustrates this point. After the discovery of America there was a large influx of Spaniards into Chile, who ultimately, and chiefly by intermarriage, incorporated amongst them a considerable element from amongst the native Araucanian Indians. The result has been that the language of Chile is Spanish, pronounced not with the genuine sounds of Spanish, but with the sounds of the Araucanian language substituted for them. Elsewhere in Spanish America the language of the conquerors remained comparatively pure, because the Spaniards were much fewer in number and had therefore to maintain themselves as a caste apart. For the same reason Latin has split up into the numerous branches which we know as the Romance languages. The particular line of development which, *e.g.*, French followed as compared with Spanish or the language of the Rhaetian Alps was conditioned by the nature of the sounds in the language which preceded it in the same area, and which was spoken by the ancient Gauls who adopted Latin. The difficulty found in all of these cases is precisely of the same kind as that which an adult at the present day speaking one language finds in attempting to learn the pronunciation of another language. On the one hand, it is only with the greatest difficulty that muscles for many years accustomed to perform one set of movements can be forced into performing another set which are very similar but yet not identical; on the other hand, to an untrained ear the difference between the two sounds may remain unappreciated. The result is that the new language is pronounced with the sounds of the speaker's original language. If the new language is adopted by a whole people to whom it was originally foreign, the children naturally learn it from their parents with the sounds of the old language which has now become obsolete. Thus the basis of articulation is changed, and if, as was the case with Latin, this process be frequently repeated among peoples speaking languages with articulation widely differing one from another, it is clear that a series of different dialects of the adopted language has been created. This kind of change is immediate and universal throughout the whole area where linguistic change has taken place.

While the syntax of individual languages was one of the first features which attracted the grammarians' attention, at any rate in so far as particular authors differed from a given standard, it is only in very recent times that syntax has received methodical treatment from the comparative point of view. It may indeed be said that almost the whole fabric of the comparative syntax of the Indo-European languages as it exists to-day has been reared by one man—Professor Berthold Delbrück of Jena. In a series of brilliant studies beginning with a pamphlet on the Locative, Ablative, and Instrumental, published in 1867, and continued in his *Syntactical Researches* (*Syntaktische Forschungen*) in five volumes, comprising a treatment of the conjunctive and optative moods in Sanskrit and Greek (1871), the theory of the Sanskrit tenses (1877), the order of words in early Sanskrit prose (Çatapatha Brahmana) (1878), the foundations of Greek syntax (1879), and the syntax of the oldest Sanskrit (*Altindische Syntax*) dealing exclusively with the literature of the Vedas and Brahmanas (1888), Professor Delbrück laid the foundations for his treatment of comparative syntax in three volumes (1893, 1897, 1900), which has formed the completion of Brugmann's *Grundriss der vergleichenden Grammatik der indogermanischen Sprachen*. The only work by another hand (on a large department of the subject) which deserves to be mentioned by the side of Delbrück's studies is the small treatise by Hübschmann on the theory of the cases (*Zur Casuslehre*, 1875). For the comparative neglect of this field of investigation there are several reasons. The earlier philologists had so much to do in determining the languages which should be included within the Indo-European group, and in organizing the field of research as a whole, that it is not to be wondered at if they were unable to devote much attention to syntax. In the 'seventies, when attention began to be more directed towards comparative syntax, the remarkable discoveries made by Verner with regard to accentuation, and by Brugmann, Collitz, and others with regard to the phonology of the Indo-European languages, again distracted attention from the subject. Moreover, the research in itself is infinitely more difficult than that into sounds and forms; for the latter may be carried on by the help of grammars and dictionaries with a comparatively small knowledge of the literature of any individual language, while on the other hand the study of syntax is impossible without a thorough and intimate knowledge of the literature and modes of expression in each separate language. It is not, therefore, matter for wonder that Delbrück has confined himself in the investigation of syntax to a part only of the languages whose sounds and forms are discussed by Brugmann in the earlier volumes of the *Grundriss*. To cover the whole ground is beyond the powers of a single man, and there is a great lack of preliminary studies on the syntax of many of the languages.

For the early history of the syntax of the verb Greek and Sanskrit are important above all other languages, because in them the original forms and the original usages are better preserved than they are elsewhere. And it is in the verb that the great difficulties of comparative syntax present themselves. The noun system is so well preserved in several languages that, when the number of the original cases had once been determined, the sifting of the pro-ethnic usages attaching to each case was tolerably easy, for besides Sanskrit and (to a less extent) Latin, Lithuanian and Slavonic have kept the pro-ethnic case system almost complete. The ideas also which had to be expressed by the cases were on the whole of a very concrete character, so that here the problem was much simplified. On the other hand, the ideas expressed by the forms of the verb are of a much more subtle nature, while the verb system in all languages except Greek and Sanskrit has broken down earlier and more completely than the noun. It is clear that the verb of the original Indo-European language possessed two voices, and forms corresponding to what we call the Indicative, Subjunctive, and Optative moods, and to the Present, Imperfect, Future, Aorist, and Perfect tenses. The imperative mood seems primitively to have been confined to the second person singular, just as the vocative, which, like the imperative, is a stem form without suffix, was confined to the singular. The infinitive, as is well known, is in all languages of this system not originally a verbal but a substantival form. The pluperfect, where it has developed, seems to be a mixed form arising from the application of aorist endings to a perfect stem. Thus far the history of the verb system is tolerably clear. But when we attempt to define the original meaning of the moods and of the tenses we pass into a region where, in spite of assiduous investigation in many quarters during recent years, the scanty amount of light thrown on the problem has only served to make the darkness visible. As regards the tenses at least, it has been shown that without doubt there is no difference in formation between present, future, and aorist stems, while the earliest meaning of the perfect was that of a special kind of present expressing either repeated or intensive action or a state. It has also been proved that the original meaning of the aorist is not past in time, and that in fact the only element whereby these languages could express remoteness in time was the augment. The augment seems to have been originally a pronominal deictic particle. Thus, as there was no original pluperfect, as neither perfect nor aorist originally referred to past time, and as the future, except in Lithuanian (with slight traces in Slavonic) and the Indo-Iranian group, cannot be clearly distinguished from the aorist, the system as a method of expressing time absolutely breaks down. The tenses in fact did not originally express the times when the action took place, but the type of action which took place. Thus the present system in the main expressed continued or durative action, the aorist only the fact that the action had taken place. The action indicated by the aorist might have been of considerable duration, or it might have been begun and ended in a moment; its characteristics in this respect are not in any way indicated by the aorist form, which intimates only that the action is viewed as a completed whole and not as a continuous process. The present system, however, is built up in a great variety of ways (thirty-two according to Brugmann's enumeration). It is *à priori* unlikely that such a multiplicity of formations had not originally some reason for its existence, and Delbrück thinks that he has discovered a difference in syntactical value between various forms. The reduplicated present forms of the type seen in Sanskrit *jígāti*, Greek δίδωμι, &c., he regards as expressing originally an action which consisted of repeated acts of the same nature (iterative), though this iterative meaning frequently passed into an intensive meaning. Presents of the type seen in Sanskrit *tṛ́ṣyati*, "is thirsty," and Greek χαίρω, "am glad" (for * χαρι̯ω), where the ι̯ (*y*) of the suffix has modified the first syllable and disappeared, he regards as *cursive*—*i.e.*, they express continuous action without reference to its beginning or end. Verbs which have regard to the beginning or end of the action he calls terminative, and finds them represented (*a*) in verbs with *-n-* suffixes, Sanskrit *ṛṇóti*, ὄρνυσι, "sets in motion," ἄγνυμι, "break to pieces"; (*b*) in verbs with the suffix *-sko-*, Sanskrit *gáchati*, "goes" (to a definite destination), Greek βάσκω, &c. The roots he classifies as momentary (Punktuell) or non-momentary, according as they do or do not express an action which is begun and ended at once.

This method of classification was no doubt suggested in the first instance by the characteristics of the Slavonic verb system. In this system a clear distinction is drawn in nearly all verbs between those which express a process (durative verbs) and those which express a completed action (perfective verbs). When perfective and durative verbs are formed from the same root, the perfective are distinguished from the durative forms (*a*) by having a preposition prefixed, or (*b*) by having a different stem formation. Thus in the Old Bulgarian (Old Ecclesiastical Slavonic) *to strike* (hit) and *to strike dead* are expressed by the same verb, but in the latter meaning a preposition is found which does not appear in the former, *biti* (infinitive), "to strike"; *u-biti*, "to strike dead." *To strike* is *durative; to strike dead* is *perfective.* As an example of difference of stem formation expressing this difference of meaning, we may quote *sěsti*, "to sit down" (perfective), *sěděti*, "to sit" (durative). Verbs with a suffix in *-n-* have often a perfective meaning: cp. the Sanskrit and Greek verbs quoted above. The *perfective* verbs correspond in meaning to the Greek aorist, and are to be carefully distinguished from *perfect* forms. The same distinction of meaning is often achieved in other languages also by means of prepositions, *e.g.*, in Latin (Seneca, *Epp.* xciii. 10), *Quid autem ad rem pertinet, quamdiu* vites, *quod* evitare *non possis?* "What does it matter how long you go on avoiding [durative] what you cannot escape [perfective]." From this example, however, it is clear that, though the means employed to make the distinction are different, there is no difference in meaning between such perfective verbs and those classified by Delbrück as terminative. Here, as in many other parts of this study, the ideas are new, and grammatical terminology has not yet sufficiently crystallized, and still leaves something to be desired both in clearness and in precision.

As regards the moods, the difficulty has been to find any criterion whereby the functions of one mood should be differentiated from those of the others. It has long been recognized that the difference between indicative and subjunctive is one of meaning and not one of formation; that, *e.g.*, in Sanskrit *bharati* (3rd sing. pres. indic.), "bears," is morphologically identical with *hanati*, "may slay" (3rd sing. pres. subj.), and that the latter is described as a subjunctive only because of the meaning, and because there exists a dissyllabic form, *hanti*, which makes the indicative "slays." Similarly in Greek it is impossible to distinguish morphologically between παύσω, "I shall check" (fut. indic.) and παύσω, "let me check" (1st aor. subj.). Moreover, in the earliest forms of the languages which preserve the moods best (Greek and Sanskrit), the connexion syntactically between the indicative and the subjunctive forms is closest. Not only does the future express futurity, but also the determination of the subject to carry out the action expressed, which, in Delbrück's discussion of the moods, is precisely the point chosen as characteristic of the subjunctive. On the other hand, the present optative differs from the present (and future) indicative and present subjunctive in having a special mood suffix, and in having secondary while they have primary personal endings. Nevertheless its meaning overlaps that of the other forms, and some excellent authorities, like Professor W. W. Goodwin, see in future indicative, subjunctive, and optative only different degrees of remoteness in the future, the remoteness being least in the future and greatest in the optative. Delbrück, however, abides, with slight modifications, by the distinction which he propounded in 1871, that the subjunctive expresses Will and the optative Wish. Here again the problem has not been solved, and it is doubtful how far any definite solution is likely to be arrived at, since there are so many gaps in our knowledge of mood forms. These gaps, owing to the break-up of the system at so early a period, it is hardly probable we shall ever be able to fill. It is possible, however, to do a great deal more than has yet been done even in the most familiar languages. In Latin, for instance, even now, the facts for the uses of the moods within the two centuries of the classical period are very imperfectly known, and it is no exaggeration to say that more has been done in the last hundred years for Sanskrit than has been done in two thousand years of continuous study for Latin or Greek.

The second of the recent additions to the domain of Philology—the study of meaning—presents fewer difficulties, but until recent years has been equally neglected. The study is so recent that the literature of the subject is still extremely small. The only attempt to deal with it on a large scale is M. Bréal's *Essai de Sémantique* (1897), now translated into English under the title of *Semantics* (1900), with a valuable introduction and appendix by Dr Postgate. From the practical point of view many of the phenomena have been classified in works on rhetoric under the headings of Metaphor, Synecdoche, and Metonymy. The psychological principle behind this superficial classification is that of association of ideas. Here, as elsewhere, changes proceed not by accident, but according to definite principles. Here, as elsewhere in language, in history, and the other moral sciences, the particular principle in operation can be ascertained only by beginning with the result and working back to the cause. In the development of meaning much more than in phonetics is this necessarily the case. In phonetics all speakers of the same dialect start with approximately the same sound. But the same combination of sounds which we call a word does not recall the same idea to all persons who use that word. The idea that the phrase *railway station* calls up in the mind of a Londoner is very different from that which occurs to the mind of a child acquainted only with a wayside station serving the wants of a country village of a few hundred inhabitants. The word *herring* suggests one idea or train of ideas to the fisherman who catches the fish, another to the merchant who purchases it from the fisherman, a third to the domestic who cooks it, and so on. To members of the same family the same word may often have widely different associations, and, if so, the metaphors for which the word will be employed will differ in each case.

For the history of meaning it is necessary to have regard to all the forms of association of ideas which psychology recognizes. These are contiguity in place or in time, resemblance and contrast. Contrast, however, as J. S. Mill and Bain have shown, is not a simple form of association, but is evolved partly from contiguity, partly from resemblance. An artificial hollow generally implies also an artificial height made of the materials excavated from the hollow. Hence in most languages some words occur with the two contrasted meanings. Thus in English we find *dyke* in use both for a ditch and for a mound fronted by a ditch, the word *ditch* being, in fact, but a dialectal form of *dyke*. In Scotland, on the other hand, where earthen mounds and stone walls form more frequent boundaries between fields than in England, the word *dyke* is now practically limited to elevated boundaries, while *ditch* is limited to excavated boundaries. Thus the proverb, "February fill dyke," which in England implies that the February rains will fill the ditches, is often understood in Scotland to mean that in February the snow will be level with the tops of the stone or turf walls. Similarly in Latin Tacitus can say *fossas proruere*, which can only apply to levelling raised mounds; while in Greek Xenophon also talks of the ditch (trench) thrown up (τάφρος ἀναβεβλημένη). It is only natural, therefore, that other words with several meanings should be used similarly: *moat*, originally a mound of earth or peat, has come to mean a big ditch; while, conversely, soldiers in trenches are not so much in ditches, as the word ought to signify, as behind breastworks. Sometimes when two actions opposed to one another are contiguous, a word seems to change to the exact opposite of its original meaning. Thus the English verb *wean*, which meant originally to accustom (to cooked food), has been transferred to the necessary preliminary, to disaccustom to the breast.

Resemblances may be (i.) genuine, and (*a*) of external appearance, or (*b*) of other characteristics, or (ii.) fanciful or analogical. From resemblance in the external appearance of the object, the word *gem*, which in Latin (*gemma*) usually means a bud, has come to mean first a pearl and then by extension of the meaning any precious stone. From the concentric coats which appear in both, the Latin word for a pearl (*unio*, acc. *unionem*) appears in English as *onion*. Examples where the characteristics are not of external appearance are such as the German *kaiser* and the Russian *tsar*, which are descended from Julius Cæsar, while the Lithuanian word for king—*karãlius*—is *Carolus*, *i.e.*, Charlemagne. So in modern Persian, *Xusrev*, "Lord," comes from the Zend proper name Husravah (Chosroes). The resemblances which have established a connexion between *pert* and *impertinent* (properly irrelevant) are in sound only. The same is true of the supposed relation of the verb *cut* to *cutlass*, *cutler*, and *cutlet*. While *train oil* really means oil in drops like tears (cp. German *Thräne*), most people connect it with railway trains. The resemblance in some cases is merely in function. Thus, though the fir and the oak have no resemblance one to the other, the word *fir* is now generally identified with the Latin *quercus* in etymology (cp. *four* and *quattuor*), in the same way as the Latin *fagus*, "beech," is with the Greek φηγός, "oak," the users of the word having, in the course of their migrations, passed from a land with oaks to a land with firs in the one case, and from a land of beeches to a land of oaks in the other. Resemblance as the basis of metaphor has a very widely extended influence on language.

The most numerous and most varied forms of change in meaning depend, however, upon the law of contiguity. Perhaps the commonest of all forms of contiguity is that where the word indicating some accompanying feature or condition replaces the word for the object referred to. In the countries that border the Mediterranean the heat of mid-day is accompanied and intensified by the dying away of the wind, a characteristic remarked upon by Aeschylus (*Agam.* 565): "What time upon his noonday couch, windless and waveless sank the sea to rest." From the Greek word καῦμα, "burning heat," arises through late Latin the English *calm*, where the absence of wind is the only idea present, that of heat having altogether disappeared. Again, in *bugle*, which is abbreviated for *bugle-horn*, the word which survives properly means *wild ox*, and the originally more important element is lost. In a combination like *silver bugle* the word has gone a stage farther; the original meaning of *horn* has also disappeared. There is no longer any thought of an animal's horn; the only idea that survives is that of a musical instrument. From the cope or cloak (*capella*) of St Martin, which was preserved as a sacred relic by the Frankish kings, comes the word *chapel*. The word was first transferred from the cloak to the holy place wherein it was kept, and thence to similar shrines, and ultimately to any place, not being a church, where prayers were said. A *jig* was originally not the dance, but the fiddle which supplied the music for the dance. The names of liquors are often replaced by some accompaniment as of the place, *port, sherry, champagne*, or by a qualifying adjective as in *brandy*, properly "burnt" from the Dutch *brande-wijn*; or, again, only the less important element of the word is retained as in *whisky*, literally "water," for the older *usquebaugh*, a corruption of Gaelic words meaning the "water of life" (*aqua vitæ*). Replacement of substantives by their accompanying adjectives is common in most languages. One of the most common methods of coining a name for a new article is to give it the name of the place or people whence it comes. Thus we have arras, lawn (from Laon), cravat (Croat), coach from Kocs in Hungary, bilboes (both fetters and swords) from the iron mines of Bilboa in Spain. Equally common are the names of inventors—pinchbeck, tontine, silhouette, guillotine, derrick. In the word *cash*, which comes indirectly from Latin *capsa*, "a box," the thing contained has taken its name from the container. Similarly *mortar*, "cement," derives its name from the mortar in which it was mixed, while in *box* the material (boxwood, Lat. *buxus*, Greek πύξος) has usurped the place of the article made. In *leper* the disease (Lat. *lepra*, the rough disease, from Greek λεπρὰ νόσος) has been made into the name of the sufferer, who was earlier called a leprous man. As a consequence, a new substantive *leprosy* has to be taken from the adjective to indicate the disease. The various changes in meaning, which are classed together as synecdoche, have their origin in contiguity. Thus we have the species for the genus; the butcher, who properly kills goats only (Old French *boc*), has ousted the flesher. But we have also the genus for the species; corn, as a rule, means in England wheat; in Scotland, oats; in America, maize. The individual becomes collective as in corps, navy, body (of men); the collective becomes individual when Latin *racemus*, "bunch of grapes," passes into English "raisin." Here would come the so-called meliorative and pejorative developments in word-meaning, whereby, *e.g.*, *steward*, "the sty-ward," becomes the title of a great officer of the realm and the name of a line of kings; or, on the other side, *sou* (Latin *solidus*) passes from the name of a gold coin to that of one of proverbially insignificant value. Here, too, would come many euphemistic uses which are, for the most part, applications of more general terms to avoid the mention of some specific act or object which is unpleasant, as death, murder, bankruptcy, debt, &c., while metaphorical terms for the same things come under resemblance. These examples do not exhaust the forms of contiguity which appear in language, but they are enough to show how far-reaching the effect of this type of association of ideas is upon language, and how extensive the field is which still calls for investigation before the study of meaning attains the same development as the investigation of the other branches of the history of language.

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Phœnix, a city of Arizona, U.S.A., capital of Maricopa county and of the territory, situated on the Salt river, a main branch of the Gila, and on the Santa Fé, Prescott, and Phœnix and the Maricopa and Phœnix railways, south-west of the centre of the territory. Population (1890), 3152; (1900), 5544, of whom 935 were foreign-born and 148 negroes.

Phœnix Islands. See POLYNESIA.

Phœnixville, borough of Chester county, Pennsylvania, U.S.A., situated on the Schuylkill river, at the intersection of branches of the Pennsylvania and the Philadelphia and Reading railways, in the south-eastern part of the state, at an altitude of 131 feet. It contains extensive iron-works, blast furnaces, and rolling mills. It is widely known for its manufacture of bridges, girders, columns, &c. Population (1890), 8514; (1900), 9196, of whom 2221 were foreign-born and 278 negroes.

Phonograph.—The phonograph is an instrument by which the mechanical effect of vibrations of sound can be imprinted on a moving surface of tinfoil or wax. By mechanical arrangements the sound can be reproduced from these imprints. The phonograph was invented by Thomas Edison in 1876, and the first design was patented in January 1877. Many attempts had been made by earlier experimenters to obtain tracings of the vibrations of bodies emitting sound, such as tuning-forks, membranes, and glass or metallic discs. In 1807 Thomas Young (*Lectures*, vol. i. p. 191) described a method of recording the vibrations of a tuning-fork on the surface of a drum; his method was fully carried out by Wertheim in 1842 (*Recherches sur l'élasticité, 1*r. *mém.*). Recording the vibrations of a membrane was first accomplished by Leon Scott by the invention of the phonautograph, which may be regarded as the precursor of the phonograph (*Comptes Rendus*, t. liii. p. 108). This instrument consisted of a thin membrane to which a delicate lever was attached. The membrane was stretched over the narrow end of an irregularly-shaped funnel or drum, while the end of the lever or marker was brought against the surface of a cylinder covered with paper on which soot had been deposited from a flame of turpentine or camphor. The cylinder was fixed on a fine screw moving horizontally when the cylinder was rotated. The marker thus described a spiral line on the blackened surface. When sounds were transmitted to the membrane and the cylinder was rotated, the oscillations of the marker were recorded. Thus tracings of vibrations were obtained. This instrument was much improved by the well-known physicist, König, of Paris, who also made with it many valuable observations. (For a figure of the improved instrument, see *Nature*, 26th December 1901, p. 184.) The mechanism of the recording lever or marker was improved by Barlow, in 1874, in an instrument called by him the logograph (*Trans. Roy. Soc.*, 1874). The next step was König's invention of manometric flames by which the oscillations of a thin membrane under sound-pressures acted on a small reservoir of gas connected with a flame, and the oscillations were viewed in a rotating rectangular mirror, according to a method devised by Wheatstone. Thus flame-pictures of the vibrations of sound were obtained (*Pogg. Ann.* cxxii. pp. 242, 660, 1864; see also *Quelques Expériences d'Acoustique*, Paris, 1882). Views of such flame-pictures may be seen in almost every text-book of physics. Clarence Blake in 1876 employed the drum-head of the human ear as a logograph, and thus obtained tracings similar to those made by artificial membranes and discs (*Archiv. für Ophthalmol.* vol. v. 1. 1876). In the same year Stein photographed the vibrations of tuning-forks, violin strings, &c. (*Pogg. Ann.*, 1876, p. 142). Thus from Thomas Young downwards successful efforts had been made to record graphically on moving surfaces the vibrations of sounds, but the sounds so recorded could not be reproduced. This was accomplished by Edison. In the first phonograph a spiral groove was cut on a brass drum fixed on a horizontal screw, so that when the drum was rotated it moved from right to left, as in the phonautograph. The recorder consisted of a membrane of parchment or gold-beater's skin stretched over the end of a short brass cylinder about 2 inches in diameter. In the centre of the membrane there was a stout steel needle having a chisel-shaped edge, and a stiff bit of steel spring was soldered to the needle near its point, while the other end of the spring was clamped to the edge of the brass cylinder over which the membrane was stretched. The recorder was then so placed beside the large cylinder that the sharp edge of the needle ran in the middle of the spiral groove when the cylinder was rotated. The cylinder was covered with a sheet of soft tinfoil. During rotation of the cylinder and while the membrane was not vibrating, the sharp edge of the marker indented the tinfoil into the spiral groove; and when the membrane was caused to vibrate by sounds being thrown into the short cylinder by a funnel-shaped opening, the variations of pressure corresponding to each vibration caused the marker to make indentations on the tinfoil in the bottom of the groove. These indentations corresponded to the sound-waves. To reproduce the sounds the recorder was drawn away from the cylinder, and the cylinder was rotated backwards until the recorder was brought to the point at which it started. The cylinder was then rotated forwards so that the point of the recorder ran over the elevations and depressions in the bottom of the groove. These elevations and depressions, corresponding to the variations of pressure of each sound-wave, acted backwards on the membrane through the medium of the marker. The membrane was thus caused to move in the same way as it did when it was made to vibrate by the sound-waves falling upon it, and consequently movements of the same general character but of smaller amplitude were produced, and these reproduced sound-waves. Consequently the sound first given to the phonograph was reproduced with considerable accuracy. Such was the first tinfoil phonograph. In 1878 Fleeming Jenkin and Ewing amplified the tracings made on this instrument by the sounds of vowels, and submitted the curves so obtained to harmonic analysis; that is to say, by the application of Fourier's theorem they were enabled to analyse the complex curves corresponding to the vibrations of vowel-tones into the simpler curves, in a harmonic series, of which they were composed (*Trans. Roy. Soc. Edin.* vol. xxviii. p. 745). The marks on the tinfoil were also examined by Grützner, Mayer, Graham Bell, Preece, and Lahr (see *The Telephone, the Microphone, and the Phonograph*, by count du Moncel, Lond. 1884; also *The Speaking Telephone and Talking Phonograph*, by G. B. Prescott, New York, 1878).

The tinfoil phonograph, however, was an imperfect instrument, both as regards the medium on which the imprints were taken (tinfoil) and the general mechanism of the instrument. From 1877 to 1888 Edison was engaged in working out the details of the wax-cylinder phonograph as we now have it, one of the most beautiful of instruments (see Fig. 1a and Fig. 1b). The improvements consisted chiefly (1) in substituting for tinfoil cylinders made of a waxy substance on which permanent records are taken; (2) in substituting a thin glass plate for the parchment membrane; (3) in improving the mechanical action of the marker; and (4) in driving the drum carrying the wax cylinder at a uniform and rapid speed by an electric motor placed below the instrument. In the first place, permanent records can be taken on the wax cylinder. The waxy material is brittle, but it readily takes the imprints made by the marker, which is now a tiny bit of sapphire. The marker, when used for recording, is shod with a chisel-shaped edge of sapphire; but the sapphire is rounded when the marker is used for reproducing the sound. The marker also, instead of being a stiff needle coming from the centre of the membrane or glass plate, is now a lever, heavily weighted so as to keep it in contact with the surface of the wax cylinder. A single vibration of a pure tone consists of an increase of pressure followed by a diminution of pressure. When the disc of glass is submitted to an increase of pressure, the action of the lever is such that, while the wax cylinder is rotating, the point of the marker is angled downwards, and thus cuts deeply into the wax; and when there is diminution of pressure, the point is angled upwards, so as to act less deeply. In reproducing the sound, the blunt end of the marker runs over all the elevations and depressions in the bottom of the groove cut on the wax cylinder. There is thus increased pressure transmitted upwards to the glass disc when the point runs over an elevation, and less pressure when the point runs over a depression on the wax cylinder. The glass disc is thus, as it were, pulled inwards and thrust outwards with each vibration, but these pulls and thrusts follow each other so rapidly that the ear takes no cognizance of the difference of phase of the vibrations of the glass plate in imprinting and in reproducing. The variations of pressure are communicated to the glass plate, and these, by the medium of the air, are transmitted to the drum-head of the ear, and the sound is reproduced with remarkable fidelity. It is necessary for accurate reproduction that the point of the marker be in the centre of the groove. In the older phonographs this required accurate adjustment by a fine screw, but in newer forms a certain amount of lateral oscillation is allowed to the marker, by which it slips automatically into the groove. Recently two other improvements have been effected in the construction of the instrument. A powerful triple-spring motor has been substituted for the electric motor, and the circumference of the wax cylinder has been increased from $6\frac{7}{8}$ inches to 15 inches. The cylinders make about two revolutions per second, so that with the smaller cylinder the point of the marker runs over nearly 14 inches in one second, while with the larger it runs over about 30 inches. The marks corresponding to the individual vibrations of tones of high pitch are therefore less likely to be crowded together with the larger cylinder, and these higher tones, in particular, are more accurately reproduced. In a form of instrument called the 200-thread machine, motion of the drum bearing the cylinder was taken off a screw the thread of which was 50 to the inch, and by a system of gearing the grooves on the cylinder were 200 to the inch, or $\frac{1}{200}$ of an inch apart. It was somewhat difficult to keep the marker in the grooves when they were so close together; and the movement is now taken directly off a screw the thread of which is 100 to the inch,

Fig. 1a.—Exterior of Edison Phonograph.

so that the grooves on the cylinder are $\frac{1}{100}$ of an inch apart. Thus with the large cylinder a spiral groove of over 300 yards may be described by the recorder, and with a speed of about two revolutions per second this distance is covered by the marker in about 6 minutes. By diminishing the speed of revolution, which can be easily done, the time may be considerably lengthened. Other forms of phonographs, some termed grammophones, have been invented, in which the records are taken on a flattened disc rotating horizontally, and so arranged that the recorder describes a series of spirals diminishing from the circumference to the centre of the disc; but they are all constructed on the general principle of the phonograph above described.

To understand how the phonograph records and reproduces musical tones, it is necessary to remember (1) that *pitch* or *frequency* depends on the number of vibrations executed by the vibrating body in a given period of time, or on the duration of each vibration, say a tone having a pitch or frequency of 200 vibrations per second, each vibration lasting $\frac{1}{200}$ of a second; (2) that *intensity* or *loudness* depends on the amplitude of the movement of the vibrating body; and (3) that *quality*, *timbre*, or *clang*, first, depends on the form of the individual vibrations, or rather on the power the ear possesses of appreciating a simple pendular vibration producing a pure tone, or of decomposing more or less completely a compound vibration into the simple pendular vibrations of which it is composed. If we apply this to the record of the phonograph on the wax cylinder, we find that, given a constant and sufficiently rapid velocity of the cylinder, a note or tone of a certain pitch will be heard when the marker runs over a number of elevations and depressions corresponding to the frequency of that note. Thus if the note was produced by 200 vibrations per second, and suppose that it lasted in the music for $\frac{1}{10}$ of a second, 20 marks, each made in $\frac{1}{200}$ of a second, would be imprinted on the wax. Consequently, in reproduction, the marker would run over the 20 marks in $\frac{1}{10}$ of a second, and a tone of that frequency would be reproduced. The loudness would correspond to the depth of each individual mark on the cylinder. The greater the depth of a series of successive marks produced by a loud tone, the greater, in reproduction, would be the amplitude of the excursions of the glass disc and the louder would be the tone reproduced. Lastly, the form of the marks corresponding to individual vibrations would determine the quality of the tone or note reproduced, by which we can distinguish the tone of one instrument from another, or the sensation produced by a tone of pure and simple quality, like that from a well-bowed tuning-fork or an open organ pipe, and that given by a trumpet or an orchestra, in which the sounds of many instruments are blended together. When the phonograph records the sound of an orchestra, it does not record the tones of each instrument, but it imprints on the wax cylinder the form of impression corresponding to the very complex sound-wave formed by all the instruments combined. This particular form, infinitely varied, will reproduce backwards, as has been explained, by acting on the glass plate, the particular form of sound-wave corresponding

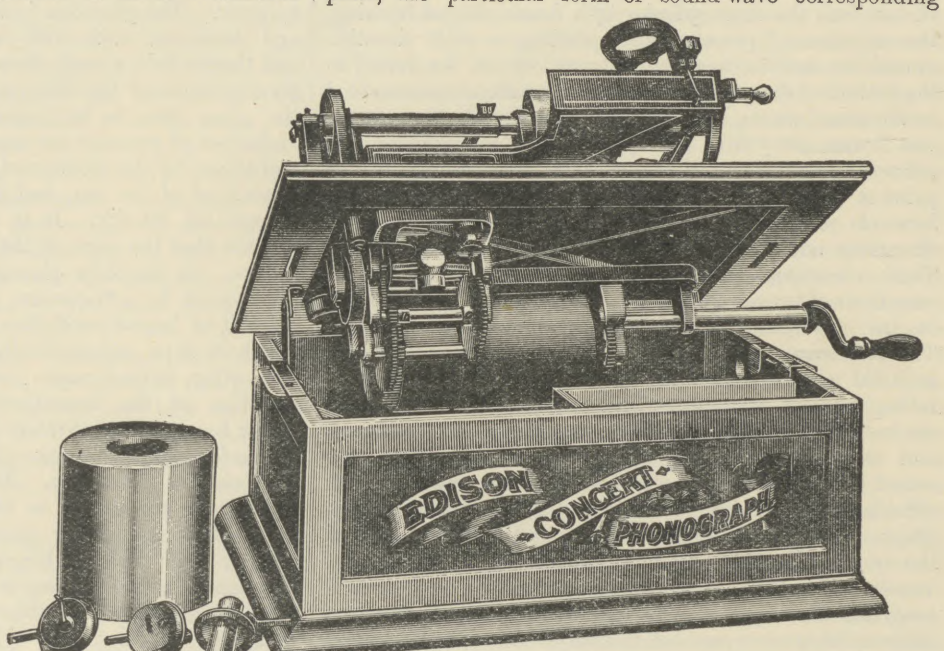


Fig. 1b.—Mechanism of Edison Phonograph.

to the sound of the orchestra. This is one of the wonderful feats of the phonograph. Numerous instruments blend their tones to make one wave-form, and when one instrument predominates, or if a human voice is singing to the accompaniment of the orchestra, another form of sound-wave, or rather a complex series of sound-waves, is imprinted on the wax cylinder. When reproduced, the

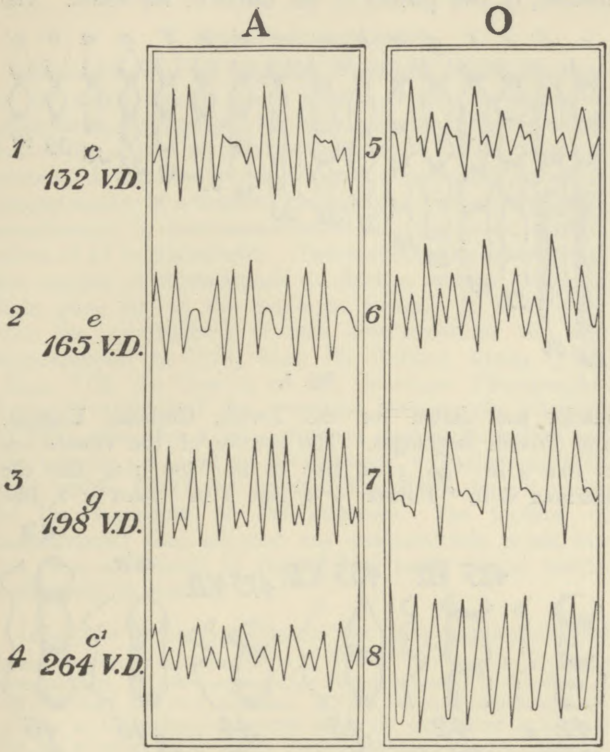


Fig. 2.

wave-forms again exist in the air as very complex variations of pressure, these act on the drum-head of the human ear, there is transmission to the brain, and there an analysis of the complex sensation takes place, and we distinguish the trombone from the oboe, or the human voice from the violin obbligato. The phonograph reduces all to mechanical simplicity; complexity arises when we have to deal with the effects on the human ear and brain.

Many efforts have been made to obtain graphic tracings of wave-forms imprinted on the wax cylinder of the phonograph. Thus the writer has taken (1) celloidin casts of the surface, and (2) micro-photographs of a small portion of the cylinder (*Journ. of Anat. and Phys.*, July 1895). He also devised a phonograph recorder by which the curves were much amplified (*Trans. Roy. Soc. Edin.* vol. xxxviii.; *Proc. Roy. Soc. Edin.*, 1896–97, Opening Address; *Sound and Speech Waves as revealed by the Phonograph*, Lond. 1897; and *Schäfer's Physiol.* vol. ii., Vocal Sounds, p. 1229). As already mentioned, so long ago as 1878 Fleeming Jenkin and Ewing had examined the marks on the tinfoil phonograph. Professor Hermann, of Königsberg, took up the subject about 1890, using the wax-cylinder phonograph. He obtained photographs of the curves on the wax cylinder, a beam of light reflected from a small mirror attached to the vibrating disc of the phonograph being allowed to fall on a sensitive plate while the phonograph was slowly travelling. (For references to Hermann's important papers, see *Schäfer's Physiology*, vol. ii. p. 1222.) Boeke, of Alkmaar, has devised an ingenious and accurate method of obtaining curves from the wax cylinder. He measures by means of a microscope the transverse diameter of the impressions on the surface of the cylinder, on different (generally equidistant) parts of the period, and he infers from these measurements the depth of the impressions on the same spot, or, in other words, he derives from these measurements the curve of the vibrations of the tone which produced the impression (*Archiv. f. d. ges. Physiol.* Bonn, Bd. 1, S. 297; also *Proc. Roy. Soc. Edin.*, 1898).

From a communication to the Dutch Otorhinolaryngological Society Dr Boeke has permitted the author to select the accompanying illustrations, which will give the reader a fair conception of the nature of the marks on the wax cylinder produced by various tones. Fig. 2 shows portions of the curves obtained by Hermann, and enlarged by Boeke one and a half times. The numbers 1 to 4 refer to periods of the vowel A (as in "hard"), sung by Hermann on the notes *c e g c'*. Numbers 5 to 8 show the curves of the vowel *o* (as in "go") sung to the same notes. The number of vibrations is also noted. Bocke measured the marks for the same vowels by his method, from the same cylinder, and constructing the curves, found the relative lengths to be the same. In Fig. 3 we see the indentations produced by the same vowels, sung by Hermann on the notes *c e g c'*, on the same phonograph cylinder, but delineated by Boeke after his method. The curves are also shown in linear fashion beside each group of indentations. From these measurements the curves were calculated and reproduced, as in Fig. 4. Thus the curves of the same vowel sounds on the same cylinder are shown by two methods, that of Hermann and that of Boeke. In Fig. 5 we see the indentations on the vowel *a*, sung by Dr Boeke, aged 55, on the notes *c d e f g a b c'*, and near the frequencies of 128, 144, 160, 170·6, 192, 213·3, 240, and 256. The numbers 33 to 40 show the marks produced by the same vowel, sung by his son, aged 13. It will be seen that the boy sang the notes exactly an octave higher. Fig. 6 shows the marks produced by some musical sounds. Each shows on the right-hand side the curve deduced from the marks, and under it a graphical representation of the results of its harmonic analysis after the theorem of Fourier, in which the ordinates represent the amplitude of the subsequent harmonic constituents. No. 41 is the period of the sound of a pitch-pipe giving *a'* (425 double vibrations per second), No. 42 the period of a Dutch pitch-pipe, also sounding *a'* (424·64 double vibrations per second). No. 43 is a record of the period of a sound produced by blowing between two

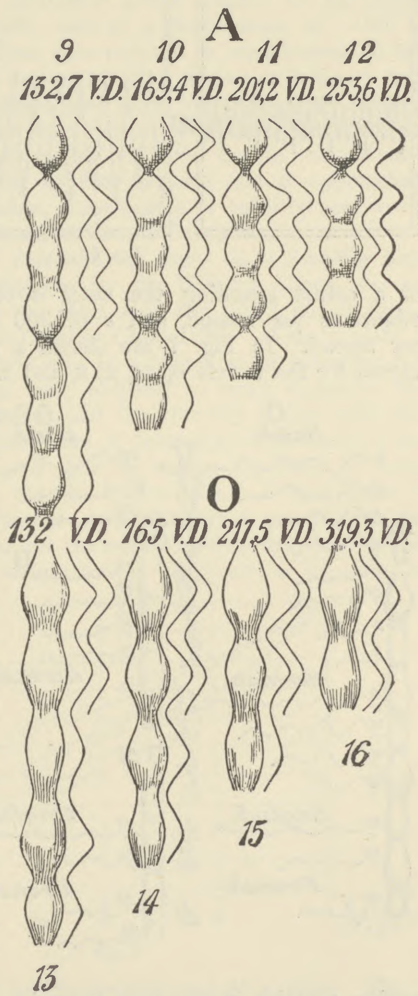


Fig. 3.

strips of indiarubber to imitate the vocal cords, with a frequency of 453 double vibrations per second. No. 44 is that of a telephone pipe used by Hermann (503 double vibrations per second). Nos. 45 and 46 show the marks

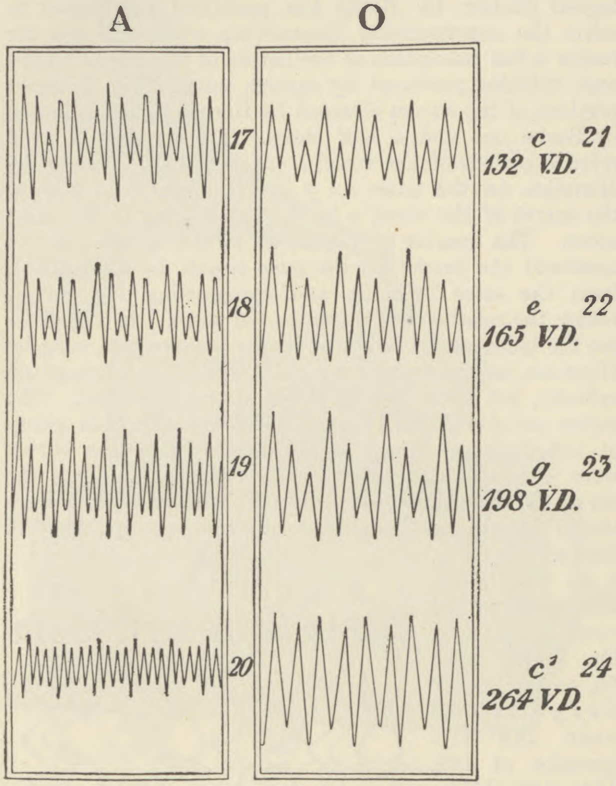


Fig. 4.

of a cornet sounding the notes a of $\pm$ 400 double vibrations per second, and e of 300 double vibrations per second. In Fig. 7 are shown a number of vowel curves for the vowels O, OE, A, E, and I. Each curve has on the right-hand side a graphical representation of its harmonic analysis. The curves are in five vertical columns, having on the left-hand side of each drawings, by Boeke's method, of two periods of the marks of the vowel. The

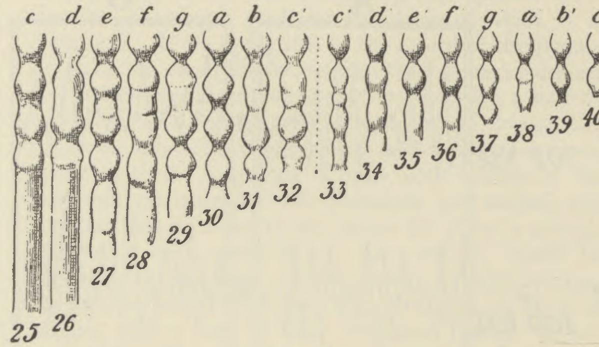


Fig. 5.

marks are shown for the Dutch, German, English, and French languages. The sounds of the vowels are *o*, like *o* in "go"; *oe*, like *oo* in "too"; *u*, like the German *ü* in "Führer"; *a*, like *a* in "hard"; *e*, like

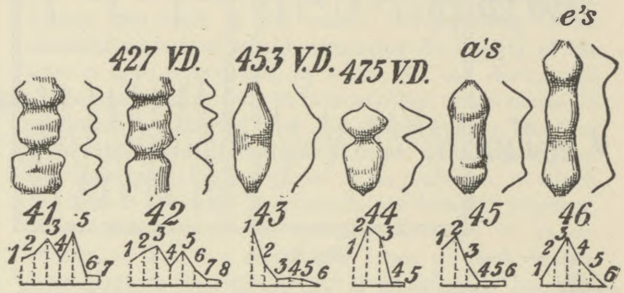


Fig. 6.

a in "take"; *ij*, not in English words, but somewhat like *ē* in "bell"; and *i*, like *ee* in "beer." The first section contains only Dutch vowel sounds, either sung or spoken by Boeke or members of his family. The second

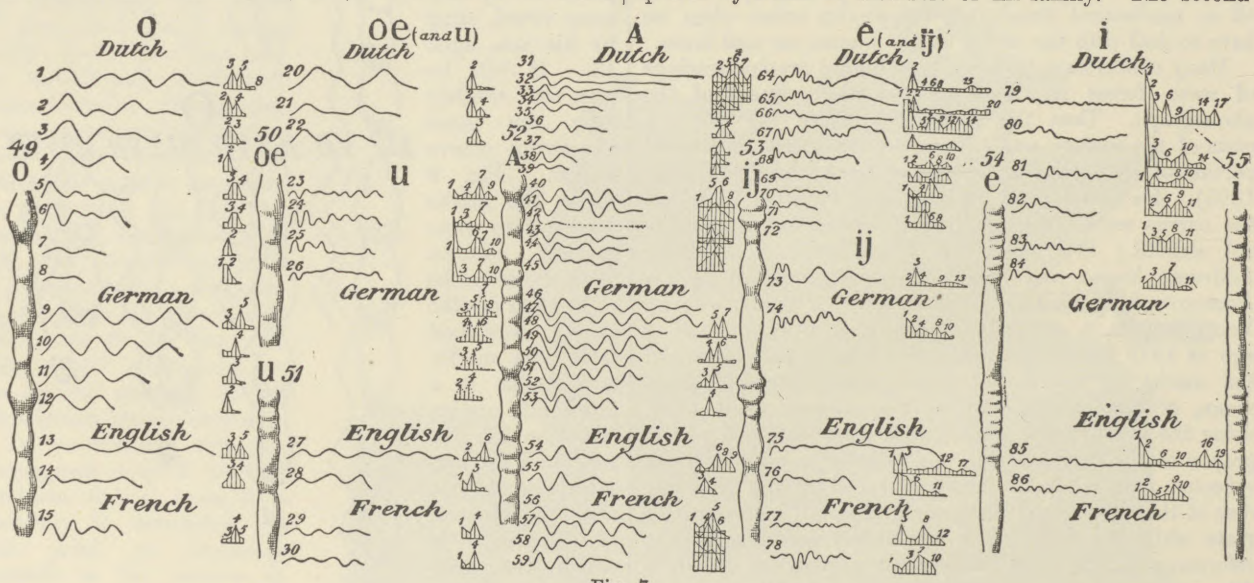


Fig. 7.

section contains curves from the voice of Professor Hermann, the third from the voice of the author from a cylinder sent by him to Dr Boeke, and the fourth from the voice of Mons. H. Marichelle, professeur de l'Institut des Sourds-Muets, also forwarded by him to Dr Boeke. Thus curves and marks of the same vowel are shown from the voices of men of four nationalities.

Apart altogether from the use of the phonograph in business and for the reproduction of music, it will be seen that it is an instrument of great value in the investigation of problems in acoustics, and that it illustrates these as no other instrument can do (see "Experimental Phonetics," by the author, *Nature*, 26th December 1901).

(J. G. M.)

PHOTOGRAPHY.

I. Scientific Advances.

Measurement of the Rapidity of a Plate.—Since the date of the article in the ninth edition of the *Encyclopædia Britannica*, photography has advanced in a direction which before the advent of gelatine plates was hardly to be expected. It has now become a matter of everyday procedure among makers of a brand of photographic plates to gauge its sensitiveness by exact measurement, and express the result in terms of an empirical unit. This is effected by ascertaining the amount of silver-deposit to which a certain impact of light gives rise on the developed image. It is believed that the practicability of such determinations was first demonstrated in 1874, when Sir William Abney (*Phil. Mag.*, "On the Opacity of the Developed Photographic Image") established the connexion between the intensity of light acting for a given time on a sensitive surface and the opacity produced on development. He demonstrated that, within limits, the transparency of the deposit varies as the logarithm of the exposure. The method of measurement then adopted was comparatively crude, but ten years afterwards he showed how much greater exactitude could be ensured.

In 1888 Sir W. Abney pointed out that the speed of a plate could be determined by the formula $T = E^{-\mu(\log E + C)^2}$, where T is the transparency, E is the exposure (or time of exposure × intensity of light acting), and C a constant. If the abscissæ (exposures) are plotted as logarithms, the curve takes the same form as that of the law of error, which has a singular point, a tangent through which lies closely along the curve and cuts the axis of Y at a point which has a value of $2E^{-\frac{1}{2}}$. If the total transparency be unity, this ordinate has a value of 1·212, the singular point having a value 0·606. The ordinate of the zero point of the curve will be where the tangent to the singular point cuts the line drawn at 1·212. The difference between the measurements of this zero point for two kinds of plates (*i.e.*, C in the formula) from the points in the abscissæ marking the same exposure, will give the relative sensitiveness of the two plates in terms of $\log x^2$. In 1890 Hurter and Driffield, in a paper read before the Society of Chemical Industry (see *Journal* of that Society, 19th January 1891), worked out a far less empirical formula connecting the exposure E with the density of deposit, which in an approximate shape had the form $D = \gamma \log \frac{E}{i}$, where D is the density of deposit (or $\log \frac{1}{T}$), i the "inertia" of the plate, T the transparency of the deposit. In the customary way a small portion of a plate was exposed to a constant light at a fixed distance and for a fixed time, and another small portion to the same light for double the time, and so on. By measuring the densities of the various deposits and constructing a curve, a large part of which was approximately a straight line, it was found possible, by the production of the straight portion to meet the axis of X, to give the relative sensitiveness of different plates by the distance of the intersection from the zero point L. (See also *Exposure Meters*, below, under II. Apparatus.)

It is believed that neither formula can be absolutely correct, though both are approximately true and are sufficiently near to be of practical value. This belief is based on the further researches described below. [Those *applicable for the correction* of star magnitudes as determined by photography have been verified and confirmed by Schwarzchild, Michalke, and others.]

Effect of Temperature on Sensitiveness.—In the year 1876 it was shown that heat apparently increased, while cold diminished, the sensitiveness of a plate, but the experiments were rather of the qualitative than the quantitative order. In 1893 fresh experiments were undertaken by Sir William Abney, and it was found that the effect of a difference in temperature of some 40° C. invariably caused a diminution in sensitiveness of the sensitive salt at the lower temperature, a plate often requiring more than double the exposure at a temperature of about −18° C. than it did when the temperature was increased to +33° C. Fig. 1 shows the result of exposing a plate when at three different temperatures for the times shown in the scale of abscissæ, the transparency of deposit for the different exposures being shown as the ordinates. The general deduction was that increase in temperature involved increase in sensitiveness so long as the constituents of the plate (gelatine, &c.) were unaltered.

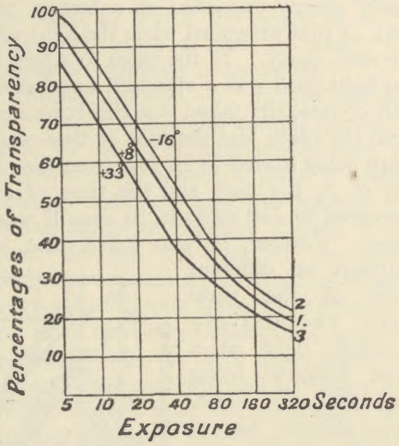


Fig. 1.

Professor Dewar stated at the Royal Institution in 1896 that at a temperature of −180° C. certain sensitive films were reduced in sensitiveness to less than a quarter of that which they possess at ordinary temperatures. It appears also from his subsequent inquiry, that when the same films were subjected to the temperature of liquid hydrogen (−252° C.) the loss in sensitiveness becomes asymptotic as the absolute zero is approached. Presumably, therefore, some degree of sensitiveness would still be preserved even at the absolute zero.

Effect of Small Intensities of Light on a Sensitive Salt.—Another investigation by Sir William Abney was described in brief in the *Proc. Roy. Soc.*, 1893, and in full in the *Journal of the Camera Club*, 1893. When a plate is exposed for a certain time to a light of given intensity, it is commonly said to have received so much exposure (E). If the time be altered, and the intensity of the light also, so that the exposure (time × intensity) is the same, it has usually been accepted that the energy expended in doing chemical work in the film is the same. A long series of experiments conducted under differing conditions has shown that such is not the case, and that the more intense the light (within certain limits) the greater is the chemical

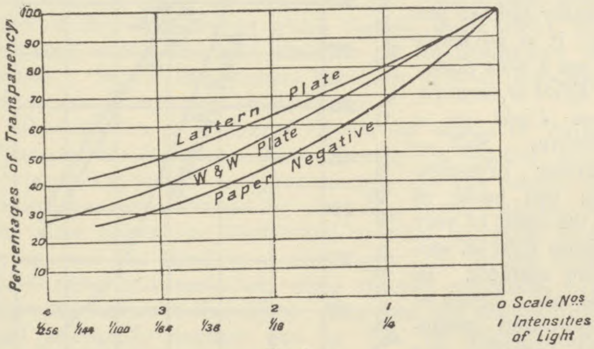


Fig. 2.

action, as shown on the development of a plate. Fig. 2 illustrates the results obtained in three cases. The exposure E is the same in all cases. The curves are so drawn that the scale of abscissæ is the intensity of the light in powers of −2, and the ordinates show the percentages of chemical action produced. If the chemical action remained the same when the intensity of light was reduced, E remaining the same, each of the curves would be shown as a straight line at the height of 100, which is the transparency of deposit with the unit of light. As it is, they show diminishing percentages as the light intensity is diminished. Thus when the intensity of the light is reduced to $\frac{1}{64}$ of the original, and the time of exposure is prolonged 64 times, the useful energy expended on a lantern plate is only 50 per cent. of that expended when the light and time of exposure are each unity. In the cases to which the diagram refers, the light used was a standard amyl-acetate lamp, and the unit of intensity taken was this light at a distance of 2 feet from the plate, and the unit of time was 10 seconds. The lamp being moved to 16 feet from the plate, gave an intensity of $\frac{1}{64}$ the unit, and the time of exposure had to be increased to 640 seconds, so that E was the same in both cases. Further, it was found that when the *times* of exposure on different parts of the plate were successively doubled, light at a fixed distance being used for one series, and altered for a second series, the slopes of the curves of transparency, as in Fig. 1 (the gradation), were parallel to one another. Fig. 3 shows this in a graphic manner, the units of the scales of abscissæ and ordinates being the same as before. This investigation is of use when camera images are in question, as the picture is formed by different intensities of light, not very different from those of the amyl-acetate lamp, the time of exposure being the same for all intensities. The deductions made from the investigation are that with a slow plate the energy expended in chemical action is smaller as the intensity is diminished, while with a quick plate the variation is much less. As a practical deduction, we may say that to obtain proper contrast in a badly lighted picture it is advisable to use a slow plate.

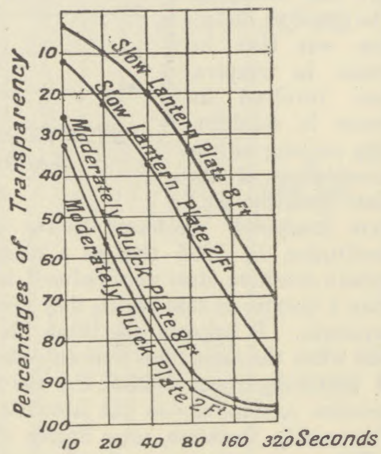


Fig. 3.

Effect of very Intense Light on a Sensitive Salt. — Another investigation was made as to the effect of very intense light on sensitive surfaces. In this case a screen of step-by-step graduated opacities was made use of, and plates exposed through it to the action of lights markedly differing in intensity, one being that of the amyl-acetate lamp, another that of the arc light, and a third the light emitted from the spark of a Wimshurst machine. The exposures were so made that one of the opacities produced on the plate from exposure to each source of light was approximately the same. Fig. 4 gives an example of the results obtained. The abscissæ are derived from the graduated opacities of the screen used, and their units and that of the ordinates are the same as before. The unit of intensity of light is of course in each case widely different. It will be seen that the slope of the curve due to the spark light is less steep than that due to the arc light, and the latter, again, is much less steep than that due to the amyl-acetate lamp. A further investigation was made of the effect of increasing the time of exposure when the intense light was diminished, and it was found that with all plates the useful chemical energy acting on a plate was least with the most intense light, but increased as the intensity diminished, though the time was correspondingly increased. This is the reverse of what we have recorded as taking place when a comparatively feeble light was employed. Further, it was proved that the variation was greatest in those plates which are ordinarily considered to be the most rapid. It follows, therefore, that there is some intensity of light when the useful chemical energy is at a maximum, and that this intensity varies for each kind of plate.

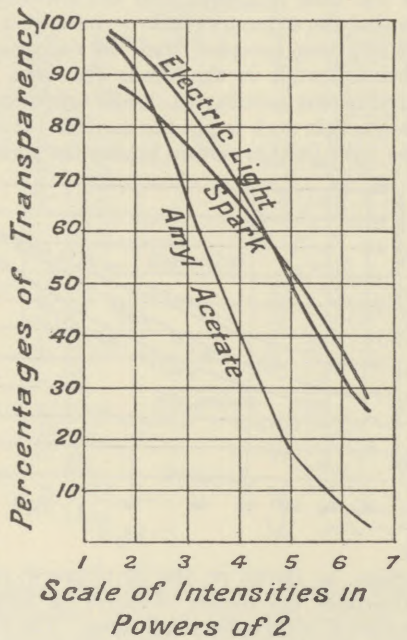


Fig. 4

Intermittent Exposure of a Sensitive Salt. — Sir William Abney has also shown that, if a total exposure is made up of intermittent exposures, the chemical action on a sensitive salt is less than it is when the same exposure is not intermittent. It was also shown that the longer the time of rest between the intermittent exposures (within limits) the less was the chemical action. We may quote one case. Exposures were first made to a naked light, and afterwards to the same light for six times longer, as a rotating disc intervened which had 12 apertures of 5° cut in it at equal intervals apart, and 720 intermittent exposures per second were given. The plate was moved to different distances from the light, so that the intensity was altered. The apparent loss of exposure by the intervention of the disc increases as the intensity diminishes, the ratios of the chemical energy usefully employed of the naked light exposure to that of the intermitting exposures being—

For intensity 1	. . .	1 to ·815
,, ,, $\frac{1}{4}$	. . .	1 ,, ·500
,, ,, $\frac{1}{16}$	. . .	1 ,, ·423
,, ,, $\frac{1}{64}$	. . .	1 ,, ·370

These results appear to be explicable by the theoretical considerations regarding molecular motion.

Effect of Monochromatic Light of Varying Wave-Lengths on a Sensitive Salt.—It has been a subject of investigation as to whether the gradation on a plate is altered when exposures are made to lights of different colours; that is to say, whether the shades of tone in a negative of a white object illuminated by, say, a red light, would be the same as those in the negative if illuminated by a blue light. Abney announced that the gradation was different; and, quite independently, Mr Chapman Jones undertook an investigation of the matter, and made a general deduction for isochromatic plates that, except with a certain developer, the gradation was steeper (that is, the curve shown graphically would be steeper) the greater the wave-lengths of the light to which the sensitive salt was subjected. Investigation shows that with plates made with the ordinary haloid salts of silver Chapman Jones's deduction requires modification. When monochromatic light from the spectrum is employed, it is found that the gradation increases with wave-lengths of light which are less, and also with those which are greater, than the light whose wave-length has a maximum effect on the sensitive salt experimented with. Thus with bromo-iodide of silver the maximum effect produced by the spectrum is close to the blue lithium line, and the gradation of the plate illuminated with that light is less steep than when the light is spectrum violet, green, yellow, or red. From the red to the yellow the gradation is much the steepest. Whether these results have any practical bearing on ordinary photographic exposures is not settled, but that they must have some decided effect on the accuracy of three-colour work for the production of pictures in approximately natural colours is undoubted, and they may have a direct influence on the determination of star magnitudes by means of photography.

Correct Rendering of Colours in Monochrome.—As to the materials used for the correct rendering of colours in monochrome, isochromatic plates have been improved in character, and there is a simple means of ascertaining what light-filter should be used for each brand of plate. Perhaps the best isochromatic plate is, at the time of writing, the "Cadett Spectrum" plate, which is sensitive from the ultra violet to the red of the spectrum, and which shows hardly any of that lack of sensitiveness in the region of the spectrum green which plates dyed with eosin derivatives always betray. When the spectrum is formed by light such as that of a paraffin lamp, the curve of sensitiveness is not far from the curve of luminosity of the spectrum of daylight; so that if a coloured object were illuminated solely by a paraffin light, a print from the negative would give a fair representation of the object in monochrome—that is, the shades of grey in the print would represent the daylight luminosity of the colours. As objects cannot usually be illuminated by this light, it becomes necessary to filter daylight through a coloured screen, which can be put in front of the camera lens. By proper means the luminosity of the light of day coming through a red, a green, a blue, and an orange glass can be very accurately measured; if $\frac{1}{2}$-inch squares of these coloured glasses, together with a white glass of the same area, be placed in a row and cemented on white glass, we have a colour-screen which we can make available for finding the kind of light-filter to be employed. This is readily done by reducing the luminosity of the light coming through all the glasses to that of the luminosity of the light coming through the blue glass. If the luminosity of the blue be 5 and that of the white light 100, then the luminosity of the former must be reduced to $\frac{1}{20}$ of its original value, and so with the other glasses. The luminosity of the light coming through each small glass square can be made equal by rotating in front of them a disc in which apertures are cut corresponding to the reduction required. The blue glass, for instance, would not be covered by the disc at all, while opposite the white square the disc would have an aperture of an angle of 18°. When a plate is exposed behind the row of glass squares, with the light passing through the rotating disc, the negative obtained would, under ordinary conditions, show square patches of very different opacity. A light-filter of some transparent colour, if placed in the path of the light, will alter the opacities, and eventually one can be found which will only allow such coloured light to be transmitted as will cause all the opacities in the negative to be the same. As the luminosities of the white light passing through the glasses are made equal, and as the photographic deposits are also rendered equal, this light-filter, if used in front of the camera lens, will render all coloured objects in correct monochrome luminosity. Another plan, based on the same principles, is to place segments of annuluses of vermilion, chrome yellow, emerald green, French blue, and white on a disc, and to complete the annuluses with black segments, the amount of black depending on the luminosity of the pigments, which can be readily measured. When the disc is rotated, rings of colour, modified in brightness by black, are seen, and each ring will be of the same luminosity. As before, a screen (light-filter) to be used in front of the lens must be found which will cause the developed images of all the rings to appear of equal opacity. It must be remembered that the light in which the object is to be photographed must be the same as that in which the luminosity of the glasses or pigments is measured.

Photography in Natural Colours.—A method, devised by M. Lippmann, of Paris, by which the natural colours of objects are reproduced by means of interference, may be briefly described as follows:—A sensitive plate is placed in contact with a film of mercury, and the exposure to the spectrum, or to the image of coloured objects to be photographed, is made through the back of the plate. On development, the image appears coloured when viewed at one particular angle, the colours being approximately those of the object. The necessary exposure to produce this result was very prolonged in the first experiments in which the spectrum was photographed, and a longer exposure had to be given to the red than was required for the blue. Lippmann at first employed collodion dry plates, prepared, it is believed, with albumen, and it required considerable manipulation to bring out the colours correctly. Lumière used gelatine plates dyed with appropriate dyes (orthochromatic plates); the exposure was much diminished, and very excellent representations were produced of all natural colours. The main point to aim at in the preparation of the plate seems to be to obtain a very sensitive film without any, or, at all events, with the least possible, "grain" in the sensitive salt. A formula published by Lumière seems to attain this object. Viewed directly, the developed images appear like ordinary negatives, but when held at an angle to the light the colours are vivid. They are not pure monochromatic colours, but have very much the quality of colours obtained by polarized light. It appears that they are produced by what may be termed "nodes" of different-coloured lights acting within the film. Thus in photographing the spectrum rays penetrate to the reflecting mercury and are reflected back from it, and these, with the incident waves of light, form nodes where no motion exists, in a somewhat similar way to those obtained in a cord stretched between two points when plucked. In the negative these nodal points are found in the thickness of the silver deposit. When white light is sent through the film after the image has been developed, theoretically only rays of the wave-lengths which formed these nodes are reflected to the eye, and thus we get an impression of colour. So far this process has been only of scientific value and of but small practical use.

Reproduction of Coloured Objects by means of Three Photographic Positives.—Ives's Process.—A practical plan of producing images in approximately the true colours of nature has been devised by preparing three positives of the same object, one illuminated by a red, the other by a green, and the third by a blue light; the images from these three transparencies, when visually combined, will show the colours of the object. This plan was scientifically and practically worked out by Ives of Philadelphia, though in France and elsewhere it had been formulated, especially by Hauron Du Cros. The following description may be taken as that of Ives's process:—By the trichromatic theory of colour-vision every colour in nature can be accounted for by the mixture of two or three of the three-colour sensations, red, green, and blue, to which the eye is supposed to respond. Thus a mixture of a red and green sensation produces the sensation of yellow; of a green and blue, that of a blue-green; of red and blue, that of purple; and of all three, that of white.

For the sensations we may substitute those colours which most nearly respond to the theoretical sensations without any material loss of purity in the resulting sensation. We must take the spectrum of white light as the only perfect scale of pure colours. From experiment it has been proved that the red sensation in the eye is excited by a large part of the visible spectrum, but with varying intensities. If, then, we can on a photographic plate produce a developed image of the spectrum which exactly corresponds in opacity and position to the amount of red stimulation excited in those regions, we shall, on illuminating a positive taken from such a negative with a pure red light, have a representation of the spectrum such as would be seen by an eye which was only endowed with the sensation of red. Similarly, if negatives could be taken to fulfil the like conditions for the green and for the blue sensation, we should obtain positives from them which, when illuminated by pure green and blue lights respectively, would show the spectrum as seen by an eye which was only endowed with a green or a blue sensation. Evidently if by some artifice we can throw the coloured images of the three positives on a screen, superposing them one over the other in their proper relative positions, the spectrum will be reproduced, for the overlapping colours, by their variation in intensity, will form the colours intermediate between those used for the illumination of the positives. For the purpose of producing the three suitable negatives of the spectrum, three light-filters, through which the image has to pass before reaching the photographic plate, have to be found. With all present plates these are compromises (see below). Roughly speaking, the screens used for taking the three negatives are an orange, a bluish green, and a blue. These transmit those parts of the spectrum which answer to the three sensations. When these are obtained, a coloured object can be reproduced.

Joly's Process.—Professor Joly, of Dublin, in 1897 introduced a colour process by which an image in approximately natural colours could be thrown upon a screen by an optical lantern, only one transparency being employed, instead of three, as in the Ives process. A "taking" screen was ruled with alternating orange, blue-green, and blue lines $\frac{1}{200}$ to $\frac{1}{300}$ inches apart, touching one another and following one another in the above order. When such a screen was placed in front of a sensitive plate in the camera, and exposure made to the image of a coloured object, there were practically three negatives on the same plate, each being confined to the area occupied by lines of the same colour. The shades of colour and the depth of the colours used in ruling depended on the brand of plate. When a perfect triune negative was obtained, a transparency was made from it, and in contact with this was placed a screen ruled with lines the same distance apart, but of the colours corresponding to the three colour sensations, namely, red, green, and blue. The red lines were made to fall on the image taken through the orange lines, the green on that of the blue-green, and the blue or violet on that of the blue. On the screen there are practically three differently-coloured images shown by one transparency. The different colours blend together and give a picture which shows approximately the correct colours of the original.

Three-Colour Photographic Printing.—Three-colour printing has made rapid strides. The most suitable negatives are those which have been described for Ives's process. Instead of using the colours which correspond to the colour sensations, their complementaries are employed, for reasons which will be evident if the absorption of dyes when superposed is considered. Thus to produce a yellow patch by Ives's process, that space must be almost bare in those positives through which red and green lights are transmitted, since red and green combined make yellow. The negatives must therefore be opaque where these spaces occur. If we use the negatives for producing (say) collotype plates, which are subsequently "inked" with coloured "inks," the spaces in the print from the "red" and the "green" negatives will "take" no colour, whilst that in the "blue" negative will have a full colour. Evidently, then, to produce a yellow when the three printings are superposed, the blue negative must be printed in yellow, the complementary to the blue that is used by Ives in the triple projection process. Similarly, for inking in the plate printed from the red negative the colour used must be a green-blue, and from the green negative a purple. These last two colours must be transparent colours if the first printing on a white surface is the yellow from the blue negative. If opaque, there would be a dirty image formed, of no particular colour. The colour next the white ground, however, may be opaque. We may expect that the difficulty of obtaining the exact depth of colour necessary for each printing will be overcome before very long, and that three-colour printings will give uniform results (see PROCESS).

Positives in Three Colours.—Ives was the first to show that a transparency displaying approximately all the colours in nature could be produced on the same principles that underlie the three-colour printing. This he effected by printing each of the three negatives, produced for his triple projection process as already described, on gelatine films sensitized by bichromate of potash. Each of the three transparent films was dyed with a colour complementary to the colour of the light which he transmitted through the positives when used for projection. Thus the "red" positive he dyed with a blue-green dye, the "green" positive with a purple dye, and the "blue" positive with a yellow dye. These three films, when superposed, gave the colours of the original object. Sanger Shepherd has made the process a commercial success, and produces lantern slides of great beauty, in which all colours are correctly rendered. Instead of using a dye for the "red" transparency, he converts the silver image of a positive image into an iron salt resembling Prussian blue in colour.

Sensitometers for Three-Colour Work.—Sir W. Abney has devised sensitometers for determining the colours of the screens to be placed before the lens in order to secure the three-colour negatives. Their production depends upon the same principles as that he devised for the correct rendering in monochrome of a colour object. When the sensitometer takes the form of glasses through which light is transmitted to the plate, the luminosities of the coloured lights transmitted are determined, and also the percentage composition of their colours in terms of the red, green, and blue lights used in the triple projection, and thence are deduced the luminosities in terms of red, green, and blue. For ascertaining what red screen should be used, the luminosity transmitted through each is so adjusted that the luminosity of the red components in each is made equal (see *ante*). This gives a sensitometer of equal red values. A coloured screen has to be found which, when placed in front of the lens, will cause the density of the deposit on the plate to be the same throughout. This is done by trial, the colour being altered till the proper result is obtained. In a similar way the "green" and "blue" screens are determined. Coloured pigments rotating on a disc can also be employed, as indicated in the paragraph on the correct rendering of colour in monochrome (see *ante*).

New Developers.—Some excellent developers have recently been brought out; formulæ for those most in vogue are appended:—

Eikonogen Developer.

Eikonogen . . .	25 parts.
Sodium sulphite . .	50 ,,
Sodium carbonate . .	50 ,,
Potassium bromide . .	½ ,,
Water	1000 ,,

This is a one-solution developer, and acts energetically.

Metol Developer.

Solution A.

Metol	2 parts.
Sodium sulphite . .	18 ,,
Water	100 ,,

Solution B.

Sodium carbonate . .	6 parts.
Potassium bromide .	1 ,,
Water	100 ,,

For use, take one part of A to from 1 to 3 parts of B.

Amidol Developer.

Amidol	3 parts.
Sodium sulphite . .	100 ,,
Potassium bromide .	1 to 3 ,,
Water	1000 ,,

This developer requires no addition of alkali.

Ortol Developer.

Solution A.

Ortol	15 parts.
Sodium metabisulphite .	7 ,,
Water	1000 ,,

Solution B.

Sodium carbonate . .	100 parts.
Sodium sulphite . .	125 ,,
Potassium bromide .	3 ,,
Water	1000 ,,

A and B solutions are mixed together in equal proportions.

Besides these, there are several more, such as Adurol, Glycine, Pyro-catechin, which have been used with more or less success. They all give a black in lieu of that dark olive-green deposit of silver which is so often found with pyrogallol developers. All are alkaline developers, and the image is built up from the sensitive salt within the film. They are applicable to gelatine or collodion plates, but for the latter rather more bromide of an alkali is added, to retard fogging.

Effect of Hydrogen Peroxide on Sensitive Plates.—Dr W. J. Russell instituted a series of experiments on the effect of exposure of sensitive plates to the action of vapours and gases for long periods. It has long been known that contact of plates with such substances as wood caused a sensitive surface to show "fog" on development. By a somewhat exhaustive series of experiments, Russell showed that the probable cause of this fog is peroxide of hydrogen, since substances which favoured its formation produced the same effect. This is somewhat remarkable, as this same substance will completely destroy the effect that light has had on a sensitive plate; indeed, it affords one way of destroying a light image on a sensitive collodion plate. The experiments of Russell give a warning to photographers to take care how they store exposed plates for brief periods. It appears that negatives wrapped in paraffin paper are secure from this danger.

(W. DE W. A.)

II. APPARATUS.

Since the ninth edition of this work was published, great changes have been made in ordinary photographic apparatus, chiefly due to the extended use of small hand cameras suitable for taking instantaneous photographs upon the rapid gelatine dry plates or films now available. These small pictures can easily be enlarged four times or more, so that the photographic travelling equipment may be reduced to a hand package. The result of this is seen in the immense expansion that has taken place in the use of photography for all purposes of illustration. The tendency in all portable cameras and apparatus has been towards lightness and compactness in construction and material. Aluminium and its alloys are largely used, instead of brass, for fittings and mountings. Instead of glass plates, flexible films of celluloid and other materials are available in single sheets like plates, or in rolls enclosed in opaque paper, which can be changed or replaced in daylight. The construction of lenses has also been improved, so as to obtain greater covering power, with flatness of field and freedom from astigmatism, with larger apertures than were available with aplanatic lenses. Greater rapidity of working is thus gained; and with the increased sensitiveness of the dry plates in use, subjects in rapid motion can be photographed with a perfection which formerly was quite unattainable.

Cameras.

The general requirements of a good camera are:—Thoroughly well-seasoned material, simplicity and strength of construction, parallelism and squareness of front and back, smoothness and regularity of movement in focussing. A rising and falling front, by which the lens can be raised or lowered to take in more or less foreground, is almost a necessity, and may be supplemented by a swing back or swing front, to prevent distortion of the image when the camera has to be tilted, or to equalize definition of objects at different distances from the camera. A side swing is specially useful for the latter purpose. These movements should be round the central horizontal or vertical axis of the back or front, as the case may be. When the rising front is used, the lens must be stopped down, or another of longer focus fitted which will cover a larger plate than the camera is made for, in order to obtain good definition over the extended area of the picture. It is convenient to have the camera square and fitted with a reversible back, so that the greatest length of the plate may be horizontal or vertical, as desired. The increase of weight and bulk is obviated in some French cameras by making the back part of the camera and bellows reversible, the former being placed upright or on its side, as required, while the small end of the bellows is made square or round, so as to fit in either position into the front of the camera behind the lens. The focussing screen may be ruled with parallel cross-lines for purposes of measurement, and as a check on the verticality of the camera when photographing buildings or other objects with vertical lines. The distance from the lens of the focussing screen, and of the sensitive surface of the plate in the dark slide, must coincide exactly. This can be tested by measurement, or by carefully focussing some bright and well-defined object on the screen and then on a ground glass plate placed in each of the dark slides to be examined. The camera and the plate-carriers must be perfectly light-tight, and all their inner surfaces dead black, to prevent any reflection from bright spots from being thrown on the plate. The plate-carrier or dark slide must permit of the sensitive plate being placed in the camera and exposed without risk of any light reaching it except that passing through the lens. The corner joints, the hinges in the shutters, and the openings at the sides and top in the book form of double carrier are all weak points, and require careful examination from time to time. They should be protected by metal plates. The plate-carriers should fit readily into their places without jerking, and the shutters must run smoothly when withdrawn and replaced. Frames may be provided for smaller plates than the carriers are made for, care being taken that the surface of the plate is at the proper distance from the lens. It is convenient to have the plate-carriers numbered in sequence, and provided with a small inlaid tablet for recording memoranda of plate, exposure, &c. A level or other means of showing that the camera is level and the plate vertical should be attached to the camera; also a view meter or finder showing the exact extent of the picture.

Studio cameras are made adjustable, both from the front and back, thus enabling short- or long-focus lenses to be used, with extra extension for copying and enlarging. As a rule they are fitted with repeating backs, for enabling two or more exposures to be made on one plate. The backs are usually square, so that the

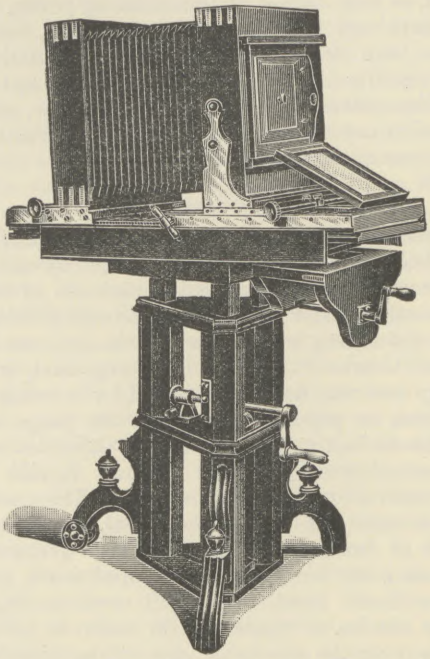


Fig. 5.—Studio Camera and Stand.

plates can be used upright or lengthways, and they are fitted with double swing movements. When single plate-carriers are used, they are sometimes fitted with a flexible shutter, by which jerking and movement of the camera are avoided. The ordinary studio cameras used for portraiture are usually mounted on strong pillar stands, raised or lowered with an endless screw or rackwork, and the flat top carrying the camera is arranged to have an angular motion vertically and horizontally. Large cameras, with long extension for copying purposes, should be mounted on substantial table stands, with adjustments for obtaining the various motions above noted. In all these stands absolute rigidity and freedom from shaking are essential. Figs. 5 and 6 show two types of modern

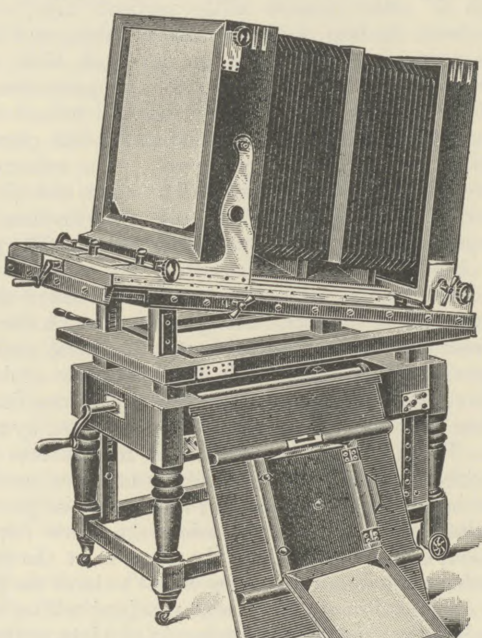


Fig. 6.—Studio Camera and Stand.

patterns of studio camera and stand. Descriptions of other apparatus of the kind will be found in the works noted at the end.

Ordinary *Field* and *Portable* cameras, other than special hand cameras, are now lighter and more compact, metal struts being used instead of wooden flaps for supporting and fixing the front and back when in use. They are made in a variety of patterns, the principal improvements being swinging fronts, tripod head and

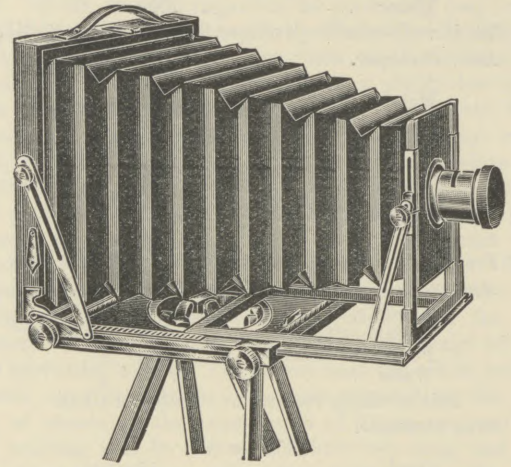


Fig. 7.—Field Camera adjusted for long focus. Turntable tripod head.

turntable in the baseboard, double-extension movements from the back and front for use with long- or short-focus lenses, and the use of aluminium for the metal-work. These cameras are fitted with a focussing screen and are intended to be used on a tripod stand, though some of the smaller sizes can be fitted with finders and used as hand cameras. As a rule the plates are carried in the usual double plate-carriers, but changing boxes for plates or cut films, or roll-holders carrying lengths of sensitive films for few or many exposures, can also be fitted. The latter are light and compact, and useful for travellers, the films being changed in daylight. Figs. 7 and 8 show a typical modern field camera adjusted for long or short focus. For photographing animals or objects in motion, when it is desirable to watch the movement till the moment of exposure, cameras fitted with twin lenses will be found useful (Fig. 9). The lenses must be of exactly the same focus, and focussed together by the same motion of the rackwork. The plate

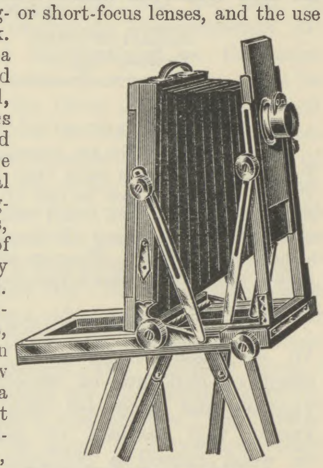
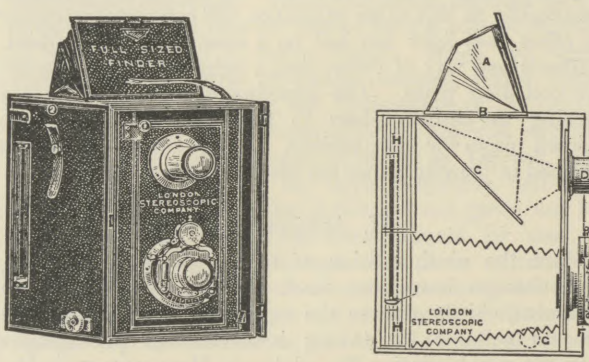


Fig. 8.—Field Camera adjusted for short focus.



Ready for use. Section to show working.

Fig 9.—Camera fitted with Twin Lenses. A, hood of finder; B, ground glass screen; C, mirror; D, viewing lens; E, working lens; F, shutter; G, focussing pinion; H, plate carrier; I, plate.

is kept ready for exposure in one compartment, while the object is viewed on the focussing screen of the other, and the plate exposed at the proper time. Several forms of binocular hand cameras are made on this principle. Field cameras are supported on wooden tripod stands, which usually fold in two or more sections, the head being separate, if not attached to the baseboard of the camera. The legs should be adjustable in length for use on uneven ground. A tripod stand may be light, but must be firm and rigid when set up.

For small field cameras the aluminium walking-stick tripods are very convenient (Fig. 10).

Folding cameras form a class of portable modern camera which has many conveniences for hand or stand work up to half or whole plate size. The best forms have most of the fittings and arrangements of a stand camera, but close up into a box which need not be larger or heavier than a hand camera, with the advantage that the camera, lens, and shutter are all in position for immediate use, while different lenses can be used if desired. With an apparatus of this kind, fitted with a light stand, any class of outdoor work can be undertaken, and glass plates, flat or roll films, can be employed, as most convenient. Some forms of these cameras are more of the hand camera type, focussing by finders and scale (Figs. 11 and 12).

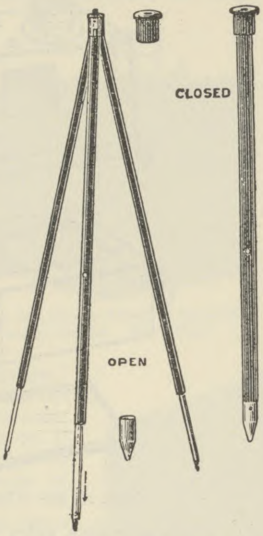


Fig. 10.—Walking-stick Tripods.

Hand Cameras.—One distinctive feature of the photography of the present day is the world-wide use of the hand camera. Its convenience, the ease with which it can be carried and worked, and the remarkably low prices at which practically useful instruments of this kind can be supplied, have conduced to this result. The close direct connexion of photography with the sciences of optics and chemistry, and its numerous artistic and scientific applications, must, when widespread as they now are by means of the hand camera, exert a powerful and important educational influence, in quickening artistic perception and scientific inquiry. Although small portable cameras for instantaneous pictures had been made by Scaife (Pistolgraph, 1858), Bertsch (1860), and others, the history of the modern hand camera dates from January 1881, when Mr T. Bolas brought forward his *detective* camera (*Photographic Journal*, 1881, p. 59). It consisted of a double camera (one used as a finder, the other for taking the picture) enclosed in another box suitably covered, which also contained the double plate-carriers, and had apertures in front of the lenses through which the pictures were viewed and taken. In another form the finder was omitted. Other similar box cameras quickly followed, but they did not come into very general use before 1888, when the Eastman Company, of Rochester, U.S.A., brought out their portable film camera under the name of Kodak, which has now become a household word and almost a recognized generic term for a hand camera.

In view of the multiplicity of forms and arrangements of hand cameras, it is difficult to classify them into distinct types. Dr

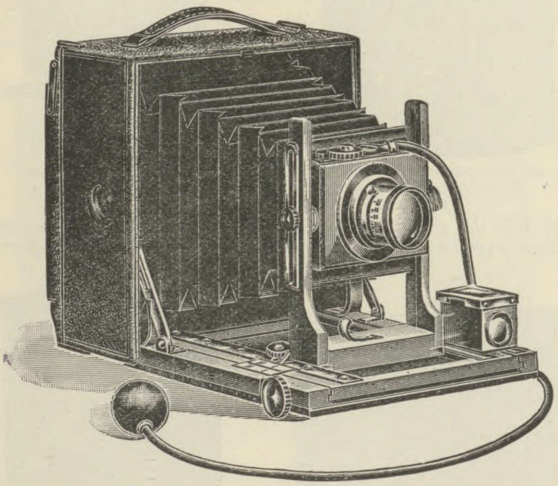


Fig. 11.—Folding Camera.

Krugener (*Die Hand Camera*) gives three principal groups: (1) for glass plates; (2) for stiff films; (3) for films in rolls. These, again, may be subdivided into *box* and *folding* cameras, and further, into (*a*) cameras with enclosed changing magazines, (*b*) with separate changing boxes or roll-holders, (*c*) with single or double plate-carriers. Most cameras that will take glass plates will take cut films in suitable sheaths, and holders for roll-films can be attached in place of holders for plates or cut films. The normal size for hand cameras is the quarter-plate ($4\frac{1}{4} \times 3\frac{1}{4}$ inches) or the Continental size, 9×12 centimetres. As a rule they do not exceed the half-plate size ($6\frac{1}{2} \times 4\frac{3}{4}$ inches), but many are made in much smaller sizes, as $\frac{1}{4}$ or $\frac{1}{2}$ quarter-plate. Sometimes these small cameras are disguised as field-glasses, books, watches, &c., or constructed for being hidden in the clothing, the lenses appearing as scarf-pins, waistcoat buttons, &c., but excepting the first, these disguises are not now so common as formerly. Such pictures are too small for use without enlarging. Hand cameras are constructed on much the same principles as stand cameras, but as they are specially intended for instantaneous work, they are simplified and adapted so that the picture may be focussed and exposed without delay. The focussing-screen is either superseded or supplemented by small finders, which should be properly arranged to show the exact limits of the subject on the plate. The focus is adjusted by a scale of distances, the accuracy of which should be carefully verified by measurement. In the "Reflex" forms (Fig. 13) the view is reflected by a mirror on to a horizontal ground glass, giving a full-sized image which can be seen and adjusted up to the moment of exposure. Swing backs and fronts are usually dispensed with, but a rising and falling front is an essential often overlooked. Quick-acting lenses of large aperture, such as $f/6$ or $f/8$, preferably of the anastigmatic type, well capable of covering the plate at full aperture and fitted with iris diaphragms, should be used. The cheap hand cameras are usually fitted with single landscape or rapid rectilinear lenses, but the want of intensity limits their use to well-illuminated subjects. For ordinary purposes the shutter should give instantaneous exposures from $\frac{1}{4}$ to $\frac{1}{100}$ of a second, and should also allow of time-exposures. It should be efficient and regular in action and readily released by

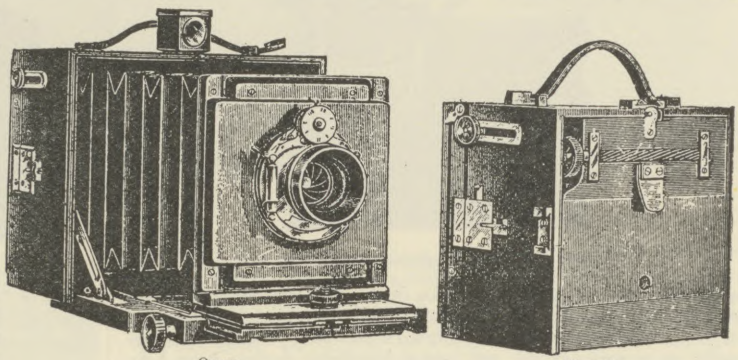

Open. Closed.

Fig. 12.—Folding Camera.

gentle pressure. Mechanism for automatically changing plates or films must be simple and certain in action and not readily put out of order, and care must be taken to avoid any rubbing or abrasion of the plates in changing or transport. In changing plates or films, the number of plates exposed should be recorded automatically. An accurately-adjusted circular level is desirable, and is best placed close to the finder.

The choice of a hand camera depends upon the circumstances in which it is to be used and the purpose for which it is principally required. For work near home, with facilities for carrying and changing plates, the folding hand or stand cameras, with full adjustments, will be found most generally useful. Magazine cameras, in which a supply of plates or films is carried ready for exposure, are very convenient and portable, and many patterns of them are available. They are generally of the box form; in some the lens is fixed in focus for all objects within a certain distance, and in others it is adjusted by the focussing scale. They are of two kinds—those with a single magazine and those

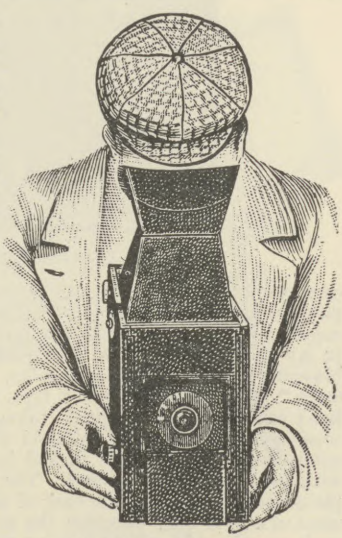


Fig. 13.—"Reflex" Hand Camera.

with two or more. One of the earliest forms of single-magazine cameras, and one still in use, is the "bag," in which a supply of plates or films in sheaths is kept at the back ready for exposure, after which the exposed plate is raised with the fingers into a bag or expanding chamber, above the magazine, and placed behind the rest of the plates at the back,—a fresh plate taking its place in front (Figs. 14 and 15). As a rule they carry 12 plates or a larger

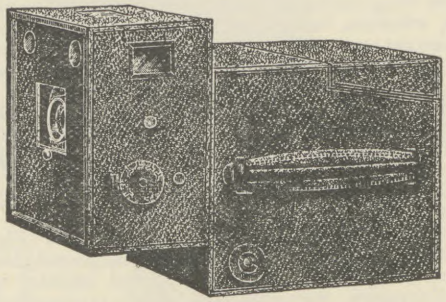


FIG. 14.—Single-magazine Box Camera.

number of cut films. In some forms the magazines are removable and replaceable by others. The arrangement is simple and effective; but the bag, usually made of soft leather or cloth, is liable to

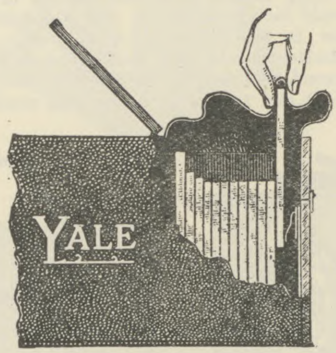


FIG. 15.—Single-magazine Box Camera.

wear and puncture, and may make dust. The arrangements with double magazines, in which unexposed plates are kept in one recess, exposed successively, and then transferred to a second recess, are much more complicated, and many ingenious devices have been invented for effecting the change (Fig. 16). Some of these

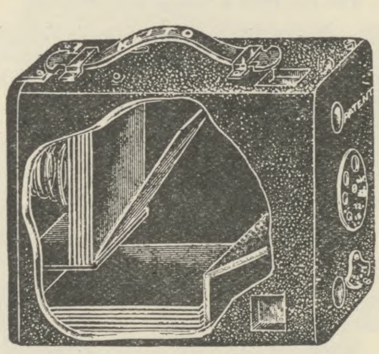
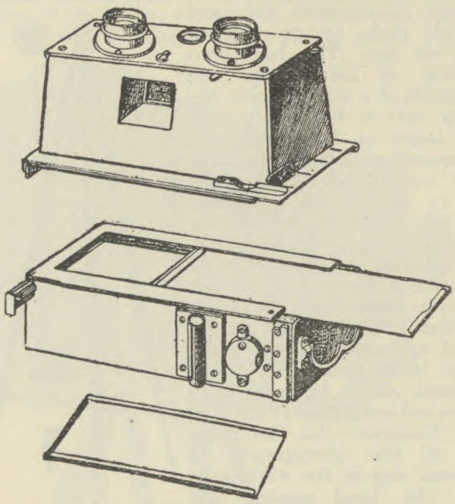


FIG. 16.—Double-magazine Box Camera.

cameras are very effective, and popular on account of their compactness and convenience, but there is always a certain risk of the mechanism failing, and great care has to be taken, in charging them, to lay the plates truly in their places. Most of the very handy binocular cameras or *photo-jumelles*, of which Richard's "Verascope" (Figs. 17 and 18) is a type, are of this class, as are also hand cameras of the original "Frena" type (Fig. 19), specially constructed for using stiff celluloid films. In these the films are notched on two sides and packed in bundles of forty alternately with cards similarly notched. The pack of films and cards is placed in a magazine at the back of the camera, and by the movement of a lever after exposure the exposed film and its following card are released, and, by turning the camera down, are dropped into a second receptacle. The special advantage of this system is the large number of films that can be carried without increase of weight; but the necessity of having specially cut films, which may not be readily procurable, is an objection which has been avoided in other forms of magazine cameras for films. These cameras are



FIGS. 17, 18.—"Verascope" Binocular Camera.

also constructed with extra magazines. In many ways the most convenient and compact hand cameras are those made specially for

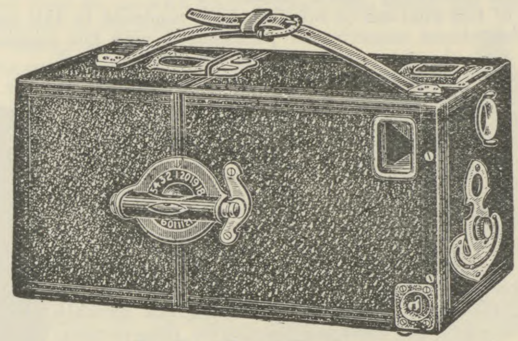


FIG. 19.—"Frena" Film Camera.

use with the roll-film cartridges in many different sizes, both in the "box" and "folding" forms, some of the latter being easily

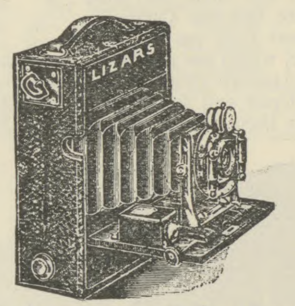


FIG. 20.—Interchangeable Hand Camera. Daylight-loading for films.

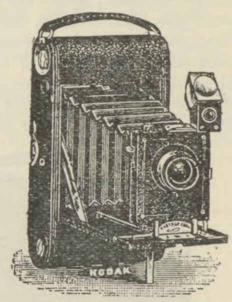


FIG. 21.—Folding Pocket Kodak.

carried in the pocket (Figs. 20 and 21). Those fitted with lenses of large aperture and rising and falling fronts are to be preferred.

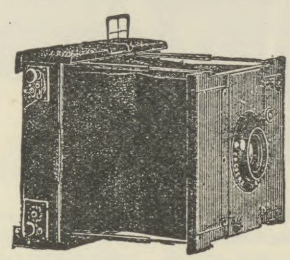


FIG. 22.—Goerz-Anschütz Camera ready for use. Front view.

FIG. 23.—Goerz-Anschütz Camera. Closed.

There are several other forms of very portable collapsible hand cameras available—the "Goerz-Anschütz," fitted with a focal plane shutter and a very quick-acting lens (Figs. 22, 23, and 24), also the "Xit," "Nydia," and the "Natti," may be mentioned as types.

In the cases which often arise, when time-exposures are necessary, it will be desirable to support the hand camera on a tripod stand. The light aluminium stands previously noticed are specially suitable; some of them are about the size and weight of a stout walking-stick, others about half the length, but all capable of extension to five feet. Details of the mechanism and construction of many hand cameras will be found in the photographic journals and year-books, and in some of the general and special treatises mentioned at the end.

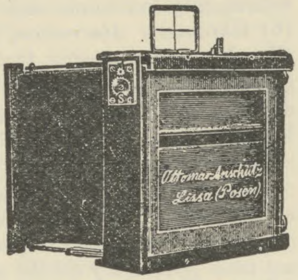


FIG. 24.—Goerz-Anschütz Camera ready for use. Back view.

Panoramic Cameras.—A large number of so-called "panoramic cameras" have been brought forward from time to time, but none of them seem to have come into general use till recently, when the use of curved surfaces of celluloid film has enabled thoroughly practical panoramic cameras of convenient size and weight to be put on the market. It is curious that these latest forms are on almost the same principle as the earliest one constructed by Martens, in 1845, to take curved Daguerreotype plates including an angle of 150°. In it the lens revolved on its centre and threw the image on to the cylindrical surface of the curved plate, through a slit which travelled with the lens. In 1861 Sutton devised a panoramic camera with a special spherical lens covering an angle of 120° for use with curved glass plates; these, however, were difficult to work, and the instrument never obtained a vogue. It was followed by Johnson's "pantascopic" camera and others, in which a long flat plate was moved tangentially to the surface of rotation of the apparatus, so that it was always perpendicular to the axis of the lens. In 1889 Moëssard greatly improved upon Marten's early apparatus in his "Cylindrograph," utilizing the property of the nodal points of any lens to form the meeting-point of the two portions of each secondary axis, one going towards the object, the other towards the image. A lens free from distortion may thus revolve round its nodal point of emergence, without the image being displaced on the sensitive surface; in fact, its position only depends on this nodal point and on the direction of the secondary axis from the nodal point of incidence to the object, which is always invariable. The instrument consists of a semicircular camera, the front of which is formed of light-proof cloth, and the back by the curved flexible carrier holding the sensitive film. The lens is fitted on a vertical axis, so that the nodal point of emergence remains motionless, and is revolved round it by means of a handle worked by hand and carrying a view meter. The illumination of the image is regulated by means of an adjustable slit in a tube attached to the lens inside the box, and by altering the rate at which the lens is revolved. The pictures taken embrace less than 180°. The apparatus folds together and is quite portable; it is fully described in Moëssard's *Le Cylindrographe*, Paris, 1889. The new "Al-vista" and the "Panoram Kodak" are apparently on the same principle as regards the rotation of the lens on the nodal point, but they are arranged as roll-holder cameras holding film sufficient for several exposures. They work instantaneously, the lens swinging rapidly round by pressure on a button. The angle included in the views is about 120° (Figs. 25, 26, and 27). Other more elaborate instruments have been made for making a complete tour of the horizon, being actuated by clockwork. Among them may be mentioned Damoizeau's "Cyclographe," which can be used with lenses of different foci and takes the pictures upon roll films, the film being unrolled as the instrument revolves, and thus the image always remains sharp (*Bull. de la Soc. Franc. de Photographie*, 1891, p. 183); Colonel Stewart's "Panoram" (1893); and the Bridges-Lee "Photo-theodolite," all of which, particularly the latter, are instruments suitable for photographic surveying.

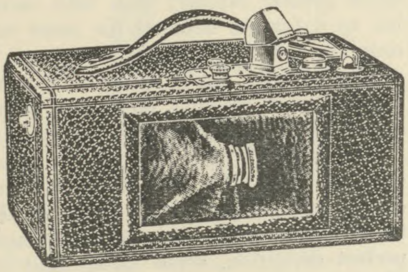


FIG. 25.—'Al-Vista" Panoramic Camera, closed.

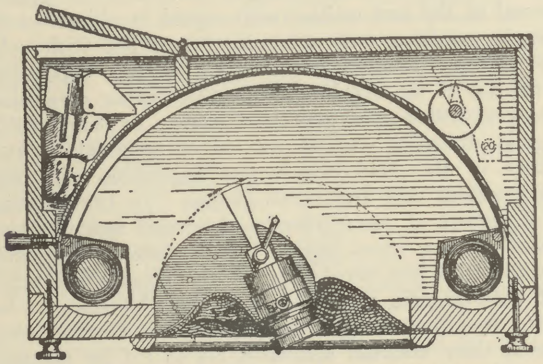


FIG. 26.—Section of "Al-Vista" Panoramic Camera.

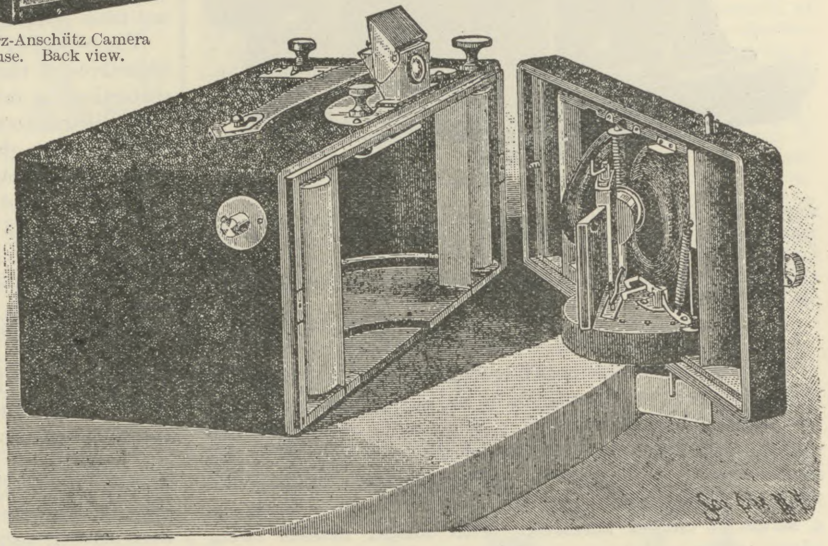


FIG. 27.—"Al-Vista" Panoramic Camera, open.

Enlarging Cameras.—A great many forms of enlarging cameras are made, depending on the nature of the illumination. They ordinarily consist of a double-extension arrangement for holding

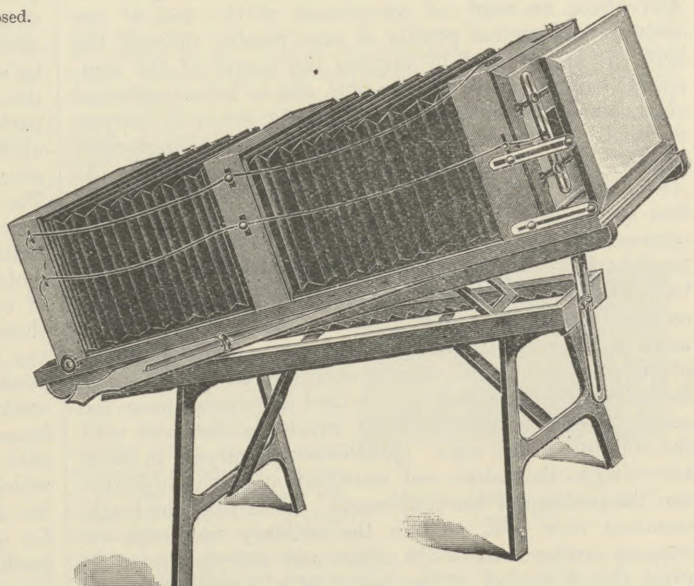


FIG. 28.—Enlarging Camera.

the negative at one end and the sensitive plate at the other, the lens being placed on a fixed partition between the two (Fig. 28). Others are made on the principle of a magic lantern for projecting an enlarged image on to a sensitive paper or plate fixed on a

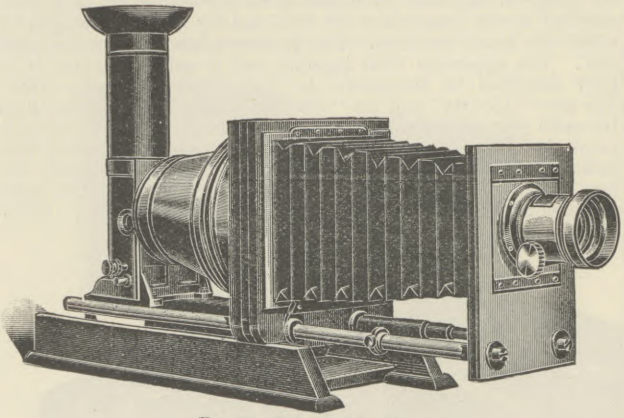


FIG. 29.—Enlarging Lantern.

screen (Fig. 29). A simple arrangement for daylight enlarging may be made by fixing a small quarter- or half-plate camera on to a larger one by a sliding front, and mounting the two on a studio stand, which can be tilted so that the image may be illuminated by the open sky.

Photographic Objectives or Lenses.

The objective is the most important item of photographic apparatus, because the success of the pictures depends upon the perfection with which it will correctly and distinctly depict upon the *plane* surface of the photographic plate actual images of objects in different planes, forming the field of view, which naturally would come to a focus on a series of *curved* surfaces. This image, besides being plane, must embrace a sufficiently wide angle and give fairly sharp definition all over the field of view it is intended to cover, even for objects at different distances from the lens. It must have sufficient luminous intensity to produce the required effect on the photographic plate with short exposures; the chemical and visual foci must coincide exactly; and it must be free from all distortion of straight or parallel lines. The fulfilment of these varied and conflicting conditions is complicated by the presence of sundry focal displacements, or aberrations, to overcome which requires the greatest optical skill and scientific knowledge. The principal of these are:—(1) *Spherical Aberration*, or want of coincidence of the foci of the central and marginal pencils of rays passing through the lens. It is corrected by varying the curves of the component lenses. (2) *Coma*, or blur, due to lateral spherical aberration of oblique rays, and mostly found in unsymmetrical combinations, such as portrait and single-view lenses. It is partly eliminated by the diaphragm. (3) *Astigmatism*, which always accompanies coma in single lens systems, and is usually present in objectives of the symmetrical aplanatic type, manifests itself by the formation of two sets of images of points off the axis, which lie in two separate curved surfaces, one set focussing tangentially as more or less horizontal lines, and the other radially as more or less vertical lines. It increases with the obliquity of the rays, and causes want of definition and difference of focus between horizontal and vertical lines away from the centre. (4) *Curvature of Field*, which also increases with the obliquity of the rays. (5) *Distortion*, varying in effect according to the nature and construction of the objective and the position of the diaphragm. Thus with the single meniscus view lens, used in the ordinary way with its concave surface towards the object and the diaphragm in front, the distortion of the image of a square will make the sides appear convex or barrel-shaped, while if the convex surface be turned to the object and the diaphragm placed behind, the sides of the square will appear concave. It can be overcome by using two such lenses, with their convex sides outwards and the diaphragm in the centre. (6) *Chromatic Aberration*, produced by the dispersion of the white light passing through a lens, and the different-coloured rays composing it coming to a focus at different distances from the visual focus in the order of their wave-lengths. It is corrected by the use of glasses of different refractive powers, but, if present, may cause a want of coincidence in the position and size of the images formed at the visual focus about the yellow, and at the chemical or photographic focus of the blue and violet rays, which act most powerfully on the sensitive films in ordinary use.

The object of the optician in constructing photographic objectives is therefore to neutralize these aberrations and distortions as far as possible, by regulating the curves of their different components, and the refractive and dispersive indices of the glasses from which they are made, so as to produce an image on the sensitive plate which shall be well defined and free from distortion. In the older types of objectives in use before 1887 these corrections could never be fully carried out; and although distortion of straight and parallel lines could be overcome in the way mentioned, there was always more or less residual curvature of field, spherical aberration, astigmatism, and, in some forms, coma, which had to be remedied as far as possible by the use of a diaphragm, which lengthened out the rays and caused them to define clearly over a larger surface, but at the expense of luminous intensity and rapidity of working. Few portrait lenses could be worked effectively with larger apertures than $f/8$, or landscape lenses with apertures larger than $f/16$ or $f/22$, and so were slow in action. Although the introduction of rapid gelatine dry plates enabled photographs to be taken with much greater rapidity than with earlier methods, it only led to a further demand for more rapidity in lenses, in order to satisfy the requirements of the necessarily very rapid exposures made in hand cameras. For studio and copying work rapidity is also an important desideratum, especially in cloudy weather and in winter.

The rapidity of a lens with a light of given intensity depends upon the size of its aperture, or that of the diaphragm used, relatively to the focal length. In order, therefore, to obtain an increase of rapidity combined with perfect definition, some means had to be found of constructing photographic objectives to work with larger effective apertures. This principle had been recognized by several of the best makers with regard to objectives of the single meniscus and aplanatic types, but with only partial success, because such objectives are dependent upon the use of the diaphragm for the further correction necessary to obtain good definition over an extended field. The great difficulty was to get rid of astigmatism and curvature of the field, which was impossible with the ordinary optical flint and crown glasses. In 1886 Messrs Abbé & Schott, of Jena, introduced several new varieties of optical glasses, which rendered it possible to overcome these difficulties, and revolutionized the science and practice of photographic optics by enabling objectives to be produced free from astigmatism, which can be effectively worked at their nominal apertures, $f/2$ to $f/4$ for portrait lenses, $f/6$ to $f/8$ for views, &c., with great flatness of field independently of the diaphragm, the principal use of which now is to extend the area of definition or increase the angle of view, and also the so-called "depth of focus" for objects in different planes. For full information regarding the theory and construction of photographic objectives, the reader may be referred to the works mentioned at the end.

Photographic objectives may be divided into the following classes:—

(1) Single achromatic combinations or "view lenses."
(2) Unsymmetrical doublets—old types.
(3) Symmetrical doublets—old types.
(4) Anastigmatic combinations, unsymmetrical and symmetrical.
(5) Triple combinations—old types.
(6) Telephotographic objectives.

(1) *Single Achromatic Combinations.*—In its ordinary form the single landscape lens of the old type consists of an achromatic compound meniscus, formed of a biconvex positive crown cemented to a biconcave negative flint, in order to secure achromatism and partially correct the spherical aberration. It may thus be looked upon as the type of the "old photographic achromat" (Fig. 30).[1] It is mounted with its concave surface towards the object, with the diaphragms in front of it, thus producing the convex distortion already noticed, which is inherent in this type of objective. In order to obtain further partial correction for astigmatism, spherical aberration, and coma, as well as depth of definition and covering power, the full aperture of these objectives has to be largely reduced by a diaphragm; consequently it is slow, though it has been much improved from its original form.

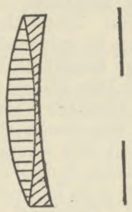


Fig. 30.—Single Landscape Lens.

These lenses have always been popular for pure landscape work, on account of the equality of the illumination over the plate and the brilliancy of the images they give, owing to their comparative thinness and freedom from reflecting surfaces. In the older forms their use was limited on account of their tendency to show "outward" distortion of the vertical lines of buildings, &c., but this is not very noticeable if they are worked well within their power and the camera is kept level. Objectives of this type are still largely used, and in some of their improved and "long-focus" forms are preferred by some portraitists for large heads, on account of the general softness of definition they give when used with large apertures. In T. Grubb's "Aplanatic" (1857) the positions of the crown and flint elements were reversed, the effective aperture increased and spherical aberration diminished (Fig. 31). J. H. Dallmeyer's "Wide-Angle Landscape Lens" (1865), composed of three cemented glasses, a flint concave between two hard crown menisci, included an angle of 75°. In it distortion was reduced and better marginal definition obtained with an aperture of $f/15$. The "Rapid (Long Focus) Landscape Lens," of the same maker, brought out by his son (1884), is a modification of the former, with an extra light flint in place of the anterior crown (Fig. 32). Working at $f/12$ it is said to give good definition with great brilliancy over an angle of about 40°, and with large apertures up to $f/8$ can be used for portraiture of large heads. The same advantages were gained in Wray's "Landscape Lens" (1886), a combination of two glasses working at $f/11$, the larger sizes working at $f/8$ being useful for portraiture. Voigtländer's "Wide-Angle Landscape Lens" (1888), constructed of Jena glasses, worked at $f/15$ over an angle of 90°, with great covering power and depth of focus. T. R. Dallmeyer's "Rectilinear Landscape Lens" (1888) was composed of three glasses, and quite novel in construction (Fig. 33). It works at $f/14$, is quite free from distortion, and has been recommended for copying purposes on account of the clearness of the lines resulting from the brilliant working of the single combination. Ross's "Wide-Angle Landscape Lens" (1890) is a triple cemented lens, made with Jena glasses, which works at $f/16$. Many other excellent lenses of this type have been made by English and foreign makers, but they are not so well suited for general purposes as are the new fully-corrected anastigmats specially constructed to work singly, such as Rudolph's (Zeiss) four-lens anastigmat, Series VII., or the single elements of many of the anastigmatic doublets, as will be noticed more fully later (§ 4).

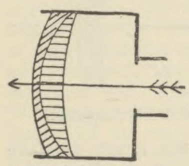


Fig. 31.—Grubb's "Aplanatic" Lens.

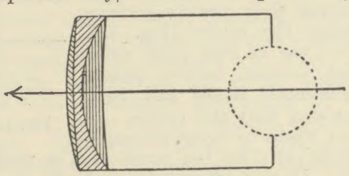


Fig. 32.—Rapid Landscape Lens. Long focus.

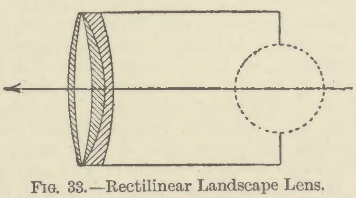


Fig. 33.—Rectilinear Landscape Lens.

[1] In the diagrams of lenses which follow, a uniform system of indicating the nature of the glass employed by means of the shading has been adopted.

Flint glass is indicated thus:—

Crown glass of low refractive power thus:—

Crown glass of high refractive power thus:—

(These two are used indiscriminately in lenses made before the introduction of the new Jena glass.)

Extra light flint glass thus:—

(2) *Unsymmetrical Doublets—Old Types.*—In this class are included objectives formed of two dissimilar combinations, which in most cases correct each other, and may or may not be capable of being used independently as single lenses, the diaphragm being placed at the optical centre between them. All the older "portrait" lenses, some of the doublets and the "orthoscopic" lens, now disused, belong to this category. Even under the vastly improved conditions of the present day, the special requirements of the portraitist working in a studio demand a quick-acting objective of large effective aperture and comparatively short focus, giving a brilliant and fairly well defined image of near objects in different planes over a restricted field of view. Such was the original portrait objective of the Petzval type, which is still largely used and preferred by many portraitists for their special purpose, though it has many defects which render it useless for any other purpose unless largely stopped-down and at the risk of "flare." The introduction of more rapid dry plates caused it to be supplanted to some extent by lenses of the rapid aplanatic or rectilinear type, but the use of Jena optical glass has enabled several improved and well-corrected combinations, of specially large aperture and small angle, to be made for portraiture and the most rapid instantaneous work. The Petzval portrait objective consists of two dissimilar achromatic combinations widely separated. In earlier forms the diaphragms were placed in front, but now they are usually between the combinations. The front element is a plano-convex, composed of a biconvex crown cemented to a plano-concave flint; while the back element is a double convex, composed of a biconvex crown, separated by an air-space from a concavo-convex flint in front of it (Fig. 34). In 1866 J. H. Dallmeyer made some essential changes in the form and relative positions of the components of the back element, and thus obtained a flatter field and freedom from "flare-spot" (Fig. 35). In this form the back element is a compound meniscus consisting of a meniscus crown in front, with its concave surface towards the diaphragm, and a meniscus flint behind, with its convex surface towards the plate. When the two components are in contact, sharp definition is obtained; but by separating them, more or less spherical aberration can be introduced, so that the definition is more diffused and the depth of focus increased. These objectives are made to cover an angle of 60° without distortion, and in three intensities, $f/3$, $f/4$, and $f/6$.

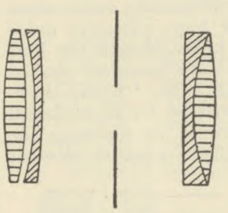


Fig. 34.—Portrait Lens.

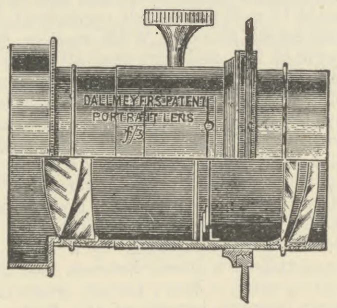


Fig. 35.—Dallmeyer's Portrait Lens, $f/3$.

Dallmeyer also brought out an extra quick-acting portrait objective for small portraits, with a working aperture of $f/2$. It differs from the preceding in the form of the back element, which is more like the original Petzval type, with a fixed air-space between the anterior flint-meniscus and the posterior biconvex crown (Fig. 36). In 1875 Dr Adolf Steinheil brought out an unsymmetrical aplanatic portrait combination of peculiar construction working at $f/3{\cdot}2$ (Fig. 37). Though it was a masterpiece of calculation and had many good qualities, it did not come into general use, and in 1881 was superseded by the "Portrait Antiplanet," which is also a distinct type, differing from the ordinary Steinheil

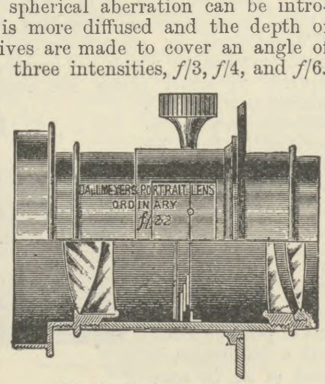


Fig. 36.—Dallmeyer's Portrait Lens, $f/2{\cdot}2$.

antiplanets and more nearly approaching a triplet, there being six reflecting surfaces (Fig. 38). It worked at an aperture of $f/4$; the

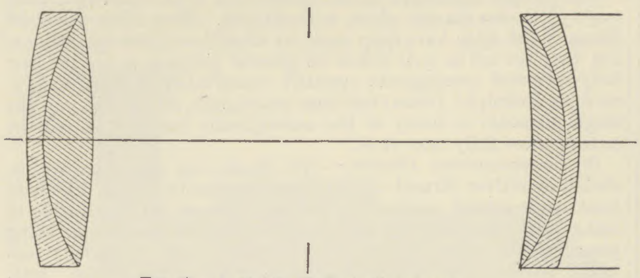


FIG. 37.—A. Steinheil's Portrait Aplanate.

spherical correction was not so complete as in the last lens, but astigmatism was removed over an angle of 14°, and the curvature of field was but slight. Steinheil's unsymmetrical "Group Aplanats" (1879), working at $f/6{\cdot}4$ over a field of about 70°, were an improvement upon the ordinary "Aplanats," but difficult to make, and were replaced in 1881 by the "Group Antiplanets," an unsymmetrical doublet of a distinct type (Fig. 39). They were made of the old

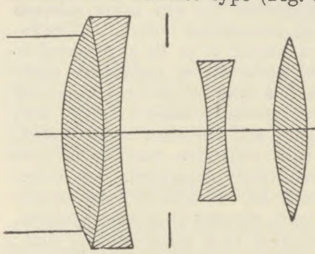


FIG. 38.—Portrait Antiplanet.

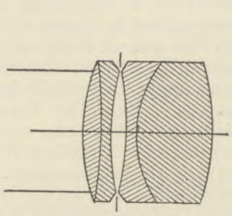


FIG. 39.—Group Antiplanet

optical glasses, and were a still further advance on the "Aplanats," working at larger apertures and giving better definition. They could be used at the full aperture of $f/5$ for instantaneous pictures and small groups. With smaller diaphragms they covered an angle of 70°, and were generally very useful lenses. According to Mr Dallmeyer, this lens is particularly interesting as being the first in which the principle was adopted of eliminating astigmatism by combining a "crown-shaped" lens of high refractive index with a "flint-shaped" of lower refractive index, though the Jena glasses were not available. All Dr A. Steinheil's lenses are marked by their originality and diversity of design. The "Group Antiplanet" was modified and greatly improved by Dr R. Steinheil (1893), as regards astigmatism and otherwise, by replacing the thick back combination by a triple long-focus negative element consisting of a crown between two flints, and by using a heavy barium crown in the front element instead of the flint. The new form has increased covering power, with a working aperture of about $f/6{\cdot}5$ (Fig. 40). Voigtländer, who was the original constructor of the Petzval portrait combination, improved it in 1878–79, and later in 1885, apparently on similar lines to Dallmeyer's improved portrait lenses of 1866. More recently he has constructed a rapid combination of this kind, working with an intensity of $f/2{\cdot}3$, intended for astrophotography, cinematograph work, and other purposes for which the greatest intensity of illumination is required on small plates not exceeding 4 inches square. An entirely new portrait combination was constructed in 1895 by Messrs Dallmeyer, for Mr Bergheim, to give a generally soft but well-defined and detailed image (Fig. 41). It is composed of a single uncorrected meniscus front lens of positive focus, with a diaphragm in front of it, in combination with a single uncorrected back lens of negative focus, and in the larger sizes it has great range of focal length on the telephotographic principle. The amount of spherical and chromatic aberration produced by the uncorrected single lenses gives the diffusion of focus which produces the peculiarly soft and delicate effect. It is most useful for large heads and life-size studies, the great depth of focus conducing to uniformity of definition. It works perfectly free from distortion, and by stopping-down to about one-third perfect definition can be obtained. Owing to both elements being single glasses, the combination gives great brilliancy. It is not achromatic.

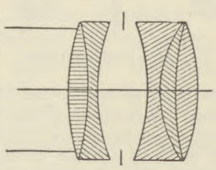


FIG. 40.—R. Steinheil's Improved Group Antiplanet.

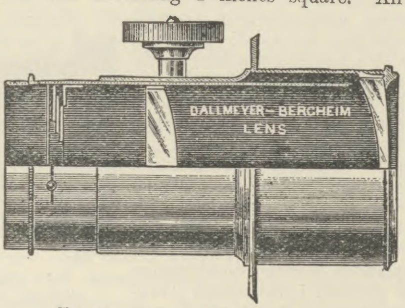


FIG. 41.—Dallmeyer-Bergheim Lens.

(3) *Symmetrical Doublets—Old Types.*—This class includes objectives formed of two similar combinations of lenses, usually of the convergent or positive meniscus form, with their concave surfaces inwards, and a diaphragm between them; consequently they are rectilinear and free from distortion of straight and parallel lines. Until the introduction of the anastigmatic doublets they were in universal use for almost all purposes. Even now they are very largely used, and have been greatly improved by the use of the Jena glasses in their construction.

Although Cundell (1844) described a symmetrical combination of two uncorrected meniscus lenses with a diaphragm between them, and several lenses of this type were brought out by various makers, it does not seem to have been recognized that this was the true cure for rectilinear distortion till C. A. Steinheil brought out his "Periskop" in 1865. This was a non-achromatized symmetrical doublet formed of two plain crown glass menisci with a central diaphragm (Fig. 42). It included an angle of 90°, and gave a much larger field than objectives of the "globe" or spherical type, because the lenses were closer together. Being non-achromatic, it had to be adjusted for the chemical focus. It was, however, perfectly free from distortion, and constructed so that the field might be as flat as possible and both nodal points together. It is said to be the best possible combination of two plain lenses, and is still manufactured for use with some of the cheaper hand cameras with fixed focus, the difference of the visual and chemical foci being allowed for. Newer objectives of this kind are fitted with mounts adjustable for the chemical and visual foci. Rodenstock's "bistigmats" are of this class. Zentmayer made a similar lens, but not symmetrical. In Adolf Steinheil's "Aplanat" (1866) the same principle was carried out with achromatized lenses, and this was a great improvement. It consisted of two positive cemented flint menisci, the outside one having a negative focus and the inner a positive one, glasses of different densities being used, but both having their concave surfaces facing the centre (Fig. 43). This use of flint glass alone was peculiar, because former achromatic lenses had been made of flint and crown. It was made to cover an angle of 90° at $f/30$, but could also be used with the larger aperture $f/8$. It was afterwards made in three different rapidities: (*a*) "ordinary," working with a relative aperture of $f/6$ or $f/7$ over an angle of 60°; (*b*) "landscape," working at $f/12$ to $f/15$ over an angle of 90°, and used largely in convertible sets; (*c*) "wide-angle," working at $f/20$ to $f/25$ over an angle of 104° for landscapes and interiors. In the aplanats of large aperture the components are from $\frac{1}{3}$ to $\frac{1}{6}$ the focal length apart, the largest diaphragm being nearly the full aperture of the lens. Spherical aberration is corrected at the expense of the angle of view. The inner curvature of the lenses is small, and consequently there is a good deal of astigmatism, and they are dependent on the diaphragm for good marginal definition. By the use of the newer and more transparent Jena glasses, as in the "Universal Aplanat" (1886), the component elements were brought closer together, the intensity of the combination increased, and the instrument made more portable. In the "Landscape Aplanats" the diaphragms were relatively smaller, the separation of the elements less, the radius of inner curvature smaller, giving less astigmatism and better marginal definition. In the "Wide-angle Aplanats" the intensity was still less, smaller stops were required, and everything was arranged to secure the greatest sharpness over a wide angle of view. The component lenses had much greater curvature and were much nearer together. J. H. Dallmeyer had been working in the same direction simultaneously with Steinheil, and in 1867 brought out his "Wide-angle Rectilinear," working at about $f/15$ and having the posterior element smaller than the front one (Fig. 44). This was also a great improvement on previous doublet combinations, and was succeeded, in 1868, by the well-known "Rapid Rectilinear," on the same principle, with the components made of menisci of flint and crown (Fig. 45). It works at $f/8$, and is largely used for copying. Ross's "Rapid" and "Portable Symmetrical" lenses, Voigtländer's "Euryscopes," and other similar lenses of

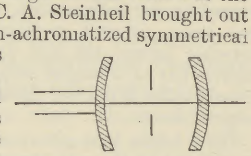


FIG. 42.—C. A. Steinheil's "Periskop."

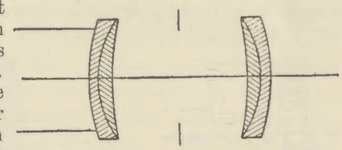


FIG. 43.—A. Steinheil's "Aplanat."

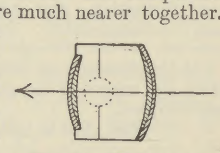


FIG. 44.—Wide-angle Rectilinear Lens.

English and foreign manufacture, are of the same type, and still largely in use. They are excellent lenses for general purposes, but more or less astigmatism is always present; and although they can be used with much larger apertures than the triplet lenses they displaced, they are dependent on the diaphragm for securing good marginal definition over the size of plate they are said to cover. They are being superseded by the anastigmatic combinations.

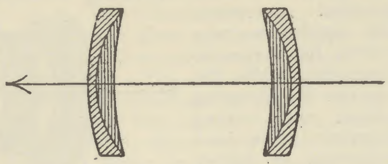


FIG. 45.—Rapid Rectilinear Lens.

(4) *Anastigmatic Combinations, Unsymmetrical and Symmetrical.*—As already stated, it was impossible to obtain flatness of field together with freedom from astigmatism in objectives constructed with the old optical glasses. In the "Antiplanets" Steinheil endeavoured to do so, but was only partially successful. The Jena glasses put a new power into the hands of opticians, by largely increasing their choice of glasses with different refractive and dispersive powers. Whereas the old glasses had high refractivity with higher dispersion, in the new ones high refractivity with lower dispersion can be set against lower refractivity with higher dispersion.

The first lens made with the new glasses was Dr Schroeder's "Concentric," patented in 1888, though not brought out by Messrs Ross till 1892 (*Phot. Journ.* xvi. 276). It is a symmetrical doublet of quite novel construction (Fig. 46), consisting of two similar combinations, each composed of a plano-convex crown glass of high refractivity, cemented on the plane surface to a plano-convex lens of lower refractivity but about equal lower dispersion. Both the uncemented surfaces are spherical and concentric, and in consequence of its shape it has considerable spherical aberration. At $f/16$ it gives equally sharp definition over a large and quite flat field of 75°. It is almost free from astigmatism, shows no distortion or "flare-spot," and gives great sharpness and depth of definition. Owing to the small working aperture it seems slow, but is not so for the definition and flatness of field obtained. It is an excellent copying lens. Both combinations can be used alone as single lenses of about double the focus. Dr Miethe calculated the data for two lenses brought out by Hartnack (1889), one of them a symmetrical anastigmatic aplanat, in which a crown of high refraction and low dispersion was combined with a flint of low refraction, thus diminishing astigmatism and giving perfect definition over a large field with a maximum aperture of $f/7 \cdot 7$. Though astigmatism was removed, other defects remained, and the lenses did not come into use. Fritsch, of Vienna, in 1888, constructed a wide-angle "Apochromat" of the symmetrical aplanatic type, composed of two similar combinations made of baryta flint and phosphate crown glasses, by which it was claimed that the secondary spectrum for the rays F, G, H was eliminated, and the dispersion of the chemical image reduced to a minimum, so that the definition was better and the image photographically more intense (*Photo. Correspondenz*, xxvi. 14). Many of the early lenses made with the Jena glasses suffered from the want of stability of the glass, and it was not until the principle of sandwiching the soft glasses between two hard ones was adopted that this was overcome. Dr Paul Rudolph, of Messrs Carl Zeiss & Co., of Jena, was the first to work out (1890) a new and practically successful method of constructing a photographic objective in which astigmatism of the oblique rays can be eliminated without loss of rapidity, and the want of marginal definition due to astigmatism removed, so that a comparatively extended field can be covered with a large aperture. This he effected by a combination of two dissimilar systems of single lenses cemented together, the positive element (converging lens) of each having in one case a higher and in the other a lower refractive index than that of the negative element (dispersing lens) with which it is associated. Both systems are approximately achromatic, the first, in which the glass of highest refraction has also the greatest relative dispersion, being what is termed a normal, or old, achromat, and the other, in which the highest refraction is accompanied by the lowest dispersion, an abnormal, or new, achromat. Both systems being spherically and chromatically corrected for a large aperture, the field is flattened, the astigmatism of the one is corrected by the opposite astigmatism of the other without destroying the flatness of field over a large angle. [A full description of the principles on which these lenses are constructed will be found in Eder's *Jahrbuch der Photographie*, 1891 and 1893; also in Prof. S. P. Thompson's translation of Lummer's *Photographic Optics.*] Several series of them have been made by Messrs Zeiss and their licensees since 1890. In England they are made by Messrs Ross. The first series were constructed

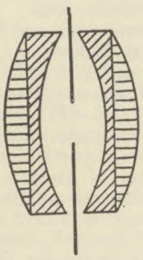


FIG. 46.—Concentric Lens.

in two different types. The more rapid had five lenses (Fig. 47), two made of ordinary glasses in the front normal achromat, which effects the spherical correction of the whole, and three in the back abnormal achromat, two crowns of exceedingly high refractive power, with a negative flint of exceedingly low refractive power

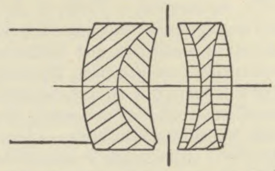


FIG. 47.—Anastigmat. Series II. $f/6 \cdot 3$.

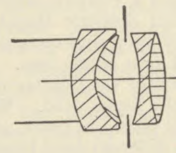


FIG. 48.—Anastigmat. Series IIIa. $f/9$.

between them. This component effects the anastigmatic flattening of the system. The fifth lens is useful in removing spherical aberrations of higher orders with large apertures. The second type (Fig. 48) has only two lenses in each component, the functions of which are as above. These combinations cannot be used separately as single lenses. Dr Rudolph also turned his attention in 1891 to the perfecting of the single landscape lens, and constructed on the same principle a single combination of three lenses, of which the centre one had a refractive index between the indices of the two others, and one of its cemented surfaces was diverging, while the other was converging (Fig. 49). This lens gave an astigmatically flat image, with freedom from spherical aberration on or off the axis. It was, however, not brought out till 1893, as a convertible lens or "Satz-anastigmatic," Series VIa (Fig. 50).

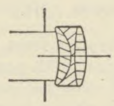


FIG. 49.—Anastigmat. Series VI. $f/14 \cdot 5$.

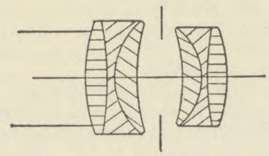


FIG. 50.—Satz Anastigmat. Series VIa. $f/7 \cdot 7$.

In the meantime Dr E. von Hoëgh had independently calculated for Messrs Goerz, of Berlin, a fully-corrected anastigmatic single lens on the above principle, consisting of a negative lens enclosed between two positive lenses, one of which has a higher and the other a lower refractive index than the negative (Fig. 51). Though

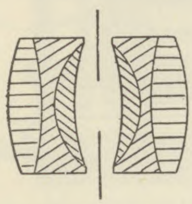
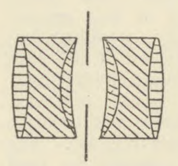


FIG. 51.—Ross-Goerz Series III.



Ross-Goerz. Series IV.

a lens of this kind could be used alone, Messrs Goerz preferred to put two of them together to form a symmetrical doublet of the "aplanat" type, and brought out the lens in 1893 under the name of "Double Anastigmat." These lenses are also manufactured by Messrs. Ross in two series—III., a universal lens, working at $f/7 \cdot 7$, and IV., a wide-angle copying lens, working at $f/11$. Both these series of lenses, at full aperture, cover a field of 70° to 75°, and with smaller diaphragms, 90°. In 1893 Messrs Zeiss issued their Series VI. and VIa of fully-corrected anastigmatic lenses with triple cemented components, which could be used either alone or as doublets, in combinations of two lenses of the same or different focus. These lenses have practically been replaced by Series VII. and VIIa, of "Convertible Anastigmats," now known as the convertible "Protar," consisting in the same way of single lenses formed of quadruple cemented components (Fig. 52). Each component comprises within itself a normal

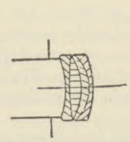
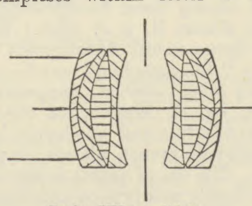


FIG. 52.—Series VII. $f/12 \cdot 5$.



Series VIIa. $f/6 \cdot 3$.

achromat of two old glasses and an abnormal achromat of two new glasses. Mr Dallmeyer, in his presidential address to the Royal

Photographic Society in 1900, says that this is the most perfectly-corrected single lens that has yet been evolved; for Dr Rudolph has not only succeeded in obtaining freedom from spherical aberration and astigmatism, but has also made a very successful attempt at the elimination of coma. The single "Protar" lenses of Series VII. have a relative rapidity of $f/12{\cdot}5$, embracing a field of 85°. With full aperture they have great anastigmatic flatness of field and only very slight marginal distortion—a condition not hitherto realized in a single lens. With the doublet combination, forming Series VII*a*, the relative rapidity varies from $f/6{\cdot}3$ to $f/8$, according to the lenses used. When lenses of unequal foci are used, the larger is placed in front, and with such a combination three objectives of different focal length are available. Quadruple convertible single lenses have also been patented by Goerz and by Voigtländer, but do not seem to have come into use.

Under the names "Planar" and "Unar," Messrs Zeiss, and in Great Britain Messrs Ross, have brought out two new anastigmatic lenses of large aperture which embody quite new features of construction. The first is a symmetrical doublet formed of two elements, each consisting of three lenses, the two inner ones being a double concave and a double convex cemented together and separated by an air-space from the outer one, which is a convex meniscus (Fig. 53). Its special points are its freedom from chromatic differences of the spherical aberration and the large relative aperture and intensity, varying from $f/3$ to $f/6$, according to the size and application of the lens, with perfectly sharp definition and anastigmatic flatness of field over an angle of view varying from 62° to 72°. The single combinations cannot be used alone, except with very small stops. It is a very rapid wide-angle lens, useful for the most instantaneous kind of work with the cinematograph; also for portraits and groups, photomicrography, and sharp reproduction. It is based on the principle of the Gauss achromatic telescope objective, and is described in Eder's *Jahrbuch*, 1898, p. 79; also Thompson's edition of Lummer's *Photographic Optics*, p. 81. The Unar (1899) consists of two unsymmetrical combinations, each formed of two thin single lenses of very transparent glass, separated by positive and negative air-spaces (Fig. 54). The halves cannot be used alone as single lenses, neither being fully corrected for colour. It works with an aperture varying from $f/4{\cdot}5$ in the small sizes to $f/5{\cdot}6$ in the largest, and gives sharp definition, with freedom from astigmatism, over a comparatively flat field of 65°. It is well adapted for portraiture, copying, and enlarging, and especially for hand-camera work, on account of its covering power combined with large relative aperture.

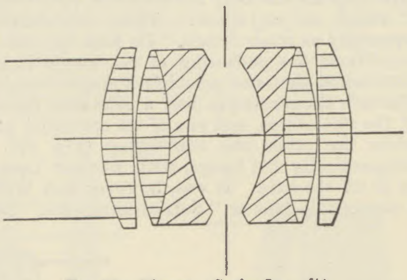


Fig. 53.—Planar. Series I*a*. $f/4$.

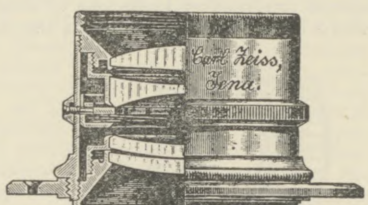


Fig. 54.—Unar Double Lens.

In 1899 Goerz brought out a double anastigmat with quintuple single lens components as a convertible lens, for which greater sharpness of definition and intensity, with perfect freedom from astigmatism and distortion in the single combination, were claimed; but, like the earlier analogous quintuplet of Turner and Reich (1895), they do not seem to have been adopted in practice. The extra cost of the number of glasses to be worked, and the difficulties of centring and construction, do not appear to be compensated by the additional advantages claimed. Several combinations of triple lenses, constructed more or less on the principles enunciated by Dr Rudolph, have been brought out by several English and foreign makers, among them Steinheil's "Orthostigmats," made in England by Messrs R. & J. Beck; Wray's "Platystigmats"; Ross's "New Symmetrical Anastigmats"; Voigtländer's "Collinears"; Lacour's "Eurygraphes," may be noted. Suter, of Basel, has introduced an 8-lens doublet, composed of two quadruple lenses. An account, by E. Wallon, of the newest types of anastigmatic doublets of triple and quadruple lens systems made in France, of Mantois's new French glasses, is given in Eder's *Jahrbuch*, 1901, p. 225. The use of quartz is also noted.

A distinctly new type of anastigmatic objective, involving several new principles of construction, was invented by Mr H. L. Aldis, who has fully described it in the *Photographic Journal*, 1896, xx. 117. It was brought out in three series by Messrs Dallmeyer, under the name of "Stigmatic." Series I. is a portrait combination, working at $f/4$, and consisting (Fig. 55) of two compound elements, the front one a deep converging meniscus with strong positive spherical aberration, but approximately correct for chromatic aberration, while the rear one is a diverging system with strong negative spherical aberration to correct the positive aberration of the front lens, and also approximately achromatic; the whole forming a converging system corrected for spherical and chromatic aberration, free from distortion, and almost free from astigmatism. It gives equal definition over a flat field, and covers an angle of about 60° with great equality of illumination. By unscrewing the back cell a certain amount of spherical aberration can be introduced, giving more equal distribution of definition over different planes. It may be noted that all the flint lenses have lower indices of refraction than the crowns. Series II. is on the same principle, but differs in construction (Fig. 56). It works at $f/6$ over an angle of 85° as a universal and convertible lens. The front or back component can be used alone, giving the choice of two additional focal lengths, $1\frac{2}{3}$ and twice the focal length of the complete lens. Series III. (Fig. 57) works at $f/7{\cdot}5$, and at $f/16$ will give sharp definition over a plate two sizes larger. The single components are not convertible. Another anastigmatic combination, also of English origin, and containing some remarkable new features, was constructed in 1893 by Mr H. Dennis Taylor, of Messrs T. Cooke & Sons, and brought out by Messrs. Taylor, Taylor, & Hobson under the name of the "Cooke Lens." It is also made by Messrs Voigtländer, under the name of "Triple Anastigmat." It is a triple combination consisting of three single lenses; two of them are positive crossed lenses of crown glass, with their most convex sides outwards, and between them, in front of the diaphragm, there is a single biconcave lens of light flint glass (Fig. 58). In Series III., which is a universal or general-purpose lens, the relative aperture is $f/6{\cdot}5$ (Fig. 59), and in Series V. $f/8$. These lenses are not convertible, but an arrangement has been made by which the focus can be lengthened by removing the back lens and replacing it by an "extension" lens of lower power. Series of them can

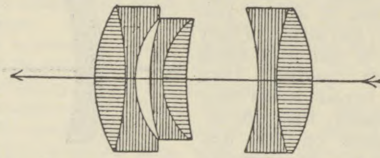


Fig. 55.—Stigmatic Portrait Lens. Series I.

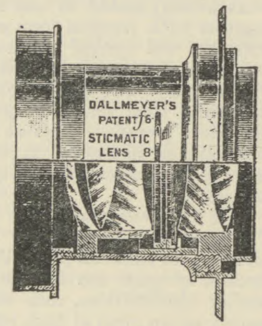


Fig. 56.—Dallmeyer's Stigmatic Lens. Series II.

Fig. 57.—Dallmeyer's Stigmatic Lens. Series III.

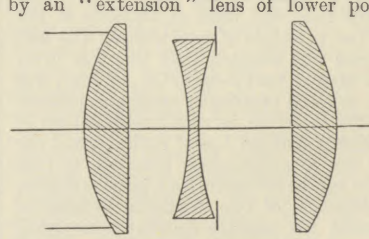


Fig. 58.—"Cooke" Portrait Lens. Aperture $f/4{\cdot}5$.

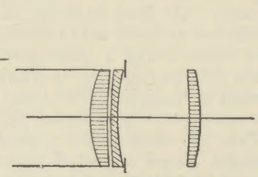


Fig. 59.—Cooke Lens. Series III.

be carried, either separately or mounted on a rotating wheel fitted inside the camera. A portrait lens, working at $f/4{\cdot}5$ over an angle of 45°, is on the same principle. An adjustment is provided with it for the introduction at will of spherical aberration evenly over the plate. In the "Process" lens, Series V. $f/8$, the combination is adjusted to secure identical size and sharpness of each colour-image in three-colour process work, and it has a screw-fitting for the attachment of a reversing prism. It is highly spoken of for its good definition and covering power in copying work. (For a full description of the principles on which these lenses are constructed, see *Photo. Journ.* 1895, xix. 64.)

Dr Harting has recently discussed the correction of the secondary spectrum in photographic lenses, and described the method followed in constructing Messrs Voigtländer's "Apochromatic Collinear Lens" (*Photo. Journ.*, 1901, xxv. p. 323). It is claimed that the colour correction of this lens is complete between C and G, and the images given by it of an object illuminated by any kind of monochromatic light fall in the same plane and are identical in size. This is of great importance in three-colour reproductions.

(5) *Triple Combinations—Old Types.*—This class comprises objectives composed of three separate combinations or glasses widely separated from each other. An early form of this type was made by Andrew Ross (1841) for Fox Talbot, others by Goddard (1859) and by Sutton (1860), but they never came into general use. J. H. Dallmeyer's well-known "Triple Achromatic Lens" (1860), though now out of date, was an excellent lens, and very useful for copying (Fig. 60). As made by Dallmeyer, the inner surface of the front and back lenses (achromatic menisci) is slightly concave, but in similar lenses made by T. Ross it was flat. The centre lens was an achromatic negative serving to flatten the field. They worked at $f/15$, giving an image fairly flat and quite free from distortion of straight lines.

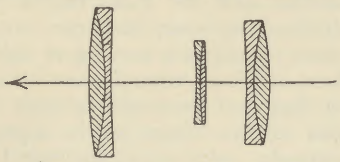


Fig. 60.—Triple Achromatic Lens.

(6) *Telephotographic Objectives.*—During the last few years special objectives, or attachments, have been constructed for photographing near or distant objects on an enlarged scale with an ordinary camera, the extension required being very considerably less than would be needed to obtain an image of the same size by means of an ordinary long-focus lens without enlargement. They consist of a combination of a positive converging with a negative dispersing lens, by which the image is picked up and enlarged to varying degrees, according to the system of lenses used and the extension given to the camera, thus producing the same effect as a positive lens of very much longer focus. Enlarged images of this kind can also be made by a combination of two converging lenses, one of them forming an image of the object, which is received on the other of shorter focus and projected on the sensitive plate, being enlarged more or less according to the optical conditions and relative positions of the lenses and sensitive plate. The photoheliographs at Greenwich and other solar observatories, designed by Dr de la Rue, are on this principle. A portable apparatus of the kind was made in 1869 by Borie and Tournemire, and later by Jarret, but this system requires much greater extension of the camera, entailing more loss of intensity of the image, and has never come into use.

The modern telephotographic combination is generally looked upon as an application of the principle of the "Barlow" lens, but it really goes back very much farther, and is contemporaneous with the telescope on the so-called Galilean system. J. B. Porta mentions the combination of concave and convex lenses for giving enlarged and clearer images of near and distant objects (*Magia Naturalis*, lib. 17, cap. 10, 1589). Kepler showed that by a combination of a convex with a concave lens images of objects could be depicted on paper of a larger size than by the convex lens alone, but reversed (*Dioptrice, Prob.* cv. 1611). Scheiner made use of the same principle in his "Helioscope" for solar observations (*Rosa Ursina*, cap. vii., 1630). If for the simple uncorrected glasses then used we substitute a system of photographically-corrected positive and negative lenses, suitably mounted, and put a sensitive plate in place of the paper, we have the modern telephotographic arrangement. Porro seems to have been the first to use a combination of this kind for photographing an eclipse in 1857, and later for terrestrial objects. It consisted of a small achromatic single lens combined with a concave lens. Many attempts were afterwards made in France, and also in England, to utilize the principle, but special lenses for the purpose were not available. Steinheil constructed one in 1889 for the Brussels Observatory, and another in 1890 for the Marine Department in Berlin. In 1891, curiously enough, three such combinations were worked out quite independently and patented, by T. R. Dallmeyer in London, A. Miethe in Berlin, and A. Duboscq in Paris. Since that time these combinations have been greatly improved. They are exceedingly valuable for obtaining details of inaccessible objects at a distance, whether architectural or topographical, and for photographing animals without approaching them too closely. Large portraits can also be taken with much better perspective effects, and more conveniently, than by using long-focus lenses much nearer to the sitter. With the very perfect telephotographic objectives now available, the loss of intensity of illumination, which no doubt was the bar to early progress in this direction, has been overcome, and definition has also been improved, so that snap-shots can readily be made with combinations of high intensity, while with those of ordinary intensity the exposures are not unduly prolonged, and good definition can be obtained over an extended field.

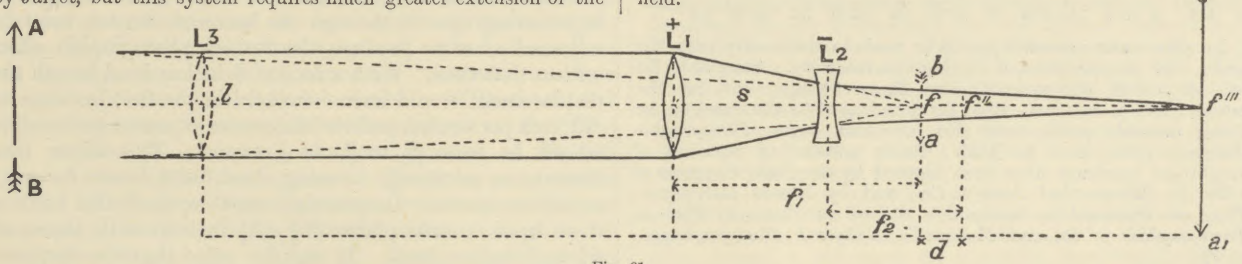


Fig. 61.

The optical principle on which these combinations are based is very simple, and will be understood from Fig. 61. It depends mainly on the fact that in order that a *real* image may be thrown on the screen of an object AB, the rays proceeding from it, which pass through the positive system L_1, must come to a focus at a point f within the secondary focus f'' of the negative system L_2. Falling within this limit, they will be intercepted by L_2 and made less convergent, so that instead of coming to a focus at f, they will continue to converge till they reach the screen at f''', and will there form a proportionally larger image $a'b'$ of AB than the image ab given by the positive lens alone at f; just as stated in Kepler's problem. Moreover, this image $a'b'$ will be of the same size as if it had been produced directly by a positive lens L_3 with a focal length equal to lf''', and this distance is the equivalent focal length of the entire system. It can be found from the formula $F=\frac{f_1 f_2}{d}$, where f_1 and f_2 are the focal lengths of L_1 and L_2 respectively, and $d=f_1+f_2-s$, s being the distance between the lenses. In many instruments of the kind a scale showing the value of d is engraved on the mount. If the rays from AB come to a focus in front of L_2, on it, or beyond f'', no real image can be projected on the screen. There is therefore a certain limit, which is greater in proportion to the length of focus of the negative system, within which the focus of the positive system L_1 may fall and produce a series of well-defined images on the screen, which can be varied in size by altering the amount of separation of the two systems of lenses within the above limit, and the distance of the screen from L_2. Every change in the position of the screen will involve a corresponding adjustment of the lenses. The greater the extension of the camera and the closer the lenses, the greater the size of the image, and *vice versâ*. The camera extension for a given magnification can be found by multiplying the focal length of the negative system by the number of magnifications, less one. The magnification produced by a given camera extension is found by dividing the latter by the focal length of the negative system, and adding one.

In its usual form (Fig. 62) the telephotographic combination consists of a quick-acting portrait lens, or an anastigmatic doublet of large aperture and relative intensity, varying in focus from 6 to 10 inches, fitted at one end of a tube, in which slides a smaller tube carrying a properly-corrected negative system, which may vary in focus from 1 to 5 inches, but must be of shorter focus than the positive (usually about half); the shorter the focus the greater the magnifying power for a given extension of camera. The amount of separation of the lenses is limited on the one hand by the position of the focus of the positive system, and on the other by the focus of the negative system, as explained above, and can be adjusted within these limits by a rack and pinion. The tubes are adjusted so that when closed up the two foci may

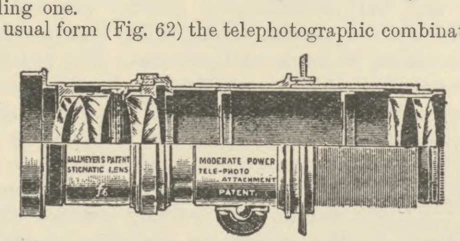


Fig. 62.—Telephotographic Combination.

coincide, or nearly so, and $d=0$, or its minimum value; and when opened to their fullest extent the focus of the positive may fall upon the negative system, or so that d may not exceed the focal length of the negative system. Within these limits the focal length of the combination will be positive, and a real image formed on the screen. Mr T. R. Dallmeyer, to whom many of the improvements in these lenses are due, has very fully discussed and explained the optical problems connected with their construction and use in his book on *Telephotography*. The other works noted at the end of this article may also be referred to.

Lens Diaphragms.—In order to regulate the intensity of the illumination by the lens, to enlarge its field, and, in the case of the older forms of objectives, to extend the area of good marginal definition, diaphragms are used, usually with circular apertures. They are made in different ways: (1) as single metal plates, fitting into a slot in the lens tube (Waterhouse diaphragms); (2) Rotatory: a single plate revolving on a central axis and pierced with apertures cut to fit centrically in the opening of the lens; (3) Iris: a form of diaphragm now very generally used, and very convenient, because it can be easily adjusted as required for intermediate apertures.

In order to provide a uniform system of diaphragm apertures, the Royal Photographic Society in 1881 drew up some rules, which were revised in 1891, and again quite recently. The former standard unit $\frac{f}{4}$ and the numerical notation used with it have been abolished. Intensity ratio is defined as dependent upon the effective aperture of a lens, and not upon the diameter of the diaphragm in relation to the focal length of a lens. The effective aperture of the lens is determined as follows:—The lens must be focussed for parallel rays. An opaque screen is then placed in the principal focal plane, and a pinhole is made in the centre of the plate (in the axis of the lens); an illuminant is placed immediately behind the pinhole itself, when the diameter of the beam emerging from the front surface of the lens may be measured. (It will be found that, except in the case of the diaphragm being placed in front of the lens, the diameter of the diaphragm itself is seldom that of the effective aperture.) Every diaphragm is to be marked with its true intensity ratio as above defined, but the present intensity ratios are retained in their order of sequence:—

$$\frac{F}{1}, \frac{F}{1{\cdot}4}, \frac{F}{2}, \frac{F}{2{\cdot}8}, \frac{F}{4}, \frac{F}{5{\cdot}6}, \frac{F}{8}, \frac{F}{11{\cdot}3}, \frac{F}{16}, \frac{F}{22{\cdot}6}, \frac{F}{32}, \frac{F}{45{\cdot}2}, \frac{F}{64}, \text{\&c.}$$

In other cases apertures are to be made in uniformity with the scale, with the exception of the highest intensity. Standards for the screws of photographic lens flange fittings, and for the screws fitted to cameras, either for attachment to the stand or for fixing movable parts, have also been laid down (*Photographic Journal*, 1901, xxv. p. 322). Other systems of notation of diaphragm apertures have been adopted by the Paris Congress of 1889, by Messrs Carl Zeiss & Co., and by Messrs Dallmeyer. They are discussed in Boursault's *Calcul du Temps de Pose en Photographie*, p. 33, and Moëssard's *L'Objectif Photographique*, p. 12.

Instantaneous Shutters.

The general use of very rapid dry plates and hand cameras rendered it necessary to have some mechanical means of regulating exposures in small fractions of a second, and the instantaneous shutter has become an essential part of modern photographic equipment in an immense variety of forms and patterns. For quick studio work, slow-acting shutters working to $\frac{1}{10}$ of a second are sufficient. Open-air exposures will usually range from $\frac{1}{10}$ to $\frac{1}{100}$, though less than $\frac{1}{30}$ of a second is seldom necessary. For objects in quick motion the range may be from $\frac{1}{100}$ to $\frac{1}{200}$, and for very rapidly moving objects from $\frac{1}{500}$ to $\frac{1}{1000}$ of a second. In ordinary practice exposures of less than $\frac{1}{100}$ of a second are not often required, and few of the shutters on the market in general use give higher speeds.

The rapidity required of a shutter in photographing moving objects is regulated by the minimum time necessary to produce a well-exposed image upon the plate, with a loss of definition, or blurring, by displacement not exceeding $\frac{1}{100}$, or preferably $\frac{1}{200}$ to $\frac{1}{250}$ of an inch, if enlargement is intended. The time required to produce a well-exposed image depends on the state of the light and the illumination of the object, the relative intensity of the lens as measured by its effective aperture and focal length, the sensitiveness of the plate, and the amount of effective light passing through the shutter during the exposure. The amount of displacement to be guarded against depends upon the rate of movement of the object, the direction in which it is moving with reference to the axis of the lens, its distance from the camera, and the focal length of the lens. It will be proportionately less as the distance of the object increases, and as the rate of its motion and the focal length of the lens for a given distance decrease, and *vice versâ*. It will be greatest when the object is moving at right angles to the axis of the lens, and least when the motion is directly towards it; but in that case there will be some increase in the apparent size of the object as it approaches the camera. For example:—An object moving 1 mile an hour advances 17·6 inches per second. With a lens of 5-inch focus this would represent a displacement on the ground glass, for an object 50 feet away, amounting to $\frac{1}{46}$ inch per second, and it would require exposures between $\frac{1}{15}$ and $\frac{1}{37}$ of a second to give maximum or minimum displacements of the image between $\frac{1}{100}$ and $\frac{1}{250}$ of an inch. An object at the same distance moving ten times as fast would require $\frac{1}{10}$ of the above exposures. If, however, the distance be increased, the possible exposure may also be increased in the same proportion, so that the object moving 10 miles an hour at 500 feet distance would only require the original exposures of $\frac{1}{15}$ to $\frac{1}{37}$ of a second. On the other hand, the limits of exposure for an object moving 1 mile an hour within 10 feet of the lens would be between $\frac{1}{75}$ and $\frac{1}{185}$ of a second. This is entirely independent of the sensitiveness of the plate, and only represents the maximum duration of exposure permissible in order to reduce the blurring of the image between certain limits. The sensitiveness of the plate, and the intensity and amount of light acting upon it through the lens and shutter, must be adjusted so as to produce the desired photographic effect within that time. With a lens of 8 inches focal length the displacement would have increased in the first instance to ·23 inch per second, and the maximum exposure permissible would be from $\frac{1}{23}$ to $\frac{1}{57}$ of a second. This shows that there is an advantage in using short-focus lenses for very rapid exposures. In practice, most work of this kind is done upon quarter-plates ($4\frac{1}{4} \times 3\frac{1}{4}$ inches) with lenses of $4\frac{1}{2}$ to 5 inches focus. It may be noted that the displacement will be greatest for an object moving at a right angle across the axis of the lens, so that an exposure sufficient for this case will be sufficient for any other. Sir William Abney has discussed this question practically in his *Instantaneous Photography*, and it is treated mathematically by Mr W. B. Coventry in his *Technics of the Hand Camera*, in which will be found formulæ and tables for ascertaining the distances and limiting exposures for moving objects, allowing for a blur of $\frac{1}{100}$ of an inch. In foreign treatises the limit is usually calculated for a displacement of $\frac{1}{10}$ of a millimetre, or about $\frac{1}{250}$ of an inch.

An efficient shutter should fulfil the following conditions:—It should be light and compact, simple in construction, but strongly made, and not liable to get out of order; capable of being set without admitting light into the camera; quite free from any tendency to shake the camera; and easily released with a very slight pressure of the finger if a pneumatic release is not fitted. It should open and close quickly, allowing the largest possible proportion of the exposure to be made with the full aperture, and it must not cut off any of the effective light passing through the lens, but should distribute it evenly all over the plate: though in landscape work it is an advantage to give the foreground more exposure than the sky. It should be adjustable for variable instantaneous and for prolonged or "time" exposures. With a good shutter there is less risk of shaking the camera in short "time" exposures, from $\frac{1}{4}$ to 1 second, than there is in taking off a cap. Shutters working between the lenses must permit of the use of diaphragms in the lenses. Above all, they must be constant in their action, giving short and variable exposures always correctly or relatively so, an important condition which apparently is not often fulfilled, and the exposures marked on the indicator should be capable of being always repeated with certainty. Shutters should also be capable of being used with different lenses. They are usually released by the pressure of the finger on the end of a lever holding the moving part in a state of tension; or better, by Cadett's system of pneumatic pressure, applied by means of a compressible rubber bulb and tube, which drives a piston acting on the lever holding the shutter, or which may inflate a collapsible bulb at the other end of the tube, and thus exert the necessary pressure on the lever. In many cases both methods can be used as desired, the pneumatic release being preferable on account of its convenience and freedom from liability to shake the camera. For hand cameras, however, the trigger pressure stud is more general, though in some forms a lever is drawn across from right to left, or *vice versâ*, being always set in both positions. Pressure is, however, better than a pull.

The following are the principal types of instantaneous shutter:—(1) Flap, (2) drop, (3) combined drop and flap, (4) rotary, (5) roller-blind, (6) focal plane, (7) lamellar, (8) moving disc or sector, (9) iris. They can be applied in four different positions: (*a*) in front of the lens; (*b*) centrally, near the diaphragm; (*c*) behind the lens; (*d*) immediately in front of the sensitive plate. They all, however, come under two main classes, *Lateral*, including those in which the exposure commences and ends at the circumference of the lens aperture, and *Central*, those in which the exposure begins and ends at the centre of the aperture. Some of them are "lateral" in their single form and "central" when double. With the "focal plane" shutters, however, different portions of the plate are exposed in succession, the lens working at its full aperture throughout the exposure. The form and position of the effective aperture of a shutter, relatively to the lens and plate, have a strong influence, either favourable or unfavourable, on the amount of effective light passing through the lens, and its even distribution over the plate. This is especially the case during the incomplete phases of opening and closing the aperture. It seems to be agreed that the best position for shutters of the lateral type is behind the objective, and for those of the central type, between the component lenses. In this latter position the whole of the plate is illuminated during the full period of exposure, with a gradually increasing intensity during the first phase, until the second phase of full opening is reached, and then the illumination gradually falls off again during the third phase until the shutter is closed again. The most effective shutter is one in which the first and third phases of incomplete illumination, during the opening and closing, are the shortest compared with the phase of full opening.

To secure successful results in using instantaneous shutters, the operator must make himself thoroughly acquainted with the working of his shutter in various circumstances of exposure with the lenses, plates, and developer he proposes to use; he should also verify the value of the various exposures marked on the indicator, and, what is more important, determine how far they can be depended on for regularity. There are many simple ways in which the actual time of exposure from opening to closing can be ascertained sufficiently closely for practical purposes. They depend upon the measurement of the trace left on a sensitive plate by the passage of a brightly illuminated object revolving at a known speed or falling vertically through a known distance, when photographed with different speeds of the shutter against a dark background. These, and the more elaborate methods for obtaining more accurate determinations of the shutter-exposure periods and of the corresponding effective exposures—*i.e.*, showing the actual effect of the shutter through its different phases from opening to closing—have been described by Sir William Abney in the work already mentioned, by Londe in *La Photographie Moderne* and *La Photographie Instantanée*, and in other works mentioned at the end of this article.

(1) *Flap Shutters.*—The simple flap shutters consisting of a hinged flap opening upwards in front of the lens, though favourites in early days for landscape work, have been almost superseded by quicker and more compact forms. They are, however, still in use with single and double flaps for portraiture and studio work, for which purpose they are made to act noiselessly and not attract the attention of the sitters. Guerry's (Figs. 63 and 64) is a good example of the type.

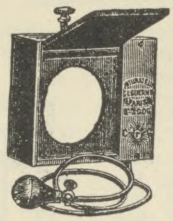


FIG. 63.—Guerry's Single-flap Shutter.

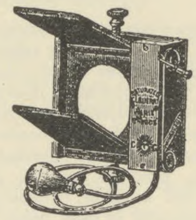


FIG. 64.—Guerry's Double-flap Shutter.

(2) *Drop Shutters.*—The old simple drop shutter, in which a plate having an opening in it falls in front of the lens aperture, has been superseded by the more compact and quicker-working roller-blind shutters, which act on much the same principle. It had a theoretical interest in connexion with the effect of different forms of aperture—circular, square, or elongated—used with shutters of the lateral type, but it is now generally recognized that a more or less extended rectangular opening, of at least the full width of the lens aperture, is best for securing the even admission of light from all parts of the image with shutters of the rectilinear lateral type, to which this and similar shutters, in which a single opening passes across the lens aperture, belong.

(3) *Combined Drop and Flap Shutters.*—In early dry-plate days several forms of this kind of shutter were brought out, under the names of Phœnix, Phantom, &c., but they are now little used. In these shutters, in addition to the drop slide, there was also a lifting flap, which on release opened from below, and, having fully uncovered the aperture, released the drop slide, which fell and closed the shutter. They were useful and effective in the smaller sizes, but heavy and cumbrous in the larger. The use of indiarubber bands for giving tension was also an objection.

(4) *Rotary Shutters.*—These are of the lateral type, and consist of a circular metal disc revolving on an axis eccentric to the axis of the lens, and furnished with a radial sector-shaped or elongated opening with circular ends, which passes laterally in front of the lens aperture when the tension of a spring is released (Fig. 65). They are largely used in various patterns in hand cameras, usually in front of the objective, though they may be placed behind it or between the component lenses. So long as the opening is at least equal to the size of the lens aperture, the illumination is sufficiently even, but the openings are usually somewhat elongated so as to give a longer period of full opening.

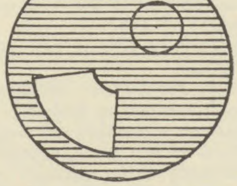


FIG. 65.—Rotary Shutter.

(5) *Roller-Blind Shutters.*—For general use the well-known roller-blind shutter of the single lateral type, as made by Thornton-Pickard and others, is undoubtedly one of the most popular and efficient. It possesses most of the qualities laid down as essential to a good shutter, gives good illumination, appears to be fairly regular in its action, and can be used for time or instantaneous exposures. It consists of a light mahogany or aluminium box, arranged so that it can be fitted in front of or behind the objective. It is made in different sizes, and each size can be adjusted to smaller objectives

Fig. 66). By pulling a cord an opaque black curtain with an elongated rectangular aperture is unrolled from the lower roller on

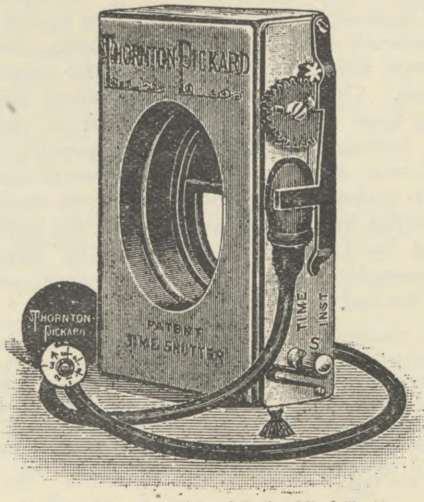


FIG. 66.—Thornton-Pickard Roller-Blind Shutter.

to the upper one, and held by a coiled spring on the lower roller (Fig. 67). Pressure on a pneumatic bulb inflates a second smaller bulb, raising a lever which releases the spring, and thus brings the blind down with a rapidity which can be adjusted by turning a handle actuating the spring, the corresponding speed being shown on the indicator. For time exposures, pressure on the bulb opens the shutter, and another pressure closes it, but an arrangement is now made by which time exposures of $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 3 seconds can be given automatically (Fig. 68), the pressure of the bulb opening the shutter, which closes of itself at the expiration of the exposure required. The theory of shutters of this type has been very fully discussed by Mr Coventry (*op. cit.* p. 50), who shows that for any given tension of the spring the actual exposure decreases as the size of the lens aperture diminishes, while the effective exposure remains constant for all apertures. This is peculiar to the lateral shutter. He also shows that with plates of very different rapidities, though the exposure may be the same, the actual exposure effective is less with the rapid plate and a small stop, than with the slow plate and a large stop; consequently the blur due to the movement of the object would be proportionately less on the rapid plate than on the slow one. He also shows that for any given lens the smaller the shutter the more rapid the exposure can be made, though with the same lens a larger shutter is capable of giving a more efficient though less rapid exposure. It is better, therefore, for moderate exposures, to have a larger shutter than the size of the lens requires. Sir William Abney has given diagrams of the action of this shutter in his book referred to; these show clearly that the centre of the plate gets more exposure than the margins; but practically this is not very noticeable, and the action is very regular.

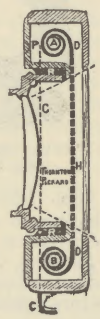


FIG. 67. — Mechanism of the Thornton-Pickard Roller Blind Shutter.—A, upper roller; B, lower roller; C, cord; D, black curtain; H, aperture in curtain; R, rubber ring adapter.

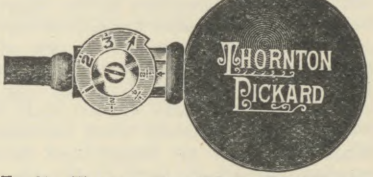


FIG. 68.—Thornton-Pickard Roller-Blind Shutter —Automatic Exposure Appliance.

(6) *Focal-Plane Shutters.*—These are also roller-blind shutters, with mechanism similar to the foregoing, but they are arranged so that an adjustable slit moves at a rapid speed a short distance in front of the plate, exposing different portions of it in turn, the intensity of the exposure being regulated by the width of the slit, which is adjustable. In this way the lens can act on the plate with its full intensity. The construction of this shutter (Fig. 24) makes it capable of giving very rapid exposures with a narrow slit, and it has been used by Anschütz for his remarkable instantaneous studies of animals, &c., in rapid motion. It is made by Thornton-Pickard, Goerz, and others. The theory of it is discussed by Coventry (*op. cit.* p. 69). As the slit moves progressively over the plate, it may in certain circumstances cause distortion of the quickly-moving images, especially if near the camera, or with a narrow slit and slow movement, but practically it is not often very perceptible.

(7) *Lamellar Shutters.*—These are a distinct type of lateral shutters, introduced abroad but not common in England. They act on the principle of a venetian blind, with a series of parallel blades or plates, which turn through a semicircle on an axis during the exposure. They are said to have the advantage of giving a *uniform* very rapid exposure, but the blades cut off a great deal of light, whether placed before or behind the lens.

(8) *Moving Disc Shutters.*—These shutters, in which two thin metal plates with round or rectangular apertures, or in other cases two curved blades, pass very quickly over each other in opposite directions, are now very generally used in a variety of patterns. Formed of two single lateral shutters, they become in most cases central, opening and closing in the centre of the lens aperture. The exposure takes place during the short period when the openings pass each other, or the curved blades open out and close again. The size of the openings generally corresponds with the diameter of the lens. If each plate moves as fast as a drop shutter, the combination gives double the speed, corresponding to half the exposure. High speeds of $\frac{1}{100}$ or $\frac{1}{200}$ of a second can therefore easily be attained, and rectangular apertures are the most effective. The plate will be most evenly and strongly illuminated when the leaves of the shutter work inside the lens near the diaphragm, as in Bausch & Lomb's (Fig. 70). This necessitates the shutter being made for the lens. Some forms are, however, suitable for use in front of the lens, such as the "Constant," Lancaster's "See-Saw" (Fig. 69), the double roller-blind, &c. In these the rectangular form of aperture is the best, circular apertures cutting off a good deal of the light, as in the case of drop shutters. Coventry has also discussed the action of the double roller-blind shutter as typical of the central class of shutters, and shows that while with the lateral shutter the effective exposure is constant and the actual exposure variable, it is the reverse with the central shutters, and it will not be so easy to calculate exposures with different-sized stops. A central shutter gives a more efficient exposure than a lateral shutter of the same dimensions as long as the opening is greater than the diameter of the lens. The greater rapidity of the double blind shutters is partly due to the spring being stronger.

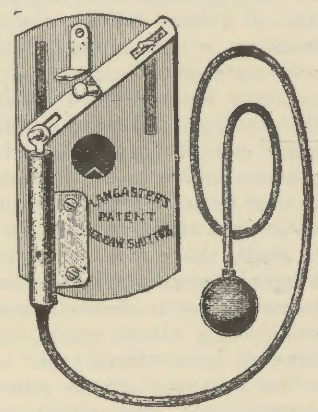


FIG. 69.—Lancaster's "See-Saw" Shutter.

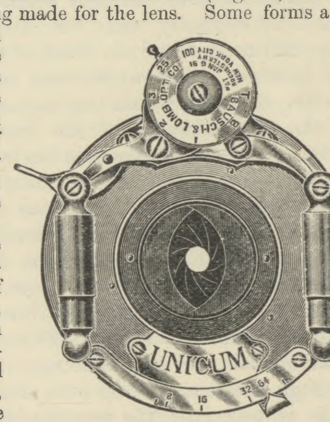


FIG. 70.—Bausch & Lomb's "Unicum" Shutter.

(9) *Iris Shutters.*—These shutters are a further development of the double curved-blade central shutters, and are constructed on the principle of the "Iris" diaphragm, to open out from the centre of the lens and close again (Fig. 71). They are in all cases fitted between the components of double objectives, and can be made very light and compact. This central position of the shutter is theoretically the best, and the "Iris" is the best form. They require very great care in construction and fitting to the lens, and consequently are expensive. They can, however, be used with convertible sets of lenses of different foci fitting the same mount. Several forms of them are made by English and foreign makers, but the principle is much the same in all, and ensures the most equal distribution of light over the plate.

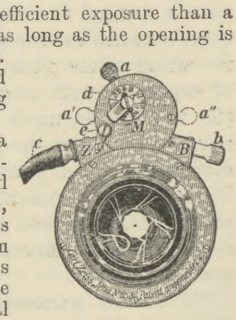


FIG. 71.—Mechanism of the "Iris" Shutter.—*a,a,'a,"* winding lever; *b*, speed brake; *c*, hand release; *d*, index for iris; *e*, index for exposures and also release; *B*, brake; *M*, instantaneous exposures; *Z*, tune exposures.

Exposure Meters.

When gelatine dry plates came into general use, and were made of many different degrees of sensitiveness, the want of a guide to the proper exposure for the various makes of plates under different conditions of lighting began to be felt, and several methods were devised for meeting the want. Some of them depend solely upon data derived from observations of the action of the principal factors affecting the result, namely: (1) The speed of the plate; (2) the actinic power of solar light for the time of year in a given latitude; (3) the time of day, with reference to the position of the sun; (4) the effective diaphragm aperture of the lens; (5) the nature and illumination of the subject. With others these data are supplemented by, and practically based upon, actinometric observations of the action of the light upon sensitive paper exposed near the camera or the subject at the time. Both methods are in many cases of undoubted use, but the information given by instruments of this kind can only be considered as approximate, and much is left to the judgment of the operator, whose surest guide will be an intelligent study of the principles on which these instruments are based, together with carefully-recorded observations of the combined working of his lenses, shutters, plates, and methods of development under the varying conditions of practical work. Before using any of these instruments, it is necessary to know approximately the relative sensitiveness or "speed" of the plate in use. In the early days of gelatine dry plates, their rapidities were stated as so many times wet plates, or as "ordinary," "instantaneous," "rapid," or "extra-rapid," terms which, though suitable for one make of plate, were of no value with reference to others. This was improved upon by the adoption of Warnerke's "Sensitometer," which was in use as a standard for some years. It consisted of a transparent scale of 25 squares of different intensities, marked with opaque numbers and arranged so that each third number indicated a doubled rapidity. This was placed in a frame in front of the sensitive plate, and exposed for thirty seconds to the constant light emitted by a phosphorescent tablet, supplied with the instrument, which was previously excited by burning one inch of magnesium ribbon in front of it. The exposed plate was then developed and fixed, and the highest number visible indicated the rapidity of the plate. In 1890 Messrs Hurter & Driffield introduced an entirely new system of calculating the sensitiveness of plates of different rapidities. They make a series of exposures in seconds on different parts of the plate in geometrical progression with a standard candle at one metre distance. After development for a certain fixed period with a standard developer, fixing, washing, and drying, the "densities," or logarithms of the opacities, of the different parts are measured by a special photometer and plotted on a skeleton diagram, producing a curve, one portion of which will practically be a straight line. The position of this line with reference to a scale of exposures given on the diagram decides the rapidity of the plate, while its length indicates the "capacity" of the plate for the truthful rendering of tone. The elaborate investigations by which these results were obtained are of great interest, and were published in the *Journal of the Society for Chemical Industry*, 1890, 1891, and later ones in the *Photographic Journal*, 1898. A paper read before the Photographic Convention in 1893 may also be noted. The sensitiveness given on the H. & D. scale is directly proportional to the number given. The method has been adopted by several dry-plate makers in denoting the sensitiveness of their different brands, and is more or less the basis on which the plate-speeds for the modern English dry-plate actinometers and exposure meters are calculated. Several systems of photometry and measurement of the speeds of dry plates were discussed at the meetings of the Congrès International de Photographie, in Paris, 1889, and Brussels, 1891, but no definite standard was finally adopted. In Germany the use of Scheiner's sensitometer has been adopted, and appears to be extending. It is based on a system of photographing the graduated tints given by rotating sectors. A full account of the instrument, and of a system of sensitometry based on its use, is given by Dr Eder in the *Photographische Correspondenz*, 1898, p. 469, and 1900, p. 244. Mr Chapman Jones has recently brought out a convenient plate-tester on the same principle as the Warnerke sensitometer, but extended by the addition of a colour sensitometer, which is useful for the comparison of orthochromatic dry plates, colour screens, light filters, &c. It consists of a screen plate, $4\frac{1}{4} \times 3\frac{1}{4}$ inches, containing a series of twenty-five tints of graduated densities; a series of coloured squares, blue, green, yellow, and red, and a strip of neutral grey, all five being of approximately equal luminosity; a series of four squares of special pure colours, each representing a definite portion of the spectrum; also a space of line design, over which is superposed a half-tone negative. To use the instrument, a quarter-plate of the brand to be tested is exposed behind the screen for a few seconds to the light of a standard candle placed at the distance of a foot, developed, fixed, and washed. An examination of the plate will show the sensitiveness, range of gradation, possible range of exposure, sensitiveness to colour, size of grain, amount of halation, and the most suitable light for development. It can be used for many other tests, and enables any brand of plates to be readily tested by the user and compared with any standard he may find convenient. In making these and similar tests, a standard developer should be allowed to act for a fixed period and at a uniform temperature (*Phot. Journ.* 1901, xxv. p. 246).

The next important factor is the actinic power of the light. It depends normally on the height of the sun for the latitude of the place at the time when the photograph is taken, and exposures in bright sunlight are found to vary approximately as the cosecant of the sun's altitude above the horizon. The light of the sun itself is practically the same at any given time and place year after year, but is liable to more or less local and temporary diminution by the amount of cloud, haze, dust, &c., present in the atmosphere at the time. It is also affected by the time of day, increasing from sunrise to noon, and then decreasing to sunset. The remaining factor is the effective diaphragm aperture of the lens in relation to its focal length. In most cases of ordinary outdoor exposures this can be taken at its normal value, but becomes smaller and increases exposure if the focal length is much increased for photographing near objects. Besides these principal factors, the nature and colour of the objects, their distance, and the amount of light received and reflected by them, have a very great influence on the result. Mr Coventry (*op. cit.* p. 75) shows how the "light coefficient" for full sunlight can be found, and gives a table for the latitude of London for every half-hour of the day in periods of ten days throughout the year; also, roughly, the relative coefficients for "diffused light," "cloudy," "dull," and "very dull." Convenient tables showing the normal exposures for each month in the year and at every hour of the day, together with others showing the influence of the different factors affecting exposure, have been published in some of the printed "Exposure Note-books." The reader may also be referred to H. Boursault's *Calcul du Temps de Pose en Photographie*, and similar works by A. de la

Baume-Pluvinel and G. de C. d'Espinassoux for a discussion of the subject in all its aspects.

Based on the same principle as these exposure tables, various portable exposure meters have been brought out, in which scales representing the coefficients for plate-speed, light, and diaphragm are arranged as in a slide rule, so that, when properly set, the normal exposure required can be found by inspection, and increased or diminished according to circumstances. In Hurter & Driffield's "Actinograph," the light coefficient is given by a printed card showing the curves for every day in the year and for every hour of the day, the unit being the $\frac{1}{100}$ part of the brightest possible diffused daylight when the altitude of the sun is 90°. The "lens" scale shows the ratios of aperture to focal length in general use, and is calculated for single, double, and triple systems of lenses. The "speed" scale is based on the exposure in seconds which with one actinograph degree of light will produce a perfect negative of an ordinary landscape. An additional scale is given for five different degrees of illumination—"very bright," "bright," "mean," "dull," "very dull." A table of factors for "Views," "Portraiture," "Interiors," "Copying," is also given, and these regulate the figure to be taken for the exposure. The scales are engraved on boxwood, and there are two sliding pieces (Fig. 72).

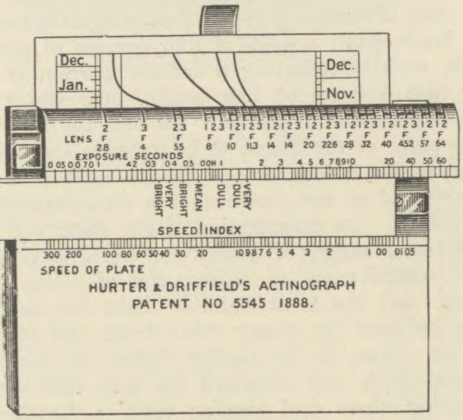


FIG. 72.—Hurter & Driffield's Actinograph.

It is specially adapted for use with plates of speed numbers agreeing with the H. & D. scale, but can be used with any plate of which the relative speed number is known. Another convenient exposure meter is made by Watkins, of Hereford, in different forms. In the first the scales of "light," "speed," "diaphragm," and "exposures" are arranged round a cylinder, and in a later pattern on a dial, but the plate speeds are taken from a table, and the light coefficient is ascertained at the time by exposing a piece of sensitive paper under a blue glass for the number of seconds requisite to match a fixed tint, a pendulum being supplied with the instrument for counting seconds. In the "dial" instrument there are four apertures, marked "Plate," "Stop," "Act." and "Exp." above the corresponding scales. The numbers showing the speed of the plate in use, the diameter of the stop, and the actinometer exposure in seconds are brought into the respective apertures, and the exposure required is read off in the "Exp." aperture (Figs. 73 and 74). Other forms are made for hand cameras and indoor exposures. Wynne's exposure meter is also in dial

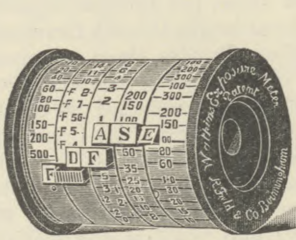


FIG. 73.—Wilkin's Exposure Meter. Cylindrical form.

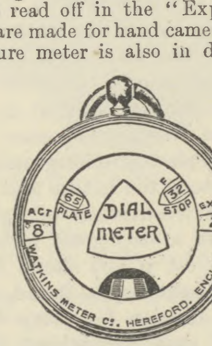


FIG. 74.—Dial Meter.

form, but the sensitive paper is exposed directly, no pendulum is used, and the scales are open on the dial. In use, the glass carrying the movable scale is turned until the actinometer time in seconds upon the exposure scale is opposite the diaphragm number of the plate; the correct exposure will then be found against each stop given on the scale. There are practically only two scales: the scale of diaphragms representing the diaphragm apertures, the speed of plate and the variation of exposure due to subject; and the time scale, representing the actinometer time and the exposure. It is thus very simple. In another smaller form the scales are on the circumference of a locket and the actinometer at the back (Figs. 75 and 76). A "Print meter" is also made for showing the exposures in contact-printing on sensitive papers, but it can also be used for testing speeds of plates and papers. Another form of exposure meter is Decoudun's, in which the exposure is estimated by the disappearance of a series of clear spots on a graduated scale

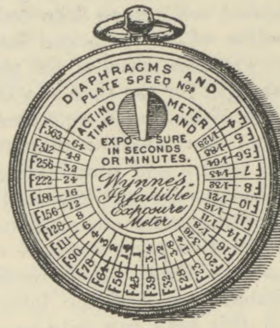


FIG. 75.—Wynne's Exposure Meter (ordinary form).

FIG. 76.—Wynne's Exposure Meter (locket form).

of densities laid on the most important parts of the image as seen on the ground glass. Its indications are not so definite as those given by the instruments noted above, and the scale is liable to change in density after a time. Other simple actinometers are in use for carbon and process printing, and usually consist of a graduated scale of different thicknesses of tissue paper, or coloured gelatine in different densities. Papers are not suitable for making actinometer scales of this kind, on account of their tendency to turn yellow with age; coloured gelatine is better.

Sensitive Plates and Films.

The special feature of modern photography is the use of trustworthy ready-prepared sensitive dry plates and films in different grades of sensitiveness, so that there is no necessity for the photographer to prepare his own plates, nor, indeed, could he do so with any advantage. The practice of outdoor and studio photography has thus been very greatly simplified; and although with wet collodion there was the advantage of seeing the results at once and retaking a picture if necessary, the uncertainties connected with the use of the silver bath and collodion, and the amount of cumbrous apparatus necessary for preparing and developing the plates, far outweighed any advantage. There is also an enormous saving of time, in using dry plates as compared with wet, by deferring development. On the other hand, the uncertainty of more or less random exposures on ready-prepared plates must not be overlooked. Besides their use in taking negatives, gelatine dry plates are also largely used for printing transparencies, lantern slides, enlargements, &c. For negative work the dry plates are prepared with an emulsion in gelatine of silver bromide, alone or with the addition of silver iodide or chloride, and are to be obtained in five or six degrees of rapidity: "slow," for photomechanical or "process" work; "ordinary," for general purposes when quick exposures are not required; "rapid," for landscape and portraits; "extra rapid," for instantaneous exposures; and "double extra rapid," for very quick snapshot work in dull weather or for special subjects. These latter kinds are exceedingly sensitive, and require great care in use to avoid fog. In order to prevent halation, or irregular action by reflection from the back surface of the glass, dry plates are coated with a non-actinic "backing," which can easily be removed before development.

The method of rendering photographic plates isochromatic, or sensitive to all colours, by dyeing them with eosine or other suitable dyes, was noticed in the 9th edition of this work. Colour-sensitive plates of this kind are now largely manufactured and used for the reproduction of paintings, as well as for portraiture, landscapes, and all subjects presenting contrasts of colours which could not be satisfactorily reproduced in their relative luminosities on ordinary plates, which are insensitive to the most luminous, or yellow, rays, and still more so to the red. The manufactured plates are of two kinds: the ordinary isochromatic, sensitive for yellow or yellow-green, and the panchromatic, which are more or less sensitive for red, orange, or yellow, as well as for the green, blue, and violet. To obtain the best results from these plates, it is necessary to use light-filters of yellow or orange glass, or glass cells containing solutions of suitable dyes or salts. For three-colour reproductions by the Sanger Shepherd, Ives, and other processes, special colour-sensitive plates and carefully selected red, green, and violet filters have to be used, and are on the market.

In order to avoid the weight of glass plates, which may become very burdensome on a tour, and also the risk of breakage of valuable records, thin films or sheets of celluloid or hardened gelatine coated with emulsion may be used instead of glass plates, with a great saving in bulk and weight. There is, however, more liability to loss of sensitiveness in gelatino-bromide films coated on celluloid, so they should not be kept too long before exposure; and if they have been kept, should be tested, if possible, before use, and should always be developed soon after exposure. They are generally placed in sheaths, for exposure, in order to keep them flat. In other respects they are treated exactly in the same way as plates.

For some years past sensitive films have been prepared in long strips of different widths suitable for use in hand cameras, particularly of the Kodak type, and in roll-holders. In the early forms of roll-holders the films were used alone, and had to be changed in the dark room, but, as already stated, they are now supplied in cartridges, which can be changed in ordinary diffused light. Silvy, so long ago as 1870, seems to have been the first to employ this method. In these cartridges the film is attached to a much longer strip of black paper and rolled up with it, so that several turns of the paper have to be unrolled before the film is ready for exposure, this point being marked on the outside paper and visible through a red glass at the back of the holder. The different lengths of film for the successive pictures are similarly indicated by numbers; and when all have been exposed, the black paper is rolled on for several turns, and when taken out of the holder the loose end is fastened up till the film is developed. Paper coated with sensitive emulsions has also been used successfully in the same way as the flat or roll celluloid films, and is very much cheaper, but is more liable to change and become insensitive from the action of the air after exposure. Such films should be developed within a short time after exposure; otherwise there is great risk of the impressed image fading and becoming undevelopable. In order to overcome the granular appearance sometimes given by paper negatives, stripping films upon a paper support have been introduced by Messrs Wellington & Ward, in sheets or rolls. Such films have the advantage that they can be printed from either side without perceptible loss of definition, which is very useful in printing by the single transfer carbon process. Flexible films in sheets and rolls have also been prepared upon hardened gelatine, but with these it is difficult to retain the original dimensions of the film, owing to expansion of the gelatine.

Photographic Printing Papers.—*Pari passu* with the supply of ready-prepared plates, facilities for obtaining all kinds of photographic printing papers ready for use have been made available, so that the photographer has now practically nothing to do with the preparation of his plates or papers. The most notable change in recent years is the supersession of albuminized papers by papers coated by machinery with emulsions of silver haloids in gelatine, the chloride being used for most of the printing-out papers, which contain more or less free silver nitrate, while the bromide forms the basis of most of the developable papers used for enlarging and direct copying, which contain no free silver nitrate, and with which the image is brought out by development, much in the same way as with dry plates. Some of the printing-out papers are also made with emulsions of silver salts in collodion. Considerable use is also made of ready-prepared platinotype paper, sensitized with salts of platinum and iron, which can be printed out entirely or only partly printed and developed with potassic oxalate. These prints have the advantage of being permanent, which is also shared by carbon or pigment prints (autotype, &c.), for which tissues, consisting of paper coated with pigmented gelatine, are now available in a great range of colours, as are also similar papers prepared with pigmented gum, instead of gelatine, for the practice of what is known as the "gum bichromate" process. For architects and engineers, cyanotype and ferrogallic papers are prepared in rolls of considerable width for the direct reproduction of tracings and drawings, as blue or black prints by these methods. The manufacture of these different photographic papers has become an important industry in Europe and the United States, as well as in Great Britain.

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(J. WA*.)

III. Pictorial Photography.

Pictorial photography differs from other branches of photographic practice in the motive by which it is prompted. Employing the same methods and tools, it seeks to use photographic processes as a means of personal artistic expression. If a given subject or theme were rendered in the same medium by a Robinson, a Davison, a Holland Day, and a Demachy, the results would differ as much as the respective authors' handwritings. To trace the development during the last quarter of the 19th century of that particular phase or application of photography which, in contradistinction to the scientific and technical, is termed pictorial, is to record in something approaching chronological order the influences which have gradually secured for it the position it now holds, rather than to notice improvements in methods of production, of which, indeed, its advancement is to a great extent independent. The growth of pictorial photography and the multiplication of amateur practitioners of photography generally, may be said to be synchronous. If the term "amateur" is taken to include those who devotedly practise for the satisfaction of their own desires rather than according to prescription and rule at the behests of another, then the two things are to be connected still more closely. At the present time, whether or not they fully understand the thing they are pursuing, by far the larger number of those in Great Britain who practise photography admit that their interest is in the pictorial side of the craft. To write the story of its progress is to show how each advance has been made by those who, in the attempt to realize their own artistic ideals, have had the courage and independence to depart from the traditions and formulæ laid down by those who have brought the mechanical process to a degree of perfection. The technician spends his best efforts on photography as a process, and the elimination of errors and defects is one of his chief aims; the pictorial worker employs the process from choice, merely as a means to an end, and if he can make a "picture" which pleases him, he does not care whether or not, as an example of photographic work, it be of the highest modern or approved type. Thus in the early days of Fox Talbot's calotype, about 1846, David Octavius Hill, a successful Scottish painter, took up this method of portrayal, and, guided by an artist's knowledge and taste, and unfettered by photographic convention, which indeed had then scarcely begun to grow, produced portraits which for genuine pictorial quality have perhaps never been surpassed, especially if some allowance be made for the necessary imperfections of the "Talbotype" (see Plate). Whether they were in their day typical examples of Talbotype with all the latest improvements, Hill probably never cared. When, again, a few years later, Sir William J. Newton, the eminent miniature painter, read a paper before the newly-formed Photographic Society of Great Britain (now the Royal Photographic Society), his recommendation to depart from the custom of defining everything with excessive sharpness caused his address to be almost epoch-making. "I do not conceive it to be necessary or desirable," he said, "for an artist to represent, or aim at, the attainment of every minute detail, but to endeavour at producing a broad and general effect. . . . I do not consider that the whole of the subject should be what is called 'in focus'; on the contrary, I have found in many instances that the object is better obtained by the whole subject being a little out of focus." The doctrine has been persistently repeated ever since, but only within the last decade of the 19th century was the suppression or diffusion of focus received by photographers generally with anything better than ridicule or contempt, because it was unorthodox. O. G. Rejlander, Mrs Julia Margaret Cameron, H. P. Robinson, and others, by precept or practice, strove against such photographic conventions as had arisen out of those technical exigencies to which pictorial qualities were so often sacrificed. As late as 1868, in the *Manual of Photographic Manipulation*, by Lake Price, the old advice to arrange a group of persons in crescent form, so as to adapt the subject to the curve of the field of the lens, was repeated, with the additional recommendation of plotting out on the ground beforehand the "curve of the focus" as a guide. As a defiance to this dictum, Rejlander, in 1869, produced a group of the members of the Solar Club in which some of the chief figures were set widely out of the "curve of the focus." The mere technical difficulties of this performance with wet collodion plates, and in an ordinary upper room, need not be touched upon here, but it is to be noted as one of those triumphant departures from convention which have marked the progressive stages of pictorial photography. At about the same period, Mrs Cameron, carrying the recommendation of "a little out of focus" rather farther, regardless of how her lens was intended to be used by its maker, secured the rendering dictated by her own taste and judgment, with the result that many of her portraits, such as those of Tennyson, Carlyle, &c., are still in their way unsurpassed. Contemporaneously, Adam Salomon, a talented sculptor, "sunned" down the too garish lights of his photographic prints, and strengthened the high lights by working on the back of the negative.

But, during the concluding quarter of the 19th century, probably the most powerful influence in pictorial photography was that of H. P. Robinson, who died in February 1901, and, but for a brief period about the year 1875, was one of the most prolific "picture makers." Inspired by Rejlander, of whom he was a contemporary, Robinson will perhaps be best remembered by his earlier advocacy of combination printing. As early as 1855 Berwick and Annan exhibited a photograph which was the result of printing from more than one negative, a figure from one plate being cunningly introduced into a landscape print from another. Then came from Rejlander "The Two Ways of Life," in which, with wonderful ingenuity, thirty different negatives were combined. Robinson followed, and between 1858 and 1887 exhibited numerous examples of combination-printing, one of the most popular and fairly typical examples being "Carolling" (see Plate), which received a medal in the Exhibition of the Royal Photographic Society in 1887.

Though in this combination-printing one may perhaps perceive the germ of incentive towards the production of special effects not seen in the original, yet the practice was not destined to become very popular, for even in the most capable hands there remains the difficulty, if not impossibility, of fitting a portion of one negative into a print from another and still preserving true relative tonality, and even true proportion. Skilfully produced, eminently popular in character though "Carolling" may be, such errors are not absent. Of this combination-printing Dr P. H. Emerson has said: "Cloud printing is the simplest form of combination-printing, and the only one admissible when we are considering artistic work. Rejlander, however, in the early days of photography, tried to make pictures by combination-printing. This process is really what many of us practised in the nursery, that is, cutting out figures and pasting them into white spaces left for that purpose in the picture-book. With all the care in the world the very best artist living could not do this satisfactorily. Nature is so subtle that it is impossible to do this sort of patchwork and represent her. Even if the greater truths be registered, the lesser truths, still important, cannot be obtained, and the softness of outline is easily lost. The relation of the figure to the landscape can never be truly represented in this manner, for all subtle modelling of the contour of the figure is lost."

Pictorial photography received a large accession of votaries in consequence of the greater facilities offered by the introduction of the gelatino-bromide, or dry-plate, pro-

"Carolling." By H. P. Robinson.

Portrait Study. By James Craig Annan.

Portrait. By David Octavius Hill, R.S.A.

cess, which, although dating from 1880, did not notably affect photographic communities until some years afterwards; and although improvement in appliances and instruments has had little to do with the advance of the pictorial side of photography, yet, indirectly at least, the dry-plate and the platinotype printing process have had an undoubted effect. The former gave enormously increased facility, and dispensed with tedious manipulations and chemical knowledge, while its increased light-sensitiveness decreased the limitations as to subjects and effects. The platinotype process was discovered in 1874–80 by W. Willis, who employed his chemical skill and knowledge to give the world a printing process more likely than the hitherto prevalent silver papers to satisfy artistic requirements.

Up to 1882 but few outdoor photographers had ventured to run counter to the general dictum that photographs should only be taken during sunshine, or good bright light, and unquestioning consent would have been given everywhere to the proposition that it would be absurd to work when anything like fog or atmospheric haze was present. Isochromatic plates, introduced for the purpose of equalizing the actinic power of various colour luminosities, and so rendering colours in correct relative value, were recommended by one writer, who applauded their supposed advantage of enabling the photographer to photograph distance without any suggestion of atmosphere. That evening or morning haze might enhance the beauty of a landscape, or that the mystery of half-concealment might itself be beautiful, does not seem to have occurred to the photographer, who had become infatuated by the exquisite clearness and sharpness which, with a minimum of labour, he was able to achieve. It is therefore interesting to note one of the first photographic successes which broke away from this convention, just as Rejlander's Solar Club group defied the formula of arranging human figures like the tiers of an amphitheatre. William M'Leish, of Darlington, a Scottish gardener who had taken to photography, and who seems to have been less under the influence, or it may have been that he was ignorant, of the old *dicta*, sent to the Royal Photographic Society's Exhibition in 1882 a photograph entitled "Misty Morning on the Wear," a very beautiful view of Durham Cathedral as seen through the mist from across the river. The judges, although they that year awarded eleven medals, passed this by; but appreciation came from outside, for newspaper critics, and practically all those who were not blinded by prejudice and conventionality, declared it to be *the* photograph of the year. Thenceforward the landscape photographer cast aside the old doctrine, and began to learn that there was such a thing as atmosphere, and that it was not undesirable even when enveloping the chief features in the view. The exhibitions immediately succeeding revealed numerous imitators of M'Leish, and both figure and landscape work began to be shown in which there was evidence of greater freedom and originality.

Meanwhile the Photographic Society of Great Britain had drifted away from its artistic starting-point, and had become chiefly absorbed in purely scientific and technical subjects. But the general apathy which existed in respect of the artistic aspirations of some workers was the forerunner of a period of renaissance which was to end in lifting the pictorial side of photography into a greatly improved position. In 1886 Dr P. H. Emerson read before the Camera Club a paper on "Naturalistic Photography," which served as an introduction to the publication (1887) of his book under that title. Unquestionably this book struck a powerful blow at the many conventionalities which had grown up in the practice of photography, the chief doctrines set forth being the differentiation of focus in different planes, a more complete recognition and truer rendering of "tone," a kind of truthful impressionism derived from a close study and general acquaintance of nature, and a generally higher and more intellectual standard. After the publication of a second edition in 1889, Dr Emerson publicly renounced the views he had published, by issuing in January of 1891 a bitterly-worded, black-bordered pamphlet, entitled *The Death of Naturalistic Photography*. But the thoughts which the book had stirred were not to be stilled by its withdrawal. Towards the end of the same year the conflict which within the Photographic Society had become apparent as between the pictorial enthusiasts and the older school, culminated in connexion with some matters respecting the hanging of certain photographs at the exhibition of that year, and a number of prominent members resigned their membership as a protest against the lack of sympathy and the insufficient manner in which pictorial work was represented and encouraged. This secession was to prove the most important event in the history of that branch of photography. The secessionists being among the most popular contributors to the annual exhibition, gathered round them numerous sympathizers. In the following year they formed themselves into a brotherhood called "The Linked Ring," and in 1893 held their first "Photographic Salon," at the Dudley Gallery, Piccadilly. This has since been held annually, exclusively for the public exhibition of such photographs as in the opinion of the responsible committee give evidence of personal artistic feeling. The most noteworthy of the early adherents attracted to the new body was James Craig Annan, whose work was practically unknown until he exhibited it at the first Salon, and almost at once he, by general consent, took a position amongst pictorial photographers second to none (see Plate).

Aroused into greater activity by these events, the Royal Photographic Society began to pay more attention to what had now become the more popular phase. At subsequent exhibitions the technical and scientific work was hung separately from the "Art Section," and a separate set of judges was elected for each section. It became the custom to allot by far the greater amount of space to the "artistic"; and later, artists were elected as judges, by way of encouraging those who were devoted to the pictorial side to send in for exhibition. In the autumn of 1900 the New Gallery was secured, and a comprehensive exhibition of all phases of photography was held; and the experiment proving successful, it was repeated in the following year.

It is interesting to note that as a distinct movement pictorial photography is essentially of British origin, and this is shown by the very gratifying manner in which organized photographic bodies in Vienna, Brussels, Paris, St Petersburg, Florence, and other European cities, as well as in Philadelphia, Chicago, &c., following the example of London, have held exhibitions on exactly similar lines to those of the London Photographic Salon, and have invited known British exhibitors to contribute. The international character of the "Linked Ring" encouraged an interchange of works between British and foreign exhibitors, with the result that the productions of certain French, Austrian, and American photographers are perfectly familiar in Great Britain. This, in the year 1900, led to a very remarkable cult calling itself "The New American School," which has been very widely exploited in England. The prints have a certain generic similarity, but are the work of some forty or fifty photographers in the United States of America. In their total disregard of the qualities which even the least conventional person is accustomed to expect in a photograph, the extreme seems to have been reached, and this, moreover, in the nature of the subjects chosen, as well as in the composition adopted. It is a question whether, in the suppression of detail, in the toning down of contrasts, and in the attempt to invest the photographic "picture" with a mystery that may appeal to the spectator by mere suggestion rather than by representation, some of the American works contain sufficient to inspire imagination. Nevertheless, the intense earnestness and serious purpose which pervade the whole as a class, command respect. Moreover, if the doctrine of the "artist-photographer" be true, there are present in the "New American School" the very conditions which should lead it to mark a period and an advance. Many of its members are trained painters and successful art students, who have taken up photography not as an aid to art work, but as an independent means of possible artistic expression; as a consequence, they have employed photographic means with entire indifference to the instructions of the chemist and the rules of the technical expert. That the "New American School" has had a powerful influence on contemporaries in Great Britain there are already clear indications.

In this review of the principal successive influences which have been brought to bear upon and have built up the pictorial photography of to-day, we have now reached the close of the 19th century, and it may be well to glance at such improvements of process or apparatus as have not been direct and essential means to pictorial advance, but rather modifications and improvements made in response to the requirements of the artistic aspirant. Such improvements are of two orders—those which are devised with the aim of securing greater accuracy of delineation, the correction of distortion and of apparent exaggeration of perspective, and the more truthful rendering of relative values and tones; and those which seek to give the operator greater personal control over the finished result. While during the past few years great advances have been made in photographic optics, it cannot be said that pictorial work has been thereby materially assisted, some of the most successful exponents preferring to use the simplest form of uncorrected objective, or even to dispense with the lens altogether, choosing rather to employ a minute aperture, technically called a "pinhole." This is but one example of many which might be quoted to bear out the statement, that in photography the advance of anything in the nature of artistic qualities has not been correlative with mechanical improvements. The hand camera can only be said to have had an indirect influence: it has increased the photographer's facilities, and by removing the encumbrance of heavy tools has widened his sphere of operations; but it is perhaps in connexion with the plates and printing processes that more direct advantages have been gained. The fact that the actinic power of colours is not proportional to their luminosity, was long regretted as an obstacle to correct representation, but by the introduction of orthochromatic or isochromatic plates in 1886 (when B. J. Edwards bought the Tailfer and Clayton patent, under which he shortly brought out his orthochromatic plates) this original disability was removed, while with increased rapidity in the isochromatic plate colour values may still further be corrected by the use of coloured screens or light filters, without interfering with the practicability of making sufficiently rapid exposures for most subjects. Again, by a better knowledge of what is required in artistic representation, certain modifications in the formulated treatment of ordinary and uncorrected plates are found to do much towards removing the evil; hence, with an ordinary plate "backed" so as to counteract over-exposure of the higher lights, an exposure may, except in extreme cases, be given of length sufficient to secure the feeble rays of the less actinic colours, and by subsequent suitable development a result hardly distinguishable from that of a colour-corrected plate may be secured. Chemical experiment has placed in the photographer's hands improved and easier means of entire, unequal, and local intensification and reduction, but utility of these is restricted. By the artistic worker it is claimed that the lens and camera are but the tools, and the negative the preliminary sketch or study, the final print standing to him in the same relation as the finished painting does to the artist. In the production of the print various means of personally controlling the formation of the image have been resorted to. Thus the local development of platinotype by means of glycerine has its champions, but it seems to have been little used, its resuscitation being chiefly due to two or three prominent workers in New York. Here should also be mentioned the revival in 1898 of rough-surface printing papers, chiefly those sensitized with silver, the roughest texture drawing papers being employed to break up the excessive sharpness of the photographic image, and by the superficial inequalities introducing the effect of luminousness to over-dark shadows and variety to blank whites. The almost forgotten process of Pouncy, and of Poitevin, now known as the gum bichromate process, was rehabilitated in 1894 by M. Rouille Ladeveze expressly to meet the needs of the pictorial worker. Perhaps the best results that have been achieved by it are those of M. Robert Demachy of Paris, though many English workers have used it with remarkable success. In it paper of any kind may be selected as the support. The power of the operator to modify the printed image to almost any extent, even to introducing and eliminating lights and shadows, and in other ways to depart widely from the image given by the negative, depends upon the fact that the coating of gum and pigment (which, being bichromatized, becomes insoluble in proportion as it is acted upon by light) holds the pigment but imperfectly, and yields it up upon a vigorous application of water. According, therefore, to its application or retention, the operator can lighten or deepen in tone any portion. Numberless variations of other methods, such as brush development and local toning or stopping, have been suggested with the same object. Other workers have shown that by dexterously shutting off and admitting the light to various parts of the negative whilst printing, the disposition of the lights and shades in the print can be modified to so great an extent as to alter the general contour of the scene. Examples of an original unaltered print, and one which has been thus modified, are shown in the accompanying Plate. Portions are shaded in by allowing the light to have access to the print, either through the negative—in which case the image, with all its details, prints more deeply—or by removing the negative, when the action of the light is to flatten and suppress both detail and contrast. Such a course opens up innumerable possibilities whereby contrasts may be intensified, shadows made light, and light areas shaded down. Latterly some few have resorted to extensive working on the negative, both on the back and on the film; drawing by hand is practised on the film to render too prominent features less obtrusive, and objects in the background are merged by an intricacy of lines and cross-hatching. Many of the results are very pleasing, although one hesitates to justify the means, however good the end. On the other hand, to exclaim for purity of method and the exclusion of extraneous aids is very like setting up an arbitrary standard no less unreasonable than those conventions against which pictorial photography has so long striven.

AUTHORITIES.—P. H. EMERSON. *Naturalistic Photography.* —H. P. ROBINSON. *Picture-making by Photography; Art Photography; Pictorial Effect in Photography; Elements of a Pictorial Photograph.*—A. H. WALL. *Artistic Landscape Photography,*

LANDSCAPE. By A. HORSLEY HINTON.

(The right-hand printing is from the same negative, but with the action of the light controlled.)

1896.—H. HORSLEY HINTON. *Practical Pictorial Photography*, 1898, and subsequent editions.—C. PUYO. *Notes sur la Photographie Artistique*, Paris. (A. H. H.)

Photogravure. See PROCESS; also ENGRAVING (MEZZOTINT).

Photometry, Stellar.—In the earlier volumes (ninth edition) of this Encyclopædia was an article on PHOTOMETRY, CELESTIAL, which gives an adequate sketch of the history of stellar photometry down to about 1885. The three modern forms of instrument for measuring the *visual* brightnesses of the stars, there briefly described, may be called Zöllner's photometer, Pickering's meridian photometer, and Pritchard's wedge photometer. It is mentioned in a footnote that extensive catalogues of stellar brightnesses or "magnitudes" had just been published by Professor E. C. Pickering of Harvard, using the second of the above instruments, and by Professor Pritchard of Oxford, using the third; but as regards the first form it is stated in the text that "this ingenious form of photometer has enjoyed considerable reputation, but no astronomer has yet persevered in producing a complete 'uranometria' by its aid." This omission has since been repaired by the labours of the late E. Lindemann of the Pulkowa Observatory (*Photometrische Bestimmung der Grössenclassen der Bonner Durchmusterung*. St Petersburg, 1889), and by a more extended work at the Potsdam Observatory by Müller and Kempf (see *Public. Potsdam Observ.*, vols. ix. and xiii.). No mention is made in the article of photographic photometry, for the reason that such work had at that time scarcely been begun, or at any rate had attracted very little attention. There is also a third method by which a star's radiance may be assessed, by measuring the amount of heat, or more properly, energy, which it conveys; and though the delicate apparatus of Mr C. V. Boys (*Proc. Roy. Soc.* April 1890) has furnished us so far with a negative result, even this is of considerable importance. In the present supplementary article it is proposed to describe rather more fully the three visual photometers mentioned above, to summarize what has been done in photographic photometry and with the "radio-micrometer," and to give a brief discussion of the effect of "colour" on all such determinations.

Pickering's meridian photometer.

Pickering's meridian photometer (see *Ann. Astron. Obs. Harv.*, vols. xiv. and xxiii.) consists of two telescopes placed side by side pointing due east, the light from stars on the meridian being reflected into them by two mirrors inclined at an angle of 45° to this direction. If there were a star exactly at the Pole, one of these mirrors would be absolutely fixed and would constantly reflect the light of this star down the axis of its telescope; in practice a slight motion can be given to the mirror so as to keep in view the polar star selected, whether Polaris, with which the brighter stars were compared, or λ Ursæ Minoris, which was used for fainter stars. The second mirror (which projects a little beyond the first so as to get an unobstructed view of the meridian) can be rotated round the axis of the telescope by means of a toothed-wheel gearing, and can thus be made to reflect any star on the meridian down the second telescope; it is also provided with a small motion in the perpendicular direction, so as to command a degree or two on each side of the meridian. Near the common eyepiece of the telescopes there is a double image prism which separates the light received from each into two pencils; the pencil of ordinary rays from one object-glass is made to coincide with that of extraordinary rays from the other, and the two remaining pencils are excluded by a stop. The two coincident pencils then pass through a Nicol prism to the eye of the observer, who by rotating the prism round its axis can equalize them at a definite reading depending on their relative intensities. This reading gives in fact the difference of magnitude between the two stars selected for comparison. It may be remarked that the position of the double image prism is important. It should be just *within*, not *at*, the common focus: this position prevents any noticeable colour in the images, and gives the ordinary and extraordinary pencils a sufficient separation at the eye-stop to permit the entire exclusion of one without the loss of any part of the other. If the prism were exactly at the focus, and any part of the superfluous images were admitted, the resulting secondary images would coincide with the others and thus lead to errors in observing. But in the actual construction of the instrument the secondary images would appear, if at all, only as additional stars near those under observation, and too faint to produce any inconvenience. It is worthy of note that Professor Pickering has extended his survey into the southern hemisphere, so that the Harvard photometry is the most complete of all. Each observation consists of four comparisons; after the first two the observer reverses the position of the star images in the field, and also reverses the double-image prism. The former precaution is necessary in order to eliminate a curious error depending on the relative position of the images, which may amount to several tenths of a magnitude. Errors of this kind affect *all* estimations of the relative brightness of two stars in the same field, as has been repeatedly shown; a striking instance is given by Mr A. W. Roberts of Lovedale, South Africa (*Mon. Not. R.A.S.*, April 1897), who found that his eye-estimations of the brightness of variable stars required a correction depending on the position-angle of the comparison star ranging over nearly two magnitudes.

Zollner's photometer.

In Zöllner's instrument an artificial star is taken as the standard of comparison. There is only one telescope, and inside the tube near the eye end is a plate of glass placed at an angle of 45° with the axis, so that the rays from a lamp which enter the tube from the side are reflected down the tube to the eyepiece, while the light from the star passes through the plate unobstructed. The lamplight passes through a Nicol prism and a plate of rock crystal, which give control over the colour; through two Nicols which can be rotated round the axis of the beam to definite positions read off on a graduated circle; and then through a convex lens which forms an image reflected by the glass plate to focus alongside the star. The whole of this apparatus is carried in a compact form on the eye end of the telescope, it being arranged that the lamp shall always stand upright. The measures are made by rotating the Nicols until the brightness of the artificial star is equal to that of the star viewed through the object-glass, and reading the graduated circle.

The wedge photometer.

With regard to Pritchard's wedge photometer, the principle of which was sufficiently described in the *Ency. Brit.*, vol. xviii. p. 841, two material improvements suggested by Dr E. J. Spitta are worthy of notice. The first (*Proc. Roy. Soc.*, Dec. 1889) corrects a slight defect in the form of the instrument. If a pencil of rays passes through a thin wedge of tinted glass, the rays do not all pass through the same thickness of glass. Dr Spitta proposes to substitute a pair of wedges with their thicknesses increasing in opposite directions. By sliding one over the other we obtain a parallel plate of glass of varying thickness, and a uniform beam of light of sensible dimensions can then be extinguished satisfactorily. He has also pointed out a source of error in the method of "evaluating" the wedge and shown how to correct it. The scale value was determined by Professor Pritchard by the use of a doubly refracting prism of quartz and a Nicol prism. Using this method subsequently, Dr Spitta found that internal reflections within the Nicol prism interfered with the accuracy of the result, but that this error could be eliminated by using a suitable diaphragm (see *Mon. Not. R.A.S.*, March 1890; Abney, *Ibid.*, June 1890).

The Purkinje phenomenon.

Since 1885 systematic catalogues of stellar brightness have been constructed with all these instruments, and it has been of great interest to compare the results. The comparison has in general shown a satisfactory agreement, but there are small differences which are almost certainly systematic, due to the difference of method and instrument. One cause of such differences, the reality of which is undoubted, but the effects of which have as yet not been perhaps fully worked out, is the "Purkinje phenomenon" (*Pflüger's Archiv*, vol. lxx. p. 297, and *Psychol. Rev.*, vols. v. and vi.). If a blue source of light and a red source appear equally bright to the eye, and if the intensity of each be diminished in the same ratio, they will no longer appear equally bright, the blue now appearing the brighter; in more general terms, the equalizing of two differently coloured lights by the eye depends upon their intensity. It is clear that this phenomenon must affect all photometric work unless the stars are all exactly of the same colour, which we know they are not. For let us suppose that both the comparison star of the meridian photometer and the artificial star of the Zöllner photometer were equalized with a bright star A, and that they could be also compared *inter se* and found equally bright. Then when a faint star B comes under observation and the intensities of the comparison stars are both reduced to equality with B, they will no longer appear equal to one another unless they are exactly the same in colour. In other words, the observed ratio of intensities of A and B will vary with the colour of the comparison star, and similarly it will also vary with the aperture of the telescope employed. To allow for this variation by direct observation would entail a large amount of work which is yet to be undertaken—the exact evaluation of the colours of stars (or at least of the comparison stars) and the effect on the eye with different intensities. It is not impossible to undertake such a detailed investigation, and so calculate the differences between the two methods, but it would be extremely laborious, and we rather look to observed differences between the results to indicate the magnitude of these effects, the general nature of which is well understood.

One complete set of numerical results has, however, been obtained by Sir W. Abney (*Proc. Roy. Soc.*, May 1891, and *Mon. Not. R.A.S.*, April 1892), viz., the limiting intensity at which each pure colour vanishes. If we start with lights C D E F G of the colours usually denoted by these letters in the spectrum, and each so bright that it appears *to the eye* as bright as an amyl-acetate lamp at 1 foot, and if then the intensity of each be gradually diminished, the C light will disappear when the original intensity has been reduced to 22,000 ten-millionths of the original value. The other colours will disappear at the following intensities, all expressed in ten-millionths of the original: D at 350, E at 35, F at 17, and G at 15. If then we had a mixture of two lights, one of C colour as bright as before, and the other of G colour 1000 times fainter (a combination in which the eye would be unable to distinguish the G light at all), and if we continually reduced the combined intensity, the luminosity of the C light would diminish so much more rapidly than that of the G that the latter would begin to assert itself, and when the combined intensities were reduced to 22,000 ten-millionths of the original value, the C light would have all disappeared, while the G light would not. Hence the colour of the light would appear pure violet, though it was originally deep red. This extreme case shows that the "last ray to disappear" when a light is gradually extinguished may be very different in colour from that of the original light, and when more usual light-mixtures are considered, such as those of sunlight and starlight, which appear nearly white to the eye, the "last ray to disappear" is found to be in the green, very near E in the spectrum. This result has two important bearings on the use of the wedge photometer. In the first place, either the wedge itself should be of a greenish hue, or green light should be used in finding the scale-value (the constant B in the formula $m = A + Bw$). In the second, star magnitudes obtained by extinction with the wedge will agree better with those obtained by photography than those obtained with other visual photometers, since photographic action is chiefly produced by rays from E to G in the spectrum, and the E light of ultimate importance with the wedge photometer is nearer this light in character than the D light with which other photometers are chiefly concerned. It would also appear that results obtained with the wedge photometer are independent of the aperture of telescope employed, which is not the case with other photometers.

Passing now to the consideration of photographic methods, it is found that when a plate is exposed to the stars, the images of the brighter stars are larger and blacker than those of the fainter ones, and as the exposure is prolonged the increase in size and blackness continues. Much of the light is brought to an accurate focus, but, owing to the impossibility of perfect achromatism in the case of refractors, and to uncorrected aberration, diffraction, and possibly a slight diffusion in both refractors and reflectors, there are rays which do not come to accurate focus, grouped in rings of intensity gradually diminishing outwards from the focus. As the brightness of the star increases, or as the time of exposure is prolonged, outer and fainter rings make their impression on the plate, while the impression on the inner rings becomes deeper. Hence the increase in both diameter and blackness of the star discs. As these increase concurrently, we can estimate the magnitude of the star by noting either the increase in diameter or in blackness, or in both. There is consequently a variety in the methods proposed for determining star magnitudes by photography. But before considering these different methods, there is one point affecting them all which is of fundamental importance. In photography a new variable comes in which does not affect eye-observations, viz., the time of exposure, and it is necessary to consider how to make due allowance for it. There is a simple law which is true in the case of bright lights and rapid plates, that by doubling the exposure the same photographic effect is produced as by increasing the intensity of a source of light twofold, and so far as this law holds it gives us a simple method of comparing magnitudes. Unfortunately this law breaks down for faint lights. Sir W. Abney, who had been a vigorous advocate for the complete accuracy of this law up till 1893, in that year read a paper to the Royal Society on the failure of the law, finding that it fails when exposures to an amyl-acetate lamp at 1 foot are reduced to $0^s{\cdot}001$, and "signally fails" for feeble intensities of light; indeed, it seems possible that there is a limiting intensity beyond which *no* length of exposure would produce any sensible effect. This was bad news for astronomers who have to deal with faint lights, for a simple law of this kind would have been of great value in the complex department of photometry. It is satisfactory to know that the law holds in certain important cases. The Astronomer Royal found in 1892 (*Mon. Not. R.A.S.*, January 1892) that it was sensibly correct for stars to the eleventh magnitude photographed according to the methods adopted for the International Astrographic Chart, although Dr Scheiner of Potsdam had previously found a very serious deviation in a similar case. Just where it begins to fail seems to be dependent on a variety of circumstances. Sir W. Abney has remarked that it is important not to use bromide plates, for instance, and there is no doubt that caution must be exercised in applying the law to the faintest star images on a plate—those just discernible as discolorations of the film. But with plenty of light (*i.e.*, a large telescope) and a rapid plate we should be able to compare the magnitudes of two stars by the ratio of the exposures required to give similar images both in size and blackness. If the approximate ratio is known, we may obtain the exact ratio by varying the exposure of one star slightly, and noting which of the series most closely resembles the other star.

Photographic photometry.

But there are many cases where it is inconvenient to give more than one exposure to a field of stars, and the question arises how to compare their magnitudes from their size or (and) blackness on a photographic plate. The easiest quantity to measure is the diameter of the image, and when measurements of position are being made with a micrometer, it is a simple matter to record the diameter as well, in spite of the indefiniteness of the border. Accordingly we find that various laws have been proposed for representing the magnitude of a star by the diameter of its image, though

Diameter as test of magnitude.

these have usually been expressed, as a preliminary, as relations between the diameter and time of exposure. Thus Bond found the diameter to increase as the square of the exposure, Turner as the cube, Pritchard as the fourth power, while Christie has found the law that the diameter varies as the square of the logarithm of the exposure within certain limits. There is clearly no universal law—it varies with the instrument and the plate—but for a given instrument and plate an empirical law may be deduced. Or, without deducing any law at all, a series of images may be produced of stars of known brightness and known exposures, and, using this as a scale of reference, the magnitudes of other images may be inferred by interpolation. A most important piece of systematic work has been carried out by the measurement of diameters in the Cape Photographic Durchmusterung (*Ann. Cape Obser.*, vols. iii. and iv.) of stars to the tenth magnitude in the southern hemisphere. The measurements were made by Professor Kapteyn of Gröningen, on photographs taken at the Cape of Good Hope Observatory; he adopts as his purely empirical formula

$$mag = \frac{B}{\text{diameter} + C}$$

where B and C are obtained independently for every plate, from comparison with visual magnitudes. C varies from 10 to 28, and B from 90 to 260. The part of the sky photographed was found to have an important bearing on the value of these constants, and it was in the course of this work that Kapteyn found a systematic difference between stars near the Milky Way and those far from it, which may be briefly expressed in the law, *the stars of the Milky Way are in general bluer than the stars in other regions of the sky.* It is intended, however, in the present article to discuss methods rather than results, and we cannot here further notice this most interesting discovery.

Of methods which choose the blackness of the image rather than the diameter for measurement, the most interesting is that initiated independently by Pickering at Harvard and Schwarzschild at Vienna, which consists in taking star images considerably out of focus. The result is that these images no longer vary appreciably in size, but only in blackness or density; and that this gradation of density is recognizable through a wide range of magnitudes. On a plate taken in good focus in the ordinary way there is a gradation of the same kind for the faintest stars; the smallest images are all of approximately the same size, but vary in tone from grey to black. But once the image becomes black it increases in size, and the change in density is not easy to follow. The images-out-of-focus method seems very promising, to judge by the published results of Dr Schwarzschild, who used a prepared comparison scale of densities, and interpolated for any given star from it. The most satisfactory photographic method would certainly be to take account of both size and blackness, *i.e.*, to measure the total deposit in the film; as, for instance, by interposing the whole image in a given beam of light, and measuring the diminution of the beam caused by the obstruction. But no considerable piece of work has as yet been attempted on these lines.

Images out of focus.

Although rather outside the domain of photometry, strictly so called, a word or two may be said here about the "radio-micrometer" of Mr C. V. Boys. This is an extremely delicate instrument for measuring radiant heat, which consists of a very light thermo-electric circuit (two tiny bars of antimony and bismuth soldered together at one edge, the outer edges being connected by a hoop of copper wire) suspended by a quartz fibre (a torsion fibre of the very greatest sensitiveness) in a strong magnetic field. A minute quantity of radiant heat falling on one of the junctions of the circuit sets up a current in the circuit, which thus rotates in the magnetic field until brought to rest by the torsion of the fibre. For use on the heavenly bodies the radiant heat is collected to focus by a reflecting telescope (an object-glass would absorb it), and when the telescope is pointed to the moon the varying radiation from different parts of the disc is beautifully shown. No heat comes from the unlit portion, and of the illuminated portion the maximum is obtained from near the limb. But when pointed to the brightest stars no indications are obtained, although the instrument is sensitive enough to detect the heat from a candle more than a mile off. It seems certain that indications of heat from the stars obtained by previous observers must be spurious. We may place alongside this result that obtained by Mr W. J. Dibdin (*Proc. Roy. Soc.*, April 1892), who compared candle-light with twenty-one stars ranging to the sixth magnitude, and found the light of a second magnitude star equal to that of ·0075 of a candle at 109 feet, or of a whole candle at 1260 feet.

No heat from the stars.

The whole domain of stellar photometry has increased in importance and in activity so rapidly since 1885 that much has necessarily been omitted in this sketch. As an instance of new applications of its methods, we may quote the systematic observations of the eclipses of Jupiter's satellites by Pickering at Harvard. Instead of merely noting the instant of disappearance or reappearance of the satellite, he has organized a regular series of measurements of the diminution of its light, both by visual and photographic observations. The result has been to determine the moment of disappearance with greatly increased accuracy; some of the observations were placed in the hands of Prof. Sampson of Durham, who is of opinion that they will afford sufficient material for forming new and improved tables of Jupiter's satellites. The photometric work done at the Harvard Observatory alone since 1885 probably far exceeds all that was done previously. As an instance again of the novelty of results now being obtained, attention may be called to the fact, discovered also at Harvard, that in certain clusters there are numerous variable stars. In the cluster M_5, for instance, Mr S. I. Bailey finds that about eighty-five stars are variable, and that their variations show a striking similarity (*Astrophys. Journ.*, November 1899). Each goes through its cycle in about twelve hours; each begins by a gradual diminution of light, remains at half brightness for a time, and then suddenly springs back to maximum again. We seem to be only beginning to understand the vast scope of photometric work. (H. H. T.)

Phrenology.—Gall's great work on phrenology (see the earlier volumes of this Encyclopædia, ninth ed.) contains a very considerable number of clinical and pathological observations that are of some value, though his deductive reasoning has failed to stand the test of time; and an attempt has lately been made to bring phrenology back into good repute, and to show that Gall's doctrines are confirmed by the modern physiological and pathological facts concerning cerebral localization. This attempt to advance phrenology to the level of the natural sciences may be studied in the volume published in 1901 by Dr Bernard Holländer, entitled *The Mental Functions of the Brain*, and bearing as a sub-title *The Revival of Phrenology.* Two chief doctrines are involved in the acceptance of phrenology, in the ordinary sense of the word. They are: i. That the outer table of the skull is so finely and accurately modelled to the surface of the brain that it is an exact copy of that surface. ii. That the grey matter on the surface of the brain is divided into thirty or more departmental regions, corresponding to certain universal habits, passions, propensities, and the like activities of consciousness. The first of these doctrines, the old belief in craniology and in "bumps," is lightly passed over by Dr Holländer. It stands in the way of every attempt to make phrenology an exact science. The varying thicknesses of different skulls, and of the same skull in its different parts, the existence of air-spaces in the frontal bone, and the mere features of the skull, which may fairly be called matters of chance, offer a fatal objection to popular phrenology; and Dr Holländer's purpose is not, primarily, to uphold popular phrenology, but to bring Gall's clinical and pathological instances into line with more modern observations. He deprecates the craniology of Gall, and honours him, with justice, as an admirable and dexterous anatomist; he calls attention to many carefully recorded clinical and pathological facts that are scattered through Gall's writings and are worth saving out of the wreck of his system; and he endeavours, by this method, to establish an unbroken connexion between phrenology, in the Greek sense, and our present knowledge of cerebral localization.

The substance of Holländer's work is of two kinds. The one kind is a tabulated statement of many hundred cases of different forms of mania, with injury or disease limited to one portion of the brain; the other kind is a tabulated statement of cases of injury or disease of the brain, followed by perversion, or exaltation, or loss of some definite instinct or faculty of consciousness.

He divides the tabulated cases of mania into three groups: i. Melancholia; ii. Irascible Insanity, "Mania Furiosa"; iii. Mania with suspicion and delusions of persecution. For these three groups of cases he lays down the following rules: i. Melancholia is especially associated with injury or disease of the parietal lobe of the brain, more particularly with injury or disease of the convolutions underlying the parietal eminences of the skull, *i.e.*, the supramarginal and angular convolutions. ii. Mania Furiosa is especially associated with injury or disease of the central portion of the temporal lobe. iii. Mania with suspicion and delusions of persecution is especially associated with injury or disease of the posterior portion of the temporal lobe.

The second kind of cases, where injury or disease of the brain, strictly localized to one part or another of its grey matter, was followed by perversion, exaltation, or loss of some one instinct, habit, or faculty, includes cases of kleptomania, cases of voracious hunger and thirst, cases of sexual desire exalted or lost, and cases of loss of certain special memories, as of words, tunes, numbers, and the like.

These two collections of recorded cases, taken from a vast mass of clinical and pathological literature accumulated during the past century, have been arranged by Dr Holländer with great industry; and they clearly express his purpose to extend the limits of the study of cerebral localization, and to advance it from the observation of the motor areas and the special sense centres to the observation of the higher acts and states of consciousness. This, we may be sure, is the tendency of all modern researches into the working of the central nervous system: to seek a higher level of interpretation, and a statement of the departmental life of the brain in terms of ever-increasing complexity. Physiology, from its objective point of view, is engaged over finer and finer issues of microscopic and experimental work; and, from its subjective point of view, is becoming more and more psychological. The motor centres, governing the voluntary purposeful movements of the body, are not simply motor, but "psycho-motor"; the speech-centres are not homogeneous, but are differentiated into sub-centres for the utterance of words, the recognition of words, and the understanding of words; the visual centres are in like manner subdivided according to the consciousness involved in the complete act of vision. There is room, therefore, for a "higher phrenology," if it can show clear evidence in favour of the localization, in determinate regions of the brain, of the physical changes accompanying certain states of consciousness.

Of the two kinds of cases that Dr Holländer has tabulated, it cannot be said that the cases of mania are convincing. Some of them are altogether beside the mark; *e.g.*, he quotes two cases of melancholia, after an injury over the left parietal bone, which were cured by an operation limited to the scalp (excision of a painful scar, removal of a small nerve-tumour of the scalp); in neither case was anything done to the skull or to the brain, but both patients were cured of their melancholy. Again, the acceptance of these rules as to the localization of these insane thoughts involves the localization of sane thoughts in the same areas of the brain, and this in turn involves assumptions that are wholly unwarranted by our present knowledge. Moreover, cases of mania are so common that it might be possible to find an equal number of cases to controvert his rules: we want *consecutive*, not *picked* cases. If 5000 consecutive fatal cases of these different kinds of mania, with the *post-mortem* record of each case, were tabulated, we should then begin to stand on surer ground. Again, though Dr Holländer seems to argue well, where he says that the facial and other movements, induced by direct electrical stimulation of certain convolutions, are such as express the mental states which he attributes to those convolutions, yet this argument is insecure, partly because Sherrington's recent work, on the motor area of the anthropoid apes, has rendered it necessary to reconsider the present localization of the motor area in man, and partly because the interpretation of facial and muscular movements as representing this or that state of the emotions is always in danger of fallacy. Altogether, these doctrines as to the cerebral areas involved in the chief forms of mania fail of their effect. They suggest many subjects worthy of consideration and of future study, but they make no solid contribution to physiology.

The second kind of cases, where injury or disease limited to one portion of the brain is followed by perversion, exaltation, or loss of some special instinct or habit, is more valuable and more convincing; especially the cases of voracious hunger and thirst, those of true kleptomania, and those of the loss of certain special memories. It is not so easy to believe that the cerebellum is in any primary way associated with sexual desire: its position, its structure, and its proved association with the co-ordination of muscular movements, seem clearly to indicate that its work is wholly subordinate and complementary to the work of the cerebral hemispheres; and the evidence adduced in favour of its being the "seat" of the sexual impulses hardly amounts to more than a probability that it may transmit or co-ordinate the performance of the sexual act.

We come to this conclusion, that phrenology is seeking to rehabilitate itself by an alliance with physiology; and that it is encouraged to take this step by the fact that physiology, in its interpretation of the central nervous system, is becoming more and more psychological. The old idea, that the brain "moves as a whole," has passed away; and the principles of cerebral localization are, after all, only a scientific statement of matters that are of general belief. We are all more or less phrenologists. Every time that a man apologizes for this or that defect in his mind, and for his "curta supellex," he appeals to a purely local weakness of his brain. "I have no ear for music—I have no memory for dates"—these common excuses are direct appeals to the doctrine of the differentiation of the work of the brain. And, as though it were to justify these appeals, physiology is beginning to feel its way forward from the localization of muscular movements and special sense-centres to the localization of the simpler faculties and instincts: working, not as Gall worked, by deduction and guess, but by induction; yet it may find a use for the clinical and pathological facts that are worth rescuing from the downfall of Gall's phrenological system.

Phylloxera, a genus of insects belonging to the family of Aphidæ, or Plant-lice, in the order Homopterous Hemiptera. It is chiefly known from the causal relation of one of its species to the most serious of vine-diseases. The name (Gr. φύλλον ξηρόν) was first given in 1834 to a plant-louse which was observed to "dry up the leaves" of oaks in Provence. About twenty-seven species are now known, all characterized by length not exceeding ·06 of an inch, flat wings, three articulations in the antennæ, one or two articulations in the tarses, with digitules, but without cornicles on the abdomen. A full description of the only species which attacks the vine, the *Phylloxera vastatrix*, or grape-louse, will be found in the earlier volumes of this Encyclopædia (ninth edition, vol. xxiv. p. 239).

The insect has a curious life-history, which may here be briefly repeated. It first appears as a minute louse (about $\frac{1}{30}$ inch in diameter) which lives on the roots of the vine. These root-forms are all parthenogenetic females, and spend their short life in sucking the juices of the vine and laying eggs, which hatch into similar forms, each of which attaches itself to the root in a suitable spot and proceeds to lay eggs. They are so prolific that a single individual might have twenty-five million descendants in six months. As the summer advances, some of the eggs of the root-forms give birth to winged females, which are capable of transporting the disease by flight over distances of many miles.

These winged females—still parthenogenetic—lay eggs which produce wingless males and females. Their brief life is wholly devoted to sexual reproduction, whereby new vitality is given to a race that would gradually die out if confined to parthenogenesis. The female lays a single egg—the so-called "winter-egg"—which remains in the crevices of the vine-bark without development through the cold weather, and gives birth in spring to a "stock-mother," closely resembling the original root-form. This creature forms a gall in the young leaf, within which it produces a large number of eggs, some of which form new galls and multiply in the leaves, whilst others crawl down to the roots and become root-forms, with which the cycle recommences. Attacked both in its leaves and roots, and deprived thus of its fair nutriment, the vine which is once infested with these rapidly multiplying pests slowly withers away, being stunted in its growth, discoloured in its leaves, and bearing imperfect grapes which do not ripen. In a year or two the vine dies.

The particular species of phylloxera which attacks the vine is a native of the United States, probably originating among the wild vines of the Colorado district. It was first observed in 1856 by Asa Fitch, who had no suspicion of its evil nature, and called it *Pemphigus vitifoliæ*. In 1863 it was independently discovered by Westwood in an English vinery at Hammersmith; he was ignorant of Fitch's observation, and called it *Peritymbia vitisana*. From 1858 to 1863 there were many importations of American vines for grafting purposes to Bordeaux, Roquemaure, and other parts of France, England, Ireland, Germany, Portugal, &c. It is practically certain that the deadly phylloxera was imported on these plants. A year or two later certain vine-growers in the South of France began to complain of the new vine-disease. M. Delorme of Arles, in 1865, appears to have been the first who recognized its novelty and had a presentiment of disaster. The disease steadily spread outwards in concentric circles from its first place of lodgment near Roquemaure. Within two or three years whole departments were infested. In 1866 a second centre of infection made its appearance near Bordeaux. The vine-growers were at their wits' end to account for this new plague, which threatened to be even more costly than the oïdium. The completeness of the ruin which threatened them may be illustrated by the statistics for a single commune, that of Graveson, whose average annual production of wine in the years 1865–67 was about 220,000 gallons. In 1868 this fell to 121,000 gallons, in 1869 to 48,400 gallons, in 1870 to 8800 gallons, and by 1873 to 1100 gallons.

In 1868 Planchon proved that the disease was due to a new species of phylloxera which was invariably found on the roots of the affected vines, and to which he accordingly gave the prophetic name of *Phylloxera vastatrix*. During the next ten years a series of students, of whom only Riley and Balbiani need be mentioned here, worked out the natural history of *Phylloxera vastatrix*, and proved its identity with the American grape-louse. Its devastations rapidly assumed gigantic proportions. In France, where the disease was by far the most prevalent—owing in great part to the obstinacy with which the vine-growers at first refused to take any reasonable precautions against its spread—M. Lalande, President of the Chamber of Commerce at Bordeaux, in 1888 calculated the direct loss to the country by the phylloxera at 10 milliards (£400,000,000), or double the indemnity which had been paid to Germany in 1871! Nearly three million acres of vineyards had then been destroyed. In the Gironde, where the phylloxera first became serious about 1877, the mean annual production of wine in 1876–85 was reduced by more than twenty-six million gallons. In the Côte d'Or the phylloxera appeared in 1878, and the annual crop at once declined from thirty-four to eleven million gallons. The effect of the phylloxera in France was to diminish the wine-crop by about one-half, while in certain parts—as in the Gironde from 1881 to 1887—the production of good wine was practically stopped altogether by the phylloxera and other pests, such as mildew.

The phylloxera has made its appearance in almost every vine-growing country in the world. Thus it appeared in Austria-Hungary in 1868; in Italy, in spite of the frantic efforts made—as in other countries—to keep it out by strict legislation against the import of vines, in 1879; in Russia in 1880; in Germany, on the Rhine and Moselle, and in Switzerland in 1872; in Madeira, Spain, and Portugal about 1876. The pest even crossed the oceans, and appeared in Australia, at Geelong, about 1880; it has since twice broken out in Victoria, and has ravaged the vineyards of South Australia and New South Wales. At the Cape, in spite of a long endeavour to prohibit the import of the phylloxera, it appeared about 1884. In 1885 it crossed the Mediterranean to Algeria. There was only one country where its ravages were long unimportant; that was its home in the United States, where the native vines had become, by the operation of natural selection, immune to its attacks. Yet no imported vine has ever lived there more than five years, and in 1890 the phylloxera crossed the Rocky Mountains, and seriously damaged the vineyards of California, where it had previously been unknown.

Three different methods of fighting the pest have been successfully adopted. One is to kill the phylloxera itself; another, to destroy it along with the infected vines, and plant fresh and healthy plants; the third, to adapt the secular therapeutics of nature, and to introduce American vines which a long acquaintance with the phylloxera has made immune to its ravages. Of the various plans adopted for killing the phylloxera, which included absurdities like burying live toads at the roots of the vines, or douching them with Lourdes water, few have survived. One consists in submerging the infected vineyard under water for at least forty days. This plan, introduced by M. Faucon of Graveson, is effective, but is clearly out of the question in the majority of vineyards, since, as Virgil said, *Vitis amat colles*. Yet large sums were spent in France on canals intended for this purpose, and much good was done in low-lying districts like those of the Gironde. Insecticides, of which the bisulphide of carbon (CS_2) and the sulpho-carbonate of potassium ($KSCS_2$) remain in use, were injected into the earth to kill the phylloxera on the roots of the vine. These methods were chiefly advocated in vineyards of the first class, where it was worth while to spend a good deal of money and labour to preserve the old and famous vines: the Château Leoville Poyferré and Clos Vougeot are instances. Some good judges attribute the peculiar and not unpleasing flavour of certain clarets of 1888 to means thus adopted to kill the phylloxera. The second plan was largely adopted in Switzerland and on the Rhine, where measures resembling those taken with cattle suspected of anthrax were applied to all diseased vineyards. The third plan, which consists in replanting the affected vineyard with American vines—such as the *Vitis labrusca*, *V. riparia*, *V. rupestris*, or *V. monticola*—has proved the most generally successful.

The department of the Hérault, which produces more wine than any equal area in any part of the world, in 1899 contained 453,000 acres of vineyards, of which 445,435 were grafted on American stocks, and the wine-crop was larger than was the case before the phylloxera appeared. The French Department of Agriculture now "looks upon the phylloxera scare as a thing of the past, it having been successfully combated and beaten" by the introduction of American stocks. Thus the total wine-crop of France, which had fallen in 1894 from 1300 to 650 million gallons, rose again in 1899 to more than 1480 millions.

A very good bibliography will be found in *Les Insectes de la Vigne*, by Professor MAJET of Montpellier (1890), which is the best book on the subject. Reference may also be made to the classic memoirs of PLANCHON, culminating in *Les Mœurs de la Phylloxera de la Vigne* (1877); DREYFUS, *Ueber Phylloxerinen* (1889); LICHTENSTEIN, *Histoire du Phylloxera*; the *Rapports Annuels à la Commission Supérieure du Phylloxera*; and the excellent *Report on Phylloxera* drawn up by the Hon. J. W. TAVERNER (Victoria, 1899, No. 68).

(W. E. G. F.)

PHYSIOLOGY.

I. General.

EVER since men began to take a scientific interest in the problems of life, two distinct rival explanatory principles of vital phenomena have claimed attention: a natural and a mystical principle. The first outcome of the scientific attempt to explain vital phenomena after the natural method and by a unitary principle was the doctrine of the *Pneuma*, held by the followers of Hippocrates, which found its clearest expression in Galen's system. According to this doctrine, the origin of all vital phenomena was a very fine substance, the Pneuma, which was supposed to exist in atmospheric air, to be inhaled into the lungs of man, and thus through the blood to reach all the parts of the body, where it produced vital phenomena. This doctrine—an attempt to explain the phenomena of life which was not only altogether natural, but even materialistic—was accepted by the Middle Ages together with Galen's system. With its translation into the Latin *spiritus*, however, the conception of the Pneuma lost its original force. The *spiritus animales* of the Middle Ages developed ere long into mystical powers, the result being the explanation of vital phenomena by a supernatural theory. Not until the scientific Renaissance of the 16th and 17th centuries did views again undergo a change. After the establishment of a scientific method in physiology by Harvey, and the development of Descartes' mechanical system of regarding living bodies, the natural explanation of vital phenomena once more universally found favour. Two schools arose, which endeavoured by dissimilar methods to find a mechanical explanation of vital phenomena: the *iatrophysical*, originating with the gifted and versatile Borelli, and the *iatrochemical*, founded by the Dutchman, Delbœ Sylvius. But when both chemical and physical methods of explanation failed at such problems as, for instance, irritability and evolution, another change in opinion took place. By degrees there emerged once more the tendency to explain vital phenomena by mystical means, finding expression in the *Animism* of Stahl, to quote an example; and in the second half of the 18th century *Vitalism*, originating in France, began its victorious march throughout the whole scientific world. Again the opinion came to be entertained that the cause of vital phenomena was a mystical power (*force hypermécanique*)—that "vital force" which, neither physical nor chemical in its nature, was held to be active in living organisms only. Vitalism continued to be the ruling idea in physiology until about the middle of the 19th century, and its supremacy was only gradually overthrown by the great discoveries in natural science of that century. The chemical discoveries resulting from Wöhler's synthesis of urea first showed that typical products of the animal body, the production of which had hitherto been supposed to be solely the result of the operation of vital force, could be obtained artificially by purely chemical methods. Then above all came the discovery of the law of the Conservation of Energy by Robert Mayer and Helmholtz, and its application to the living organism by Mayer, Helmholtz, Dulong, Frankland, Rubner, and others, to prove that the manifestations of energy by the organism are simply the result of the quantity of potential energy received into the body by means of food. Finally, the stupendous results arrived at by Darwin and the establishment of the fundamental law of "biogenesis" by Haeckel, prepared the way for a natural explanation of the enigma of evolution and structure of organisms. Thus by the second half of the 19th century the doctrine of vital force was definitely and finally overthrown to make way for the triumph of the natural method of explaining vital phenomena, which down to the present time has continued to spread and flourish with an unparalleled fertility. It would, it is true, appear as if in our day, after the lapse of half a century, mystical tendencies were again disposed to crop up in the investigation of life. Here and there is heard once more the watchword of Vitalism. But all the so-called *neo-vitalistic* efforts (such as those of Bunge, Rindfleisch, Reinke, and others) have nothing to do with the older vitalism. They originate solely in a widespread confusion with regard to the boundaries of natural science, their principal tendency being to amalgamate psychological and speculative questions with problems of purely natural science. In the face of all these efforts, which by their unfortunate designations of Vitalism and Neo-vitalism give rise to entirely false conceptions, and which by their intermingling of psychological questions and questions of natural science have led to mere confusion in research, it is essential that natural philosophy should be called upon to realize its own limits, and above all clearly to understand that the sole concern of physical science is the investigation of the phenomena of the material world. Physiology, as the doctrine of life, must therefore confine itself to the material vital phenomena of organisms. It is self-evident, however, that only such laws as govern the material world will be found governing material vital phenomena,—the laws, that is, which have hitherto been brought to their most exact and most logical development by physics and chemistry, or, more generally speaking, by mechanics. The explanatory principles of vital phenomena must therefore be identical with those of inorganic nature—that is, with the principles of mechanics.

The problem of life.

Vitalism and Neo-vitalism.

The investigation of vital phenomena in this sense requires, in the first place, an exact knowledge of the substratum in which these phenomena are manifested, just as in chemistry and physics a thorough knowledge of the composition of the material world is a necessary premise to the investigation of the phenomena of inorganic nature. The knowledge of the composition and structure of organisms has in the course of the scientific development of anatomy attained to an ever-increasing minuteness of detail, without having as yet reached a definite limit. The last important step in this direction was the discovery by Schleiden and Schwann that all organisms are built up of elementary living structural components, namely, of cells. For the details of the anatomical construction of organisms, see Anatomy. We would here merely point out that a cell is the simplest particle of living substance which appears to be permanently capable of life. Different elements are essential, however, to the existence of the cell—two, at least, so far as has hitherto been discovered—the protoplasm and the nucleus. It must at present be regarded as at least very doubtful whether the *centrosome*, which in recent times it has been possible to demonstrate as existing in very many cells, and which appears sometimes in the protoplasm, sometimes in the nucleus, is a general and third independent cell-constituent. On the other hand, the number of special constituent parts which appear in various cell-forms is very large. A question which has long been discussed, and which has received special

Ultimate elements of life.

and animated attention, is that with regard to the finer structure of the cells—with regard, that is, to the protoplasm and the nucleus lying in it. Views on this subject have diverged very widely, and several totally diverse theories have been opposed to one another. One theory maintains that the living cell-substance has a reticular structure; another, that it is fibrillous. According to a third theory, the essence of the construction of the cell-substance lies in the granules which it contains; and according to a fourth, it lies in the ground-substance in which these granules are embedded. One view holds this ground-substance to be homogeneous, another regards it as possessing a fine foam-structure. It may at present be regarded as incontrovertible that living substance is more or less fluid, and that there does not exist any *general* structure for all cell-forms. But in some special cases all the theories which have been quoted are to a certain extent correct. In different cells there are reticular, fibrillous, and granular differentiations respectively, and differentiations in foam-structure; in many cells, however, the protoplasm appears to be beyond doubt homogeneous and without a distinct structure, and only under certain conditions to assume changing structures. But the fact which is of most importance for the right understanding of vital phenomena is that the cell-substance is always more or less fluid, for only in a fluid substratum can such intense chemical processes be enacted as are to be found in every living cell.

Where the analytical powers of the microscope in anatomy can go no farther, chemical analysis of the composition of the cell steps in. By its means the discovery is made that there is no *elementary* difference between organic and inorganic nature, for only such chemical elements as are known to exist in the inorganic world are found in the organic. On the other hand, however, the living cell-substance possesses chemical *compounds* which find analogues nowhere in inorganic nature. The characteristic organic substances which are present in every cell are proteids and proteid-compounds. Besides these there occur, widely disseminated, carbohydrates, fats, and other organic substances, which partly originate in the decomposition of proteids and their compounds, and are partly used for their construction. Lastly, there are in addition great quantities of water and some inorganic salts.

Such are the structure and composition of the substratum in which vital phenomena play their part. When we consider vital phenomena themselves in the various living organisms—in protista, plants, animals, man—there appears an incalculable diversity of phenomena. Here, however, as in the case of the structure of organisms, we have to analyse and to penetrate ever farther and deeper till we reach the fundamental phenomena. We then find that the great variety of vital manifestations may be traced back to a few fundamental general groups, which are precisely the same groups of phenomena as those to be observed in inorganic nature. All the processes that take place in the organic world may be regarded from the three different standpoints of their changes in substance, in energy, and in form; for substance, energy, and form are all necessary to our conception of matter. Accordingly, the general elementary vital phenomena likewise fall into three groups—metabolism, the mechanism of energy, and the assumption of form. Every cell, so long as it is living, takes in certain substances from its environment, submits them to chemical transformation in its interior, and gives out other substances. This *metabolism* is manifested in several special functions—in nutrition and digestion, respiration and circulation, secretion and excretion.

General phenomena of life.

The essence of the whole process is the fact that while out of these ingested stuffs living substance is always again being formed by the living substance which already exists, it is itself continually undergoing decomposition, and the products of this decomposition are what the cell gives off again to the outside. With metabolism, however, there is inseparably associated a *transformation of energy*. These substances taken in by the cell contain a large quantity of potential energy, which is transformed into kinetic energy. This has for its result the manifold activities of the organism, more especially motion, heat, electricity, and light. Finally, the chemical transformations in living substance may also manifest themselves outwardly in *changes of form*, as is the case generally in the matter of growth, reproduction, and development. The three general elementary groups of vital phenomena are therefore in reality merely the expression of the various aspects of one and the same process—of the actual vital process itself. The ultimate object of all physiology is to discover what this vital process is, that is to say, what is the exact cause of these manifold vital phenomena—a goal from which it is at the present day still very remote.

Conditions of life.

As every physical and chemical phenomenon of inorganic nature occurs only under distinct conditions, so vital phenomena are also dependent upon certain conditions of life. Every living body, every living cell, requires food, water, oxygen, and, further, a certain temperature, and a certain pressure in its environment. These are the *general* conditions of life. But the *special* conditions on which depends the continued existence of the individual forms of organism are as numerous as the forms of organisms themselves. Now, just as the physicist or chemist varies those conditions under which a phenomenon occurs in order to get at its causes, so does the physiologist try to experiment with vital phenomena, altering the vital conditions and testing the changes which are thereby produced. The great importance of this method consists in the power it gives the experimenter of analysing vital phenomena systematically from definite points of view. Every change in its normal vital conditions which produces any effect whatsoever upon an organism is termed a *stimulus*. This is the only general definition we have for a conception which is of such vast importance to physiology. According to it, experimental physiology is entirely a physiology of stimuli. It further follows from this conception of stimulation that there must be an enormous multiplicity of stimuli, since each particular vital condition may be subjected to some change capable of acting upon it as a stimulus. But, besides this, other factors may be brought to bear upon organisms which have absolutely no place among their vital conditions, for instance, many chemical reagents and electric currents. These influences come under the general definition of stimulus, because they likewise imply a change in the conditions under which the organism lives. From their qualitative nature stimuli are distinguished as chemical, thermal, photic, mechanical, and electrical. Each of these several varieties may, however, be applied quantitatively in various degrees of intensity, and may in consequence produce quite different results. This opens up to experimental physiology a vast field of research. But the physiology of stimulation is not only of the greatest value as a *means* of research: its importance is much increased by the fact that in nature itself stimuli are everywhere and constantly acting upon the organism and its parts. Hence the investigation of their action comes to be not merely a *means*, but a direct *end* of research.

Although it is not at present possible to define all the laws that govern stimulation, on the one hand because the number of stimulating effects known to us in the whole organic world is as yet too limited, and on the other because those already known have not yet been thoroughly analysed, yet it is within our power to classify stimulating effects according to their various characteristics, and to ascertain a few facts concerning their general and fundamental conformity to law.

Actions of stimuli.

The first fact, apparent from a glance at a great many of the various forms of stimulation, is that all their effects are manifested in either a *quantitative* or a *qualitative* alteration of the characteristic vital phenomena of each living object. The quantitative is the usual mode of action of stimuli. It is generally found that a stimulus either increases or diminishes the intensity of vital phenomena. In the first case the effect is one of excitation; in the second, of depression. It is the more important to bear in mind this twofold operation of stimuli, owing to the fact that in former times physiologists were very apt to conceive of excitation and stimulation as identical. It is now, however, an undisputed fact that depression may also occur as a typical effect of stimulation. This is most apparent in cases where the same stimulus that produces excitation may, on being applied for a longer period and with greater intensity, produce depression. Thus narcotics (alcohol, ether, chloroform, morphia, &c.) on certain forms of living substance produce the phenomena of excitation when their action is weak, whereas when it is stronger they produce complete depression. Thus, likewise, temperature stimuli act differently upon vital phenomena according to the degree of temperature, very low temperatures depressing, medium temperatures exciting with increasing intensity, and higher temperatures from a certain height upwards again depressing. The effects of stimulation are not, however, always manifested in merely quantitative changes of the normal vital phenomena. Sometimes, especially in the case of long uninterrupted and chronic stimuli, stimulation is found gradually to produce phenomena which are apparently quite foreign to the normal vital phenomena of the cell in question. Such *qualitative* alterations of normal vital phenomena are perceptible chiefly in chronic maladies in the cells of different organs (the heart, liver, kidneys, spleen, &c.), in which the vital conditions become gradually more and more modified by the cause of the malady. To this category pertain all the so-called chronic processes of degeneration which in pathology are known as fatty degeneration, mucous degeneration, amyloid degeneration, and so forth. The characteristic element in all these processes is that the normal metabolism is diverted into a wrong channel by the altered vital conditions of the cells of the organ affected, so that substances are formed and accumulated in the cell which are entirely foreign to its normal life. But this class of stimulation is still very obscure as regards causes and inner processes, and it is within the range of possibility that the ultimate cause of the qualitative changes in the normal metabolism is to be found simply in the processes of excitation and depression which chronic stimulation produces in separate parts of the metabolism. Thus, at least with regard to fat-metamorphosis (fatty degeneration), it is highly probable that fat is deposited in the protoplasm simply because, owing to an inadequate supply of oxygen, it cannot, when it originates, be oxidized in the same proportion as it is formed, whereas in the normal cell all fat which originates in metabolism is consumed as soon as it is produced. According to this conception, therefore, fatty degeneration is attributable primarily to a depression of the processes of oxidation in the cell. If we may accept this view as correct with regard to the other metamorphic processes also, the qualitative changes in vital phenomena under the influence of stimuli would after all depend simply upon the excitation or depression of the constituent parts of the vital process, and, according to such a view, all stimuli would act primarily only as exciting or as depressing agents upon the normal process of life.

In accordance with the three groups into which general vital phenomena are divided, it follows as a matter of course that the excitation or depression produced by a stimulus can manifest itself in the cell's metabolism, assumption of form, and manifestation of energy. The effects of excitation upon the production of energy are the most striking, and were therefore in former times frequently thought to have a claim *par excellence* to rank as stimulating effects. These reactions attract most attention in cases where the production of energy is proportionately very great, as with muscle, for instance, which is made to twitch and perform work by a feeble stimulus. Processes of discharge (Auslösungsvorgänge), however, lie at the bottom of cases like these. Potential chemical energy, which is stored up in a considerable quantity in living substance, is converted by the impulse of the stimulus into kinetic energy. Therefore the amount of the effect of stimulation—that is to say, the quantity of work performed—bears no proportion whatever to the amount of energy acting as a stimulus upon the muscle. The amount of energy thus acting may be very small as contrasted with an enormous production of energy on the part of the living substance. It will not do to make generalizations, however, with regard to this proportion, as was frequently done in former times. All processes of stimulation are not processes of discharge. The influence of many stimuli, as has been observed, consists far more in depression than in excitation, so that in certain circumstances a stimulus actually diminishes the normal liberation of energy. There is therefore no general law as to the proportion which the amount of energy acting as a stimulus upon living substance bears to the amount of energy liberated.

Among special varieties of stimulation there is one class of stimuli which has attracted particular attention, namely, those which act unilaterally upon free-moving organisms. It is principally with the lowest forms of life that we have here to do—unicellular protista and free-living cells in the bodies of higher organisms (sperm-cells, leucocytes, &c.). When from one direction a stimulus—be it chemical, thermal, photic, electrical, or of any other kind—acts upon these organisms in their medium, they are impelled to move in a course bearing a definite relation to the source of the stimulus—either directly towards that source or directly away from it, more rarely in a course transverse to it. This directive action of stimulation is under such a fixed conformity to law, that it vividly recalls such purely physical processes as, for instance, the attraction and repulsion of iron particles by the poles of a magnet. For example, if light falls from one side upon a vessel full of water containing unicellular green algæ, according to the intensity of the light these organisms swim either towards the illuminated side, where they form a compact mass on the edge of the vessel, or away from it, to cluster on the opposite edge. In the same way infusoria in water are observed to hasten towards or to flee from certain chemical substances, and leucocytes in our bodies act in the same manner towards the metabolic products of pus-forming bacteria which have penetrated into an open wound. The suppuration of wounds is always accompanied by an amazing conglomeration of leucocytes at the seat of the lesion. Perhaps the most striking effects, however, are those of the constant electric current upon unicellular organisms, since in this case the motion follows the cause with absolutely auto-

Directive stimulation.

matic regularity, certainty, and rapidity. Thus, for example, after the establishment of the current many Infusoria (Paramæcium) accumulate at the negative pole with great celerity and without deviation, and turn round again with equal celerity as soon as the direction of the current is altered. As such cases of directive stimulation may occur among all varieties of stimuli whenever stimuli act unilaterally, they have been designated, according to the direction in which they occur in relation to the source of the stimulus, as positive or negative Chemotaxis, Phototaxis, Thermotaxis, Galvanotaxis, and so forth. The strange and perplexing element in these phenomena becomes clear to us as soon as we know the characteristic method of locomotion for each form of organism, and whether the stimulus in question in the given intensity exercises an effect of excitation or of depression upon the special form. The direction of motion is the essential mechanical result of unilateral stimulation of the organs of locomotion. Seeing that these reactions are exceedingly widely distributed throughout the whole organic world, and possess a deep biological significance for the existence and continuance of life, the interest they have awakened is thoroughly justified.

One of the most important physiological discoveries of the 19th century was that of the "Specific Energy of Sense-substances." Johannes Müller was the first to establish the fact that very different varieties of stimuli applied to one and the same organ of sense always produce one and the same variety of sensation, and that, conversely, the same stimulus applied to the different organs of sense produces a different sensation in each organ—the one, in fact, which is its specific attribute. Thus, for example, mechanical, electrical, and photic stimuli applied to the optic nerve produce no other sensation than that of light; and, conversely, any one variety of stimulus—take the electrical, for example—produces sensations of light, hearing, taste, or smell, according as it affects the optic, auditory, gustatory, or olfactory nerves. This law of the "Specific Energy of Sense-substances," as Johannes Müller called it, has come to have a highly important bearing upon scientific criticism, since it proves experimentally that the things of the outer world are in themselves in no way discernible by us, but that from one and the same outward object—the electric current, or a mechanical pressure, for instance—we receive altogether different sensations and form altogether different conceptions according to the sense-organ affected. But this law does not possess significance for psychology alone; as regards physiology also it has a much more general and more comprehensive force than Müller ever anticipated. It holds good, as demonstrated by Hering and others, not of sense-substances only, but of living substance generally. Each cell has its specific energy in Johannes Müller's sense, and in its extended form there is no more general law for all the operations of stimuli than this law of specific energy. To take examples, whether a muscle be stimulated by a chemical, mechanical, thermal, or electrical stimulus, the result is in each case the same, namely, a twitching of the muscle. Let a salivary gland be stimulated chemically, mechanically, electrically, or in any other way, there always follows the same specific action—a secretion of saliva; no matter what be the kind of stimulus acting upon it, the liver-cell always reacts by producing bile, and so on. On the other hand, one and the same stimulus—the electric current, for example—gives in each form of living substance a specific result: twitching in the muscle, secretion of saliva in the salivary gland, production of bile in the liver-cell, &c. That is, of course, with the proviso that the effect of the stimulus be exciting and not

"Specific energy."

depressing. The following general formulation, however, of the law of specific energy brings the depressing stimuli also within its scope: "Different stimuli produce in each form of living substance an increase or a diminution of its specific activity." As already observed, it will probably be found that those weak chronic forms of stimulation which produce qualitative changes may also be comprised under this general law.

The knowledge thus far acquired from analysis of vital phenomena and their changes under the influence of stimuli affords but a very indefinite temporary basis for the theory of the actual vital process itself, of which vital phenomena are the outward manifestation. The conceptions to which physiological research has hitherto attained in this matter are of a more or less doubtful nature. The facts contained in them still require to be linked together by hypotheses if we are to obtain even a vague outline of what lies hidden behind the great riddle of life. Such hypotheses, serving as they do to link facts consistently together, are absolutely essential, however, to the further progress of research, and without their aid any systematic investigation would be impracticable. But at the same time it must never be forgotten that these hypotheses are merely provisional, and that whenever they are found to be no longer in harmony with the widening range of new experiences and ideas, they must either be proved to be facts or be subjected to modification. This is the point of view from which we must deal with modern ideas concerning the nature of the actual vital process—the mechanism of life.

Mechanism of life.

The fundamental fact of life is the metabolism of living substance which is continually and spontaneously undergoing decomposition, and building itself up anew with the help of the food-substances it takes in. These processes of decomposition and of reconstruction may be briefly designated as *Dissimilation* (Catabolism) and *Assimilation* (Anabolism) respectively. Now the question arises: How are we to understand this process of dissimilation and assimilation from a mechanical standpoint? It is quite evident that we have to do with some chemical occurrence; but *how* are the chemical transformations brought about? There are obviously two possibilities. It is conceivable that the decomposition of foodstuffs and the formation of excretion-products in the cell-body are caused by the repeated casual encounter of a great series of chemical combinations and by their repeatedly reacting upon one another in the same manner, bringing about transformations and forming waste products which are excreted, while at the same time certain chemical affinities are always taking in from without new chemical combinations (food-stuffs) and uniting them. This theory was in fact occasionally advanced in former times, particularly in its chemical aspect, and the belief was especially entertained that the enzymes in living substance might play an important part in these transformations. This assumption, however, leads to no clear and lucid image of what takes place, and moreover draws too largely upon auxiliary hypotheses. It has therefore met with but little acceptance. The other possible explanation of metabolism is, that its whole process is confined to one single class of chemical combinations whose tendency it is to be constantly undergoing spontaneous decomposition and regeneration. This latter theory was founded by Hermann, Pflüger, and others, and has met with universal recognition because of its naturalness, simplicity, and clearness.

Metabolism.

Starting with this hypothesis, the path of further research lies clear and well-defined before us. In the first place, we are obviously met by the question: What conception are we to form of these combinations on which hinges the whole vital process? Among the organic matters which compose living substance, proteids perform the most important part. Proteids and proteid-compounds form the only organic matter which is never absent from any cell. They form also the greater part of all the organic compounds of the cell, unless reserve-stuffs are accumulated to a considerable extent, and they are by far the most complicated of the compounds of living substance. While animal life is impossible without proteid food, there are on the other hand animals which can continue to subsist on proteid alone. This series of facts proves very conclusively that proteids and their compounds play by far the most important part of all organic matter in the processes of life. The idea thus naturally presents itself that the required hypothetical compound forming the central point of metabolism will be found to bear a very close relation to proteids. But another point must be here considered. The proteids and their compounds known to us are, comparatively speaking, stable compounds, which never undergo spontaneous decomposition so long as they are protected from outward injury, whereas the hypothetical combination which lies at the centre of organic metabolism is extraordinarily labile and continually undergoing spontaneous decomposition. Therefore we have to think not of ordinary proteids in this case, but of still more complicated combinations, the atoms in the molecule of which have a strong tendency to group themselves in new arrangements. Owing to their fundamental importance, these combinations have been termed "biogens." When we come to inquire how such labile biogen molecules are built up out of the proteids of food, we find our knowledge very much restricted. Doubtless the intramolecular addition of inspired oxygen has much to do with it, for living substance when deprived of oxygen loses its irritability, that is to say, its tendency to decomposition. The fact that the decomposition of living substance is always associated with the formation of carbonic acid—a circumstance obviously necessitating the aid of oxygen—also points to the absolute indispensableness of oxygen in the matter. Pflüger has further suggested that the molecule of living substance owes its lability and its tendency to form carbonic acid when joined by oxygen atoms principally to cyanogen groups which are contained in it. According to this view, the following is supposed to be the process of the formation of biogen molecules: It is assumed that the biogen molecules already present in living substance take out of the proteids of food certain groups of atoms, and dispose them so as to produce cyanogen-like compounds. The addition of oxygen atoms then brings the biogen molecule to the maximum of its power of decomposition, so that—partly spontaneously, but more especially when impelled by a stimulus—it breaks down somewhat explosively, causing the formation of carbonic acid. In this proceeding, according to the hypothesis which is the most widely accepted and the most fruitful in results, would lie the very germ of the vital process.

Proteids.

If we accept these views as far as their general principle is concerned, assimilation is the re-formation of biogen molecules by those already existing, aided by food-stuffs; dissimilation, the decomposition of biogen molecules. To this primary process, however, is attached a whole series of secondary chemical processes, which serve partly to work upon the food so as to fit it for the building up of biogen molecules, and partly to form out of the direct decomposition-products of the biogen molecules the characteristic secretion-products of living substance (excretions and secretions). The various workings of matter in the cell are rendered very much more complex by the circumstance that the living cell exhibits various morphological differentiations—above all, the differentiation in protoplasm and nucleus. Again, a transformation of energy is inseparably connected with metabolism. Along with food and oxygen potential chemical energy is continually being introduced into the cell, to be accumulated in the biogen molecules, and at their decomposition transformed into kinetic energy, which finds an outlet in the various manifestations of energy in the cell—motion, heat, and so forth. In the light of this hypothesis the operations of stimuli also become comprehensible. Seeing that there is an initial tendency to the occurrence of certain definite chemical processes, which are associated with the reconstruction and decomposition of biogen molecules, various stimuli will either further or hinder the course of this metabolic series. A cell which is exposed to no outward disturbance, and which continues always in the unvarying medium provided by an exact sufficiency of food, will be in "metabolic equilibrium"; that is to say, its assimilation and its dissimilation will be equal ($A = D$). When, however, the influence of external stimuli is brought to bear upon them—that is to say, any change in their environing vital conditions—A and D will either be altered in similar proportion, or their mutual equilibrium will be disturbed. In the former case the vital processes will merely be intensified in their course; in the latter and usual case the result will be determined according to the part of metabolism excited or depressed. When the effect of a stimulus is to excite D continuously in a high degree without correspondingly increasing A, the result is a dying off—an atrophy. In the contrary case, when A remains continuously greater than D, the result is growth, increase, and reproduction of the cell. Experience proves, however, that A and D stand in a certain relation of mutual dependence to each other, with the result that when D has been increased by a stimulus, for example, A correspondingly increases during the stimulation, and continues to do so after its cessation, till the loss in living substance produced by the stimulation of D is eventually made good, and metabolic equilibrium is restored. The muscle may be taken as an example of this self-regulation of metabolism common to all living substance (Hering's *Selbststeuerung des Stoffwechsels*). When a muscle has been fatigued by some stimulation causing an enormous increase of D, there is a corresponding spontaneous increase in A. After some time the muscle is observed to have recovered. It has once more become capable of performing work; its metabolism is again in equilibrium.

Mechanism of cell-life.

Metabolic equilibrium.

The vital phenomena of the cell may be derived mechanically from metabolism and the changes it undergoes under the influence of stimuli. Our ability to do this will increase more rapidly as we become better acquainted with the details of the metabolism of the cell itself. The foregoing outline must be regarded, of course, as embodying only a fragmentary hypothesis, which can serve as a guide for further research only so long as it does not clash with facts, and which must be amplified, specialized, and developed with the widening of specific knowledge regarding the cell's metabolism. The relations already known are so exceedingly complex, that only by slow degrees can we pursue the investigation of separate fragments of the entire metabolic series. The differentiation of nucleus and protoplasm in the living substance of the cell alone gives rise to an extraordinary complication in the metabolic process, for these two parts of the cell stand in the most complicated correlation with one another as well as with the environing medium—a fact of which the experiments made by vivisection in various free-living cell-forms have furnished abundant evidence. The farther such knowledge advances, the more rounded, clear, and free from hypotheses will be-

Cell-processes the secret of life.

come our conception of the cell's metabolism. But the cell is the elementary component part of all organisms, and from the life of individual cells is constructed the life of the separate tissues and various organs, and thus of the entire organism. Hence the cell is the only vital element which the organism possesses, and therefore the investigation of the vital processes in its separate cells leads ultimately to a knowledge regarding the mechanism of life in the whole. (M. V.)

II. Nutrition.

Living matter is living in virtue of the persistence of a constant cycle of chemical changes, consisting in a continual breaking down (Catabolism) on the one hand and a continual building up (Anabolism) on the other. By the breaking-down changes the energy is evolved which is required for the constructive processes by which the mass of living material is maintained or grows, and for the production of motion, of heat, and of all the various phenomena associated with vitality. Nutrition deals specially with the way in which these changes are carried on, with the manner in which the necessary energy-yielding material is supplied to and utilized by the protoplasm, and with the disposal of the waste material resulting from the catabolism. The present article deals with the nutrition of Vertebrates, and more especially with the nutrition of mammals.

A. *Metabolism.*

Anabolic changes.

Protoplasm, or living matter, is not a substance but a vortex of substances, a vortex constantly sucking in fresh material and as constantly throwing off the old. To attempt to analyse it is hopeless; but when its metabolism is stopped—when it is no longer protoplasm—it is found that the most abundant solid present belongs to the group of *Proteids* (see p. 724). Many speak of proteids as the essential constituent of protoplasm; but how, and in what form, they are present is unknown, owing to the important molecular changes which go on at death, as indicated by the liberation of carbon dioxide and lactic acid in considerable quantities. Whatever be the true relationship of proteid to protoplasm, the fact is clear that a supply of the former is necessary for the continuance of the latter. In green plants the proteid is built up from nitrates, water, and carbonic acid, but in animals it must be supplied ready made from plants or from other animals. The proteids are complex substances with large molecules, which, when built into the protoplasm molecule, readily break down into simpler substances with the liberation of energy. Many organisms are capable of repairing the expenditure of matter and of energy, and of continuing to live on proteids, along with water and salts; but the vast majority of animals have the power of using *Fats* and *Carbohydrates* as additional sources of energy, and many procure from these substances the greater amount of the energy they evolve. Thus man, on an ordinary diet, gets five times as much energy from these as from the proteids of the food. (For the energy-value of each of these materials, see DIETETICS.) For the liberation of their energy these substances must be *assimilated*, drawn into the vortex, and built up to form an integral part of the protoplasm. Some plants, like the yeasts, have the power of evolving the energy of sugar through the action of one of their products, but all the evidence indicates that in animals assimilation is an essential step to utilization.

This is clearly indicated by the following considerations:—(1) Of the innumerable organic compounds which in their disintegration liberate energy, the animal body can use only a very limited number, belonging to the three groups of Proteids, Fats, and Carbohydrates; only a few substances outside these groups can be assimilated and used to a small extent as sources of energy, *e.g.*, alcohol. (2) Proteids, Carbohydrates, and Fats, when in the blood undergo no such changes as they undergo when they become part of the living protoplasm. (3) Ammonium lactate, which undergoes no change in the blood, when introduced into the body of a living mammal is changed to urea, and in a living bird to uric acid; while urea injected into the bird is in part changed into uric acid, and uric acid in the mammal may be changed into urea. In each case the substance must become part of the living protoplasm, and undergo profound alteration.

(4) A number of substances, as benzyl alcohol, $C_6H_5CH_2OH$, and salicylic aldehyde, $C_6H_4{COH \atop OH}$, are not oxidized in the blood, but when taken up by the protoplasm of the tissues are changed into benzoic acid, $C_6H_5CO_2H$, and salicylic acid, $C_6H_4{CO_2H \atop OH}$.

In all probability the degree of assimilation which is necessary for the chemical changes in various substances acted on by living protoplasm varies greatly. Thus proteids must be carried in to the inmost and most essential vortex, while gelatine, carbohydrates, and fats must also take part in the more intimate chemical changes. On the other hand, the changes of lactate of ammonia, of urea, of uric acid, and the various chemical substances mentioned above, probably go on more towards the edge of the vortex, and without ever taking part in the fundamental series of changes.

It was formerly supposed that the *oxygen* of the air directly oxidized the constituents of living matter, but the fact that the same changes go on in the living tissues of the frog for some time after they have been deprived of all free oxygen, shows this idea to be erroneous. The oxygen must be assimilated, must be part of the protoplasm, must be what Pflüger calls *intramolecular*. Its presence in the complex molecule along with carbon, hydrogen, and nitrogen of course greatly increases the molecular instability. Living matter has a great affinity for oxygen, and not only takes it greedily from the air, but can actually separate it out of various chemical compounds, such as oxyhæmoglobin, or even from more stable pigments, such as alizarin blue.

Catabolic changes.

Protoplasm thus built up by the assimilation of Proteids, Fats, and Carbohydrates, with oxygen, undergoes changes by which it is broken down and the energy of these substances is liberated. These changes are accompanied by an oxidation, the intramolecular oxygen of the protoplasm being distributed in simpler and more stable compounds. Proteids, Carbohydrates, and Fats, when burned outside the body, yield carbon dioxide and water, and in the body these are the chief products of the disintegration of living matter. But the proteids contain nitrogen and sulphur, which are also oxidized. In the animal body the sulphur is in great part converted to sulphuric acid, though some is got rid of in a less oxidized state. The nitrogen, on the other hand, is in fishes, amphibia, and mammals excreted chiefly as carbamide (urea), and to a smaller extent as ammonia and various diureides (see below, *Chemistry of Animal Body*). In birds and reptiles the diureides are the chief waste nitrogenous products. But while the waste nitrogen is thus got rid of in substances more complex than ammonia, the fact discovered by Minkowski, that in the goose exclusion of the liver from the circulation causes the appearance of lactate of ammonia in place of uric acid in the urine, tends to show that in all cases ammonia, or a closely allied substance, is actually formed, and is built up into somewhat more complex substances, probably to facilitate excretion. The catabolism of the nuclein compounds (see p. 724) of the protoplasm is somewhat more complex. The proteid moiety is broken down in the manner just described, and the nucleic acid is split into phosphoric acid and a series of bodies which E. Fischer names the Purin Bases — Hypoxanthin, Xanthin, Uric Acid, Adenin, &c. The amounts of these formed vary with the amount of nucleic acid which is broken down, but they are all capable of being further changed into urea.

The metabolic processes of protoplasm appear to be modified in response to various stimuli. For example, in carnivorous animals the result of administering acids is the formation of ammonia in sufficient quantities to combine with them. Free fatty acids determine the production of glycerin in the intestinal wall, and benzoic acid gives rise to amido-acetic acid, with which it links, to be excreted as hippuric acid.

Metabolism of muscle.

In vertebrate animals muscle plays the most important part in the general metabolism. Not only is it the most constantly active and by far the most abundant of the tissues—in man it constitutes about 43 per cent. of the total weight—but, since its two great functions are the production of heat and mechanical work, it is the great energy-liberating machine, the great expending tissue of the body. For its nourishment food is procured and digested, and the purpose of the various organs of excretion is to get rid of its waste products. The metabolism of muscle is therefore the great governing factor in the nutrition of the body. The proportion between the amount of energy set free in mechanical work and in heat production has been studied by many investigators, but the most trustworthy results have been obtained by Zuntz and his fellow-workers at the Veterinary School of Berlin. By investigation on men, horses, and dogs, they have shown that under the most favourable conditions about $\frac{1}{3}$ of the energy liberated by the muscle may be used for mechanical work, while about $\frac{2}{3}$ is used in heat production; while in less favourable circumstances a much smaller proportion of the energy is available for mechanical work.

Muscle contains about 20 per cent. of proteids, some of which are soluble, others insoluble, in salt solution. The insoluble part consists of the collagen of the connective tissue, and of a phosphorus-containing proteid Myostromin, which makes up the framework of the fibres. The soluble proteids are of the nature of globulins, and two of these (Myosinogen and para-Myosinogen) tend to pass into an insoluble condition (Myosin). This occurs after death, and leads to the familiar stiffening of muscle. Another globulin, Myoglobulin, takes no part in the formation of the myosin. The remaining organic substances, amounting to 1 or 2 per cent., consist of glycogen, glucose, and fats, and of waste matters, such as methyl-guanidin-acetic acid—creatin. The ash amounts to about 1 per cent., the most important base being potassium and the most abundant acid phosphoric acid.

When work is done, the disintegration of muscle substance is proportionately increased. Thus Zuntz found the excretion of carbon dioxide in a dog to vary as follows:—

	CO_2 per min. in cubic centimetres.
Resting, lying	124·7
,, standing	170·2
Forward movement (unloaded)	525·0
,, ,, (drawing weight)	798·9

He further found that the more rapidly work is done, the greater is the disintegration. The simple oxidized compounds of the greater part of the carbon and hydrogen are given off from the muscle, and, with or without further modification, are excreted from the body as carbon dioxide and water. Nitrogen in simple combinations also appears to be set free, for the proportion of nitrogenous substances soluble in alcohol is increased after contraction in excised muscle. But in muscle in the body, waste nitrogen is not given off proportionately to the work done; indeed, increased excretion is not a necessary accompaniment of the performance of muscular work. Provided the work is moderate, and provided the supply of non-nitrogenous food is sufficient for the energy required, and the supply of oxygen adequate for repair, there is no increased excretion of nitrogen. But when the work is excessive in relation to the amount of food absorbed and the amount of oxygen taken up, at once the waste nitrogen is thrown off in increased quantities. An increase in the excretion following muscular work is therefore correlated with deficiency of the materials required for reconstruction. It thus seems that, except under special conditions, the nitrogen, instead of being thrown off, is used again, and, in combination with fresh carbon and hydrogen in fats and carbohydrates, and with oxygen, is rebuilt into the muscle protoplasm.

Measure of metabolism.

The course of metabolism and the rate of combustion of proteids and fats in the body may be studied with considerable accuracy in the human subject. It is necessary to ascertain the amount of nitrogen and of carbon excreted by the various channels—the kidneys, the lungs, the skin, and the bowel. By the two last almost negligible quantities are given off, so that it is usually sufficient to confine the analysis to the urine and the expired air. In proteids there is 16 per cent. of nitrogen to 54 per cent. of carbon, and hence in the excreta every gram of nitrogen derived from proteids must be accompanied by 3·4 grms. of carbon. Any carbon above this amount must be derived from the fats of the body during fasting, or from the fats and carbohydrates of the food. The data for such studies are these:—

N excreted $\times$ 6·2 = proteids used.

C (*a*) an amount equal to N $\times$ 3·4 is from proteids.

(*b*) all above this is from fats and carbohydrates, and during fasting from fats. The amount of fats is obtained by multiplying by 1·3.

Metabolism in fasting.

In fasting, the breaking-down changes by which energy is liberated continue, but since no energy from without is introduced, the animal's own tissues are used. The rate of wasting depends simply upon the amount of energy required for muscular work and for heat production; an individual kept warm and at rest will endure a fast for a much longer period than one exposed to cold and compelled to carry on strenuous labour. In the course of a fast the tissues do not waste equally: the more essential live on the less essential. The heart muscle hardly loses weight, and it must therefore subsist upon the proteids of the less essential skeletal muscles, which lose considerably, in turn deriving their supply of energy from the stored fat of the body. At the commencement of a fast the rate of wasting is rapid, but after a time it diminishes and the animal lives more economically, more especially as regards its proteids. This is well shown by the observations made in a case of prolonged voluntary fast undertaken by an Italian:—

Day of Fast.	Proteid Waste.	Fat Waste.
1st	104 grms.	—
10th	51 ,,	170 grms.
20th	33 ,,	170 ,,
29th	31 ,,	163 ,,

So long as fats remain, they are used in preference to the proteids, and it is only when they have nearly disappeared that the proteids are called upon to supply the energy. Taking food increases the work of the muscles and glands of the alimentary canal, and hence when an animal which has been fasting is fed, there is a rise in the excretion of carbon dioxide and nitrogen. If the animal has been wasting 33 grms. of proteid and 170 grms. of fat per diem, and if a diet containing these quantities be given, on account of the increased demand for energy in digestion, the food is insufficient to maintain the weight.

Internal secretions.

Certain organs of the body produce substances which are carried to the muscles and other tissues, and exercise an important influence on the chemical changes going on therein. (For information as to the structure of these organs, see ANATOMY.)

Thyroid Gland.—The removal of this structure leads to a train of symptoms which varies somewhat in different animals, but is essentially the same in nearly all. The connective tissues tend to revert to the embryonic conditions, and the amount of mucin increases. The temperature falls, muscular tremors appear, the functions of the higher nervous system become sluggish, and the animal usually dies. By administering the substance of the thyroid, or by giving extracts of it, most of these symptoms may be delayed or prevented. When thyroid gland or extract is given to healthy animals in moderate doses, it causes an increased metabolism of both fats and proteids, and thus may induce emaciation. It would appear as if one function of the organ is to produce this internal secretion, in order to regulate the rate of the metabolic processes in the body by increasing them when such an increase is desirable.

Ovaries and Testes.—It is well known that removal of these organs causes characteristic changes in the animal, a tendency to the deposition of fat being produced and the activity of the central nervous system being somewhat modified. Several years ago Brown-Séquard maintained that by the administration of testicular substance the general effects of atrophy of these organs might be obviated; and more recently, as a result of clinical experience, the administration of extracts of the ovaries has been said to relieve certain of the nervous symptoms which supervene on their removal or atrophy. It has been found, too, that ovarian substance when given to dogs, whether male or female, causes a marked increase in the rate of proteid disintegration, but no similar action has been found with testicular substance. There is thus evidence that the ovaries, like the thyroid, form an internal secretion having an important action in accelerating the metabolism; and it is at least probable that the testes produce a similar substance.

Pancreas.—That the pancreas is the most important of the digestive glands, has for long been known, but in 1889 von Mering and Minkowski demonstrated a further function. They discovered that excision of the pancreas produces a condition of diabetes—an increase of sugar in the blood, the appearance of sugar in the urine, an increased excretion of nitrogen, and a general emaciation. These symptoms do not occur when the duct is tied or occluded, but they are invariable when a sufficient amount of the gland is cut away. They are not prevented by the administration of pancreas, either fresh or as extracts. In this condition sugar seems to be formed from the proteids, because it appears after all the glycogen has been removed, and its amount is proportionate to the amount of nitrogen excreted. Normally, proteids are a source of carbohydrates in the body, and it would seem as if the pancreas in some way exercises a restraining influence in this splitting of proteids, and that the removal of the organ permits it to occur to an excessive extent. Since the only respect in which the pancreas differs in histological character from the parotid gland—removal of which has no effect on the metabolism—is in the presence of epithelial islets, one is inclined to ascribe this action to them.

Pituitary Body.—Removal of this causes in cats and dogs a fall of temperature, lassitude, muscular twitchings, dyspnœa, and ultimately death. Injection of extracts of the substance is said to diminish these symptoms, but so far no study has been made of the influence of such injection on the metabolism of healthy animals.

Suprarenal Body.—Long ago Brown-Séquard stated that removal of these bodies causes great muscular weakness, loss of tone of the vascular system, loss of appetite, and finally death in a short time. Addison had already pointed out that a similar set of symptoms, accompanied by pigmentation of the skin, is associated with diseased conditions of these organs in man. Within the last few years it has been demonstrated that injections of small quantities of the central portion of the bodies has a powerful effect on the muscular system generally, and especially on the muscles of the vascular system, an enormous rise in the blood-pressure being produced. So far the influence of the suprarenal on the general rate of metabolism has not been investigated.

B. *Blood and Lymph.*

The blood circulates in a system of closed tubes, the smallest of which—the capillaries—form a network in the tissues and have their walls composed of a single layer of flattened endothelial cells. From the capillaries fluid escapes into the spaces between the tissue elements, to form the lymph. The lymph from these spaces is conducted by a series of tubes—the lymphatics—which, after passing through lymphatic glands, join together and finally enter the blood-stream just as the blood is returning to the heart. The whole arrangement resembles an irrigation system, the blood being comparable to the water in the trenches, the lymph to the water as it percolates through the soil.

The blood is a red fluid, having a bright cinnabar colour when oxygenated, and a dark, more purple hue when deprived of oxygen. In man its specific gravity is about 1060. Its reaction is alkaline —the alkalinity corresponding to about 0·3 per cent. of carbonate of soda. It is opaque, on account of the presence of numerous pigment-containing cells, which float in a more or less colourless fluid, the plasma. These cells constitute about 48 per cent., the plasma about 52 per cent., of the blood, which when dried is found to contain 20 per cent. of solids, with 10 per cent. of blood pigment —hæmoglobin—and about 8 per cent. of other proteids. The remaining 2 per cent. is made up of other organic bodies and inorganic salts. The cells are of three kinds—Red, White, and Platelets. When shed, the plasma forms a jelly enclosing the cells, and the blood is said to have clotted. This process of clotting takes place at different rates in different animals and under different conditions. In man, under ordinary conditions, it occurs in about three minutes. The clot contracts and squeezes out a fluid—the blood-serum. The process is due to a change in at least one of the proteids of the plasma, of which there are three, Serum Albumen, Serum Globulin, and Fibrinogen—a globulin. Under the influence of various factors, when blood is shed the fibrinogen becomes changed into a stringy tough insoluble substance—Fibrin—which forms the clot. It is possible that the chief cause of the clotting is the breaking down of white cells, with the liberation of a substance which may be called Fibrin Zymin.

The *Plasma* contains, in addition to the above proteids: (1) A small quantity (about 0·15 per cent.) of glucose, partly free and partly in organic combination, probably as jecorin; (2) a small quantity of fat, varying in amount with the character of the diet, but present even in starvation; (3) traces of various, more or less simple, combinations of nitrogen, the result of the disintegration of the tissues; and (4) various inorganic salts, of which the most abundant is chloride of sodium, but the most important are the phosphate and carbonate of soda. When carbonic acid is not being poured into the plasma from the tissues, the soda is all taken up by phosphoric acid to form Na_2HPO_4; but when carbonic acid is in abundance, it takes up a certain quantity, and bicarbonate of soda is formed. The way in which the carbonic acid is carried from the tissues to the lungs is considered under RESPIRATION. As to the source of the constituents of the plasma: (i.) The water is usually ingested; but when it is withheld, it is derived by the plasma from the tissues in which it has been stored. (ii.) The proteids are primarily derived from the food; but whether the peptone formed during digestion and taken up by the white cells is liberated as albumen or globulin, or as both, is not known, although various attempts have been made to show that in starvation it is the albumen which is diminished. But the blood proteids are also derived from the tissues, and in starvation proteid is carried in the blood from one tissue to another, *e.g.*, from the skeletal muscle to the heart muscle, and (in the salmon) from the muscles to the growing ovaries and testes. (iii.) The glucose and fats are derived from the food, but they may also be derived from the tissues in which they have been stored. (iv.) The urea and other nitrogenous substances are derived from the tissues. (v.) The salts are primarily derived from the food, but it is also possible that they may be given off from tissues in which they have been stored; *e.g.*, the phosphates stored in the muscle of the salmon pass to the ovaries and testes. The proteids, carbohydrates, and fats are used in the nourishment of the tissues, while the nitrogenous waste products are excreted.

Cells.—The source of the various blood-cells is described under ANATOMY (9th edit.), and the chemistry and functions of the red cells and their pigment below under RESPIRATION. That the life of the white cells is short, is shown by the rapid appearance and disappearance of digestive leucocytosis. After a meal of meat the leucocytes in the dog may increase 100 per cent., and in five or six hours again fall to their normal number. It is more difficult to determine the life-duration of the red cell. That they are constantly breaking down, is shown by the constant excretion of bile pigment and urinary pigment, which are both derived from hæmoglobin. From the small amount of these pigments daily produced, it is certain that the red cells continue in existence much longer than the white cells. Whether they break down in the general blood-stream or in special organs, is not fully investigated. The salts of the bile acids are powerful solvents of red cells, and since these salts are absorbed from the intestine, it is probable that the solution of old red cells goes on in the portal system. Evidence has been adduced that the spleen also plays an important part in the process.

Lymph.

It is through the lymph that the blood is brought into relationship with the cells of the body. Lymph is a colourless or yellow fluid, resembling closely the blood plasma in all its characters. Its reaction is alkaline. It contains about 6 per cent. of solids, though the amount varies in different parts of the body. About 1 per cent. is inorganic and about 5 per cent. organic. It is the latter constituents which vary in amount. The chief organic substances are the proteids. In the lymph of the limbs these amount to about 2 to 3 per cent., in the lymph of the intestine to 4 to 6 per cent., and in the lymph from the liver to 6 to 8 per cent. They are serum albumen, serum globulin, and fibrinogen. On account of the presence of the last, lymph clots like blood under the influence of the factors, causing the change of fibrinogen to fibrin. The lymph in the tissue-spaces is practically devoid of formed elements, but after it has passed through lymph-tissue it contains leucocytes in greater or lesser numbers. These are chiefly of the small round nucleated variety—the lymphocytes. When the animal is on a fatty diet, the lymph from the intestine—the chyle—is rendered milky by the presence of fat in a fine state of subdivision. Within the last few years the origin of lymph has been much studied, and it has been shown to have a double source—first from the blood, and secondly from the tissues. Heidenhain thus speaks of *Blood-Lymph* and *Tissue-Lymph.* The former has for long been recognized, and it was formerly regarded as an exudation from the capillary blood-vessels. Ludwig believed that the amount produced depended on the intravascular pressure; but the fact that in the limbs where the blood-pressure is high, lymph-formation goes on very slowly, while in the liver, where pressure is low, it is very rapid, shows that intravascular pressure alone is not a sufficient explanation. Heidenhain considered that this absence of relationship between blood-pressure and lymph-formation indicated that the blood-lymph is produced by a process of secretion by the endothelium of the vessels, and, in his opinion, the increased lymph-formation caused by the injection of extract of the muscle of the crab, by proteoses, &c., is due to an increased activity of the endothelium. Starling, on the other hand, points out that this secretion theory is unnecessary, and considers that lymph-formation is governed, first, by the varying permeability of the capillary walls in different parts of the body, and, secondly, by the pressure within the vessels. More lymph is produced in the liver than in the limbs, because of the greater permeability of the capillaries. The permeability is increased by injuring the vitality of the endothelial cells, as by injecting hot water; and, according to Starling, Heidenhain's so-called lymphagogues—crab's muscle, proteoses, &c.—act by poisoning the vessel walls, and by thus diminishing their resistance to the passage outwards of the plasma constituents. That lymph is formed by the withdrawal of water from the tissues, is shown by the injection into the blood of substances of high osmotic equivalent, such as sugar, neutral salts, &c. This causes not only a dilution of the blood, from the passage of water into the vessels, but also an increased formation of lymph, which must of course come from the tissues. Substances which thus produce an increased lymph-flow Heidenhain has called *Tissue Lymphagogues.*

C. *Supply of Matter and Energy required by the Tissues.*

The supply and intake of oxygen are dealt with under RESPIRATION, and the sources from which the necessary supply of proteids, fats, carbohydrates, and salts are procured in the various food-stuffs are considered in the article DIETETICS. Before these food-stuffs are available they have to undergo certain preparatory processes, either outside the body by cooking, or in the alimentary canal by digestion, the processes of which are very fully dealt with in the 9th edition (see NUTRITION, vol. xvii.).

Digestion.

One of the most striking results of recent work on digestion has been to emphasize the importance of the pancreatic secretion as *the* essential digestive fluid. The salivary glands may be cut out without causing any change in the health of the animal, and the stomach may be excised without the individual manifesting any marked disturbance, but exclusion of the pancreatic secretion from the intestine causes great alteration in the digestion of all classes of food-stuffs.

The other main advances have been in the elucidation of the influence of the nervous system on the gastric and pancreatic secretion, and the more complete working out of the stages of the chemical changes in the food-stuffs which constitute digestion, and of the course and duration of digestion in various parts of the alimentary canal.

Nerves of Digestion.—Pawlow, by dividing the œsophagus in the dog and bringing both divided ends out in the neck, was able to allow the animal to feed without the food reaching the stomach. He showed that this "pseudo-feeding" leads to a free flow of gastric juice. This reflex flow is brought about by the vagi, since it occurs after section of the splanchnics, but is stopped by section of both vagi. Stimulation of the lower end of the cut vagus by slow induction shocks brings about a flow of gastric juice after a somewhat prolonged latent period. That the vagus is the secretory nerve of the pancreas, as was indicated by the investigations of older physiologists, has been also more clearly demonstrated by Pawlow by the method of stimulating some days after section. Stimulation of the central end of the cut vagus, or of the lingual, brings about a reflex secretion, but, as shown by Popielski, the vagus also contains efferent inhibitory fibres, so that it has a double action in the pancreatic centre.

Course of Gastric Digestion.—Numerous studies of the course of

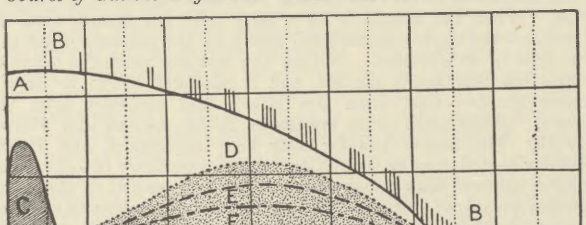


Diagram illustrating the course of Gastric Digestion in Man. A, Solids in stomach; BB, opening of pylorus; C, amylolytic digestion; D, peptic digestion; E, total HCl; F, combined HCl.

gastric digestion in man have been made by removing the contents of the stomach at various periods after a meal by means of a soft rubber tube. The result of these studies may be tabulated in the foregoing diagram. The steps by which the complex proteid molecules taken in the food are in the stomach broken down into the simpler peptone molecules, have arrested the attention of several chemists, some of whom have increased rather than dispelled the obscurities surrounding the problem. Neumeister, however, shows that the process may be divided into the following stages:—

Native Proteid.
Syntonin (Acid Proteate).
Proto-proteose. Hetero-proteose.
Deutero-proteose.
Peptone.

That a splitting of a large into smaller and smaller molecules takes place in the process, is shown by the proportion of metallic salts combining with these various bodies. The molecular weight of such a native proteid as egg albumen is probably no less than 15,000, that of its proto-proteose 2400, and of peptone 400. Thus six peptone molecules will be yielded by one of proto-proteose. It appears that the hetero-proteose molecule is about five or six times the size of the molecule of proto-proteose.

Curdling of Milk.—The way in which milk is clotted by the gastric juice has been considerably elucidated. It has been shown that the casein occurs in milk as a neutral lime salt, and that a mineral acid splits this, taking the lime and causing the casein to be precipitated. But under the action of rennin, in neutral or even in faintly alkaline solution, a lime salt of para-casein is set free, with a small amount of "whey albumen." This salt of para-casein is insoluble, and hence it separates as the curd. If lime salts are precipitated, the process cannot go on. The para-casein is acted on by pepsin and hydrochloric acid, and is changed into proteose and para-nuclein, which very slowly splits into proteose and para-nucleic acid containing phosphorus. The rennin or milk-curdling zymin of the pancreatic juice has a somewhat peculiar action. It forms a granular precipitate at the body-temperature, which changes to a coherent curd when the milk is cooled. The process is not prevented by the precipitation of the lime salts with oxalate of potash. The true chemical nature of the precipitate has not been studied.

Pancreatic Splitting of Proteids.—It has for long been known that pancreatic juice has a more profound action on proteids than the gastric juice; that it does not merely reduce them to the simplest proteid molecule—peptones—but that it breaks these down into yet simpler molecules. For long only two of these combinations, leucin and tyrosin, were known, but it has now been ascertained that these bodies may be classified as follows:—

Amido-Acids of the Fatty Acid gives	Bases.	Aromatic Bodies.	Other Bodies.
Amido-caproic acid (leucin)			Tryptophan.
Diamido-caproic acid (lysin)	Methyl-guanidin-propionic acid (lysatinin).		
Amido-valerianic acid	Ammonia.	Para-oxy-phenyl-amido-propionic acid (tyrosin).	
Amido-succinic acid			
Amido-pyrotartaric acid			

The main interest of this decomposition is the light it throws upon the constitution of the proteid molecule, nearly all the derivatives being amidogen compounds.

Intestinal Secretion.—Investigations have proved that the great chemical action of the intestinal secretion is to convert disaccharids into monosaccharids. Thus maltose is changed to dextrose, cane sugar to dextrose and lævulose. Apparently, however, lactose is not split, although it undoubtedly is split before it passes into the blood. The secretion has also a slight diastatic action; but as this is possessed by all secretions containing mucin, and by nearly all the tissues, it is of no special importance.

Bile.—The flow of bile, which begins in intra-uterine life, persists throughout life, even during protracted starvation; and while the taking of food increases it, the increase does not reach its maximum for many hours. In these respects it differs from the other secretions poured into the alimentary canal. In man the amount secreted per diem is probably about 800 c.c. with about 15 grms. of solids. Although the secretion of bile is not immediately connected with the taking of food, it is influenced by the character of the food. The most marked increase in secretion follows a proteid diet, the next most marked a fatty diet, the least marked a carbohydrate diet. Bile may leave the liver as it is secreted, or it may accumulate in the bile passages and gall bladder, to be expelled afterwards. For this reason the flow is very irregular, and is influenced by such factors as the pressure of the viscera upon the liver and the reflex stimulation of the nerve passing to the muscular walls of the bile passages. The slight increased flow of bile immediately after the ingestion of food is due to this expulsion of bile.

The older analyses were made on bile taken from the gall bladder, where it appears to be concentrated from the absorption of water. Various observations have now been made on bile escaping from a fistula, and these show that the percentage of solids usually given is too high. In such bile the solids amount to between 1·5 to 2·0 per cent., the inorganic solids being about 0·6 to 0·8 per cent. The salts of the bile acids are about 0·4 to 0·8 per cent., and are by far the most important organic constituents. That the salts are formed in the liver cells is demonstrated by the fact that when the liver is excluded from the circulation and the bile duct ligatured, they do not appear in the blood. In man the chief salt is glycocholate of sodium; the acid of this salt splits into amido-acetic acid and cholalic acid. In dogs, taurocholate of sodium is the chief salt, and the taurocholic acid yields amido-ethane-sulphuric acid and cholalic acid (p. 725). Both, therefore, are amidogen compounds. These salts must therefore be derived from the proteid constituents of the tissues or of the food.

The pigments of the bile are iron-free, and are derived from the hæmatin moiety of the hæmoglobin molecule. They are formed in the liver cells, exclusion of the liver from the circulation preventing their appearance. Not only can the liver cells form these pigments, but they can take them, as well as other pigments, from the blood and excrete them. Cholesterin, the important constituent of most gall-stones, is formed within the liver, and not merely excreted by it. The investigations of Naunyn have led him to the conclusion that it is derived from the breaking down of the cells in the bile passages, and not from the liver cells. The fat and lecithin are apparently derived from the fats and lecithin always present in the liver tissue.

The action of the bile in digestion is of small importance, and its exclusion from the intestine does not seem to have a prejudicial effect, either on men or on animals. Its main, if not its only, digestive function is to act as adjuvant to the pancreatic juice. It dissolves the fatty acids freed by the fat-splitting zymin, and thus assists their absorption. For this reason exclusion of bile from the intestine markedly diminishes the absorption of fats, about 30 per cent. escaping. Bile, indeed, is not so much a digestive secretion as an excretion. This view is confirmed by the following facts:—(1) The small importance of bile in digestion. (2) The presence of a pigment, the result of breaking down of hæmoglobin. (3) The chemical nature of the acids, indicating their origin from the decomposition of proteids. (4) The secretion of bile before birth and during starvation. (5) The absence of any immediate relationship of bile secretion to the ingestion of food.

Synopsis of Digestive Processes.

Section of Alimentary Canal.	Chemical Change.	Active Agent.
I. Mouth	Starch to maltose.	Ptyalin.
II. Stomach (first ½ hr.)	1. Starch to maltose.	Ptyalin.
	2. Maltose to lactic acid.	Bacteria.
(Reaching maximum in 3 or 4 hrs.)	3. Proteids to peptone.	Pepsin and HCl.
III. Intestine.		
(*a*) Pancreatic secretion	1. Proteids to peptone.	Trypsin.
	2. Starch to maltose and dextrose.	Amylopsin.
	3. Fat to glycerin and free acids (soaps).	Pialin.
	4. Peptone to tyrosin, &c.	Trypsin.
(*b*) Succus entericus	Disaccharids to monosaccharids.	Zymin.
(*c*) Micro-organisms		
(1) Small intestine	Sugar to organic acids.	*B. lactis*, &c.
(2) Large intestine	Proteids to indol, &c.	*B. coli communis*, &c.

Micro-organisms in Digestion.—The micro-organisms of the alimentary canal have been extensively studied. A very large number of bacteria are swallowed in the saliva and with the food. How far their passage downwards is checked by the leucocytes which are poured out into the saliva from the lymphoid tissue of the tonsils, has not been definitely settled, but it is highly probable that it is so checked. When the stomach is reached, the organisms swallowed with the food continue to act, and thus sugar is changed to lactic acid; but when free hydrochloric acid appears, the growth of nearly all organisms is checked, while some—*e.g.*, the comma bacillus of cholera—are destroyed. Most of the organisms pass on into the intestine; and as the free hydrochloric acid becomes combined and neutralized, the acid-forming organisms again become active and proceed to split up sugar, setting free lactic, acetic, and other acids, and so, by keeping the contents of the small intestine acid prevent the growth of putrefactive organisms. Under normal conditions the alkalis formed in the intestine gradually neutralize the acids produced; and by the time the large intestine is reached, the putrefactive organisms are able to grow, and to split up the proteid molecule to form various aromatic bodies, such as tyrosin, indol, scatol, &c. Of the organisms of the large intestine, the *bacillus coli communis* is by far the most constant and most abundant. The theory has been advanced that these organisms play an important part in digestion; but by procuring fœtal guinea-pigs directly from the uterus with aseptic precautions, and feeding them on sterilized food, it has been shown that micro-organisms in the intestine are of secondary importance.

Absorption of Food.—The portions of the food which are to be used in the metabolism are absorbed from the alimentary canal. As a result of digestion, the three proximate principles of the diet are changed—the carbohydrates to monosaccharids, chiefly dextrose, the proteids to peptones, and the fats to soaps, fatty acids, and glycerin. Absorption does not occur uniformly throughout the canal. Thus, while sugar and peptones are absorbed from the stomach, water is absorbed only to a small extent. That absorption is not due merely to a process of ordinary diffusion or osmosis, is clearly indicated by many facts. Heidenhain has shown that absorption of water from the intestine takes place much more rapidly than diffusion through a dead membrane. The relative rate of absorption of different substances does not follow the law of diffusion. Grübler's peptone passes more easily through the intestine than glucose, but glucose passes more readily through parchment paper, while sodium sulphate, which is more diffusible than glucose, is absorbed much less readily. Again, as shown by Reid, an animal can absorb its own serum under conditions in which filtration into blood capillaries or lacteals, osmosis and adsorption, are excluded; and this absorption is stopped or diminished when the epithelium is removed, injured, or poisoned, in spite of the fact that removal must increase the facilities for osmosis and filtration.

There are two channels of absorption from the alimentary canal: the veins which run together to form the portal vein of the liver, and the lymphatics which run in the mesentery, and, after passing through some lymph glands, enter a *receptaculum chyli* in front of the vertebral column. From this the great lymph vessel, the *thoracic duct*, leads up to the junction of the left subclavian and innominate vein, and pours its contents into the blood-stream.

While peptones are formed from proteids by digestion, they undergo a change in the intestinal wall before passing to the tissues. It is probable that they are taken up by the leucocytes of the adenoid tissue of the wall of the alimentary canal, since under a proteid diet these increase in number and stream away in the blood, to produce a digestive leucocytosis. By breaking down in the blood-stream they probably set free the proteids for use in the tissues. When an excess of proteids is taken in the food, it is broken down in the lining membrane of the gut, its nitrogenous part forming ammonia compounds. Its non-nitrogenous part may yield carbohydrates, since a proteid diet leads to the accumulation of glycogen in the liver. The ammonia compounds are carried to the liver and there changed to urea, and excreted as such, and thus the entrance of an excess of nitrogen to the tissues is prevented. It has been pointed out that gastric juice does not dissolve the phospho-proteids, but that they are dissolved by the pancreatic juice. The phosphorus is undoubtedly absorbed in organic combination, but the mode of absorption and the channels by which the blood-stream is reached have not been investigated. Though the chief monosaccharid formed in digestion is dextrose, others are also produced—from cane sugar lævulose, and from milk sugar galactose as well as dextrose. All these are absorbed in solution, and are carried away in the blood by the portal vein. It was for long thought that the fats are absorbed as a fine emulsion, but the most recent investigations seem to indicate that, after being split up into the component acids and glycerin, they pass, as soluble soaps or as the fatty acids soluble in the bile, through the borders of the intestinal epithelium. Here they appear to be again converted to fats by a synthesis of the acid with glycerin, and as fine fatty particles they are passed on from the cells, through the lymph tissue of the villus, into the central lymph vessels, and thus on through the thoracic duct to the blood-stream. Unlike the proteids and carbohydrates, they are not carried directly to the liver.

Fate of absorbed food.

The food thus absorbed may be used immediately as a source of energy, either for the construction or reconstruction of tissues, or for the production of mechanical work or heat. Or, on the other hand, it may be stored for future use in the body. Such storage takes place chiefly in three situations: (1) Fatty tissue; (2) Muscle; (3) Liver.

1. *Storage in Fatty Tissues.*—In most mammals the chief storage of surplus food is in the fatty tissues. That the fat of the food can be stored in them is shown by the fact that the administration of fats different from those of the body leads to their appearance in those tissues. Fats are also formed from the carbohydrates of the food. Feeding experiments upon pigs and other animals have definitely proved that sugary foods are changed to fat in the body and stored in that form. In fact, the conversion of cheap carbohydrates into the more expensive fats is the basis of the profits of the grazier. When it is remembered that as much energy is stored in a pound of fats as in two pounds of carbohydrates, the advantage of this conversion becomes manifest. There is good evidence that in excessive proteid feeding the non-nitrogenous part of the proteid molecule may be stored as fat. It has been maintained that the evidence in favour of the formation of fats directly from proteids is unsatisfactory; but since proteids do yield carbohydrates, and since carbohydrates form fats, it must be admitted that proteids may be a source of fats.

2. *Storage in Muscle.*—Some animals, as the salmon, store fats within their muscular fibres, but in mammals such a storage is limited in amount. The salmon also stores surplus proteid material in the muscles, and mammals too appear to do the same. How far a passive storage may occur is not known, but feeding experiments on mammals indicate that only a small amount of proteid can be accumulated. On the other hand, the experience of athletic training shows that the muscles may be enormously increased by building up the proteid of the food into their protoplasm.

3. *Storage in the Liver.*—The liver is the chief storehouse of carbohydrates in all animals, and of fat in some—*e.g.*, the cod.

Action of liver.

It is a matter of interest that the liver develops as a digestive gland—as a couple of diverticula from the embryonic gut. But early in fœtal life it comes to have important relationship with the blood going to nourish the body from the placenta. The vein bringing the blood breaks up into a series of capillaries in the young liver, and in these capillaries for a considerable time the development of the red cells of the blood goes on. Soon the liver begins to secrete bile, while animal starch and fat begin to accumulate in its cells. Gradually the formation of red cells stops, and the mass of liver cells become larger in proportion to the capillaries. As the fœtal intestine develops, the vein bringing blood from it—the portal vein—opens into the capillary network of the liver, so that, when at birth the supply of nourishment from the placenta is stopped, the liver is still associated with the blood bringing nutrient material to the tissues.

Claude Bernard discovered that there is a constant formation of sugar in the liver. Even when an animal undergoes a prolonged fast, the amount of sugar in the blood on account of this constant supply does not diminish. In starvation there are only two possible sources of this glucose—the fats and the proteids of the tissues. That fats can be changed to sugar in the liver was maintained by Seegen as a result of experiments *in vitro*, but his results have been questioned by subsequent investigators. That proteids are a source of sugary substances is shown by the accumulation of a starch in the liver in animals fed upon proteids; it is therefore probable that in starvation the proteids of the body are broken down and their non-nitrogenous part changed to sugar. Not only does the liver manufacture sugar for the tissues in starvation, but when the supply of sugar is in excess of the demands of the tissues, it stores it as a form of glycogen, and gives it out as sugar as this substance is required. On a carbohydrate diet the accumulation of glycogen in the liver is very great; but even on a proteid diet, in dogs at least, a smaller accumulation takes place. The observation that various monosaccharids are stored as the same form of glycogen, shows that they must first be assimilated by the liver protoplasm and then converted into glycogen. The mode in which glycogen is again changed to sugar is more doubtful. The fact that the liver after treatment with alcohol can change glycogen to glucose, has induced some physiologists to believe that it is by a zymin that this conversion goes on during life. But there is considerable evidence against this view; and it is possible that the conversion results from chemical changes in the liver protoplasm, which are controlled by the nerves of the liver. If too much sugar passes from the liver, or if the tissues do not use up the sugar produced, it appears in the urine, and *glycosuria* occurs.

Though the fats are not carried directly to the liver, like proteids and carbohydrates, they are stored in large amounts in the liver of some animals, *e.g.*, the cod among fishes and the cat among mammals. It appears that animals which have little power of storing fat generally throughout the muscles and other tissues, have a marked capacity for accumulating it in the liver. Even in starvation the fats do not disappear from the liver, and throughout all conditions of life a fairly constant amount of lecithin—a phosphorus and nitrogen containing fat—is present in the liver cells. There is good evidence that the lecithin is a stepping-stone in the formation of the more complex nuclein bodies of living cells; and it is possible that, in the formation of lecithin in the liver by the synthesis of glycerin, fatty acids, phosphoric acid and cholin, the first steps in the construction of the nuclein are carried out. If this is so, the fat of the liver may play an important part in retaining and fixing phosphorus in the body. There is some evidence, though not conclusive, that the liver fats may be formed from carbohydrates.

Along with the intestinal wall, the liver regulates the supply of proteids to the body. Study of the chemical changes in muscle has shown that the waste of proteid is normally small in amount, and that a great part of the nitrogen is capable of being used again if a supply of oxygen and carbonaceous material is forthcoming. Hence the demand for nitrogen in the muscles is small; and for this reason, apparently, any excess of proteid in the food is decomposed to ammonia compounds in the intestinal wall, and these are built into urea in the liver, to be thus excreted. After the splitting of the nitrogenous portion, the liver has the further power of turning the non-nitrogenous part into sugar, and either sending it to the tissues or storing it as glycogen. How far it is also able to perform the initial splitting of the proteid molecule has not been determined, but that it can manufacture urea from proteids without the co-operation of the digesting intestinal wall, is indicated by the constant production of urea in starvation. With one special proteid—hæmoglobin—the liver has important relations. The hæmoglobin breaks down, and the proteid part, which constitutes about 96 per cent. of its weight, is further decomposed, and its nitrogen excreted as urea, while the pigmented hæmatin portion is deprived of its iron and excreted as bilirubin.

The functions of the liver as regards the general metabolism may therefore be summarized thus:—(1) It regulates the supply of glucose to the body, (*a*) by manufacturing it from proteids when the supply of carbohydrates is cut off, and (*b*) by storing it as glycogen when the supply of carbohydrates is in excess, and afterwards giving it off as required. (2) It regulates the supply of proteids to the body, along with the intestinal wall, by decomposing any excess and giving off the nitrogen as urea, &c. (3) It regulates, in many animals at least, the supply of fat to the body by storing any excess. (4) It regulates the number of hæmocytes by getting rid of waste hæmoglobin and retaining the iron for further use.

D. *Excretion.*

Though our knowledge of the various stages of the catabolism of protoplasm is defective, the end products are fairly well known. These are excreted from the body, sometimes in the form in which they leave the tissue producing them, sometimes after further modification. The carbon dioxide and water formed in the tissues are excreted by the lungs (see RESPIRATION, below) and by the kidneys and skin without further change. The creatin of muscle is dehydrated to creatinin in the kidney before being excreted in the urine. As already pointed out, the various ammonia compounds are in the liver built up into urea or into diureides. That ammonia is a source of these diureides in birds, is shown by the fact that exclusion of the liver from the circulation in these animals leads to their disappearance from the urine, and to the appearance of lactate of ammonia in their place. How far in mammals the diureide molecule is derived solely from the splitting of nucleic acid, is not yet definitely known.

Kidneys.

The chief channel of the excretion of the nitrogenous waste products is the kidneys (see ANATOMY). In spite of many investigations, the difficulty of fully and satisfactorily explaining the way in which urine is produced in them has proved insurmountable. What is actually known may be briefly summarized:—(1) The watery part of the urine is produced by a process of filtration from the glomerular tufts. (2) Solids are also excreted from the glomerular tufts, since the fluid in the capsules is *alkaline*, and since such a pigment as sulph-indigotate of soda has been found in the epithelium covering the glomeruli. (3) The specific constituents of the urine are secreted by the epithelium of the convoluted tubules. (4) The convoluted tubules can also secrete water to a very considerable extent. This has been demonstrated by Munk's experiments of stopping the secretion of urine from the glomeruli by section of the cord, and then injecting caffeine, urea, &c., and producing a flow of urine from the tubules. But the old problem, whether any water or solids are reabsorbed in the tubules remains unsolved, though it must be admitted that nearly all the evidence which appears to support this view equally supports the other view, that the urine is changed in the tubules by the addition of solids. The very high osmotic equivalent of the urine as compared with that of the blood plasma is certainly opposed to the view that there is a passage of water from the urine to the plasma, for to bring about such an absorption the cells would have to do an amount of work so enormous that it is impossible to conceive that they accomplish it.

The acid reaction given to the urine in its passage through the tubules may equally well be explained by the absorption of its alkaline constituents, or by the addition of such acids as phosphoric and sulphuric acid. Perhaps the only experimental support for this idea of absorption is to be found in the observation of Ribbert, that removal of the medulla leads to the production of a more watery urine. But some experiments by Francis Boyd have yielded results which do not corroborate those of Ribbert.

In connexion with the action of the kidneys, a very curious observation has been made by Rose Bradford: that if, after one kidney has been removed from the dog, portions of the second are cut out, an increased flow of urine takes place; while if only about one-sixth of the total kidney substance is left, not only polyuria but an increased excretion of nitrogen, resulting from a rapid dissolution of the proteids of the body, chiefly of the muscles, occurs, and the animal dies in a short time. In all probability this is due to the accumulation of some toxic substance in the blood, and not, as has been suggested, to the formation of an internal secretion by the kidney.

Other organs of excretion.

The *Skin* is a channel of excretion of secondary importance compared with the lungs or the kidneys. By it are excreted in the sweat:—(1) Water. (2) Sodium chloride. (3) Nitrogen. (4) Carbon dioxide. (5) Various other substances in small quantities. The excretion of water varies with the temperature, from less than 500 to probably over 3000 c.c. per diem. Of the nitrogen excreted in the sweat, about 68 per cent. is in the form of urea, the rest being in the form of ammonia. The cutaneous excretion of nitrogen may amount to between 4 and 5 per cent. of the renal excretion. The carbon dioxide varies in amount; it probably does not usually exceed 9 grms. per diem, but under the influence of high temperature may rise to over 20 grms. One special modification of cutaneous excretion is the production of *milk*. In the 9th edition of this Encyclopædia the mode of secretion and the composition of milk are dealt with. The mode of secretion has not recently been investigated, but our knowledge of the composition of milk has been considerably extended. The chief proteid, caseinogen, is a pseudo-nucleo-proteid of marked acid character, occurring in a neutral lime combination which is not precipitated on boiling. But whenever the lime combination is split up by an acid, the free caseinogen becomes precipitated. When acted on by the rennet-zymin, caseinogen is split up into whey albumen and into para-caseinogen, which latter combines with the soluble lime salts of the milk to form an insoluble casein. This, with the entangled fats, constitutes the curd. The amount of phosphorus in caseinogen is small—only about ·8 per cent. After separation of the caseinogen, milk is found to contain traces of an albumen and of a globulin. Phosphorus occurs in milk in two organic combinations other than caseinogen: (1) Phosphocarnic acid, a substance which splits into phosphoric acid and carnic acid, which, according to Siegfried, is identical with antipeptone; and (2) Lecithin. It also occurs as inorganic salts of potassium, sodium, and calcium. The proportions of phosphorus in these different combinations vary much in different animals. The subjoined table shows that in human milk the greater amount of the phosphorus is organically combined:—

Per Centage of Phosphorus as P_2O_5.

	Organic.	Inorganic.	Total.	Per Cent. of Organic.
	P_2O_5.	P_2O_5.	P_2O_5.	P_2O_5.
Human . .	0·04	0·007	0·047	85
Cow . .	0·076	0·074	0·150	50
Goat . .	0·13	0·16	0·290	41

From the various *mucous membranes*, but chiefly from the mucous membrane of the bowel, a certain excretion of water, mucus, and various salts takes place. In some herbivora the excretion of phosphates by this channel occurs, to the exclusion of their excretion by the kidneys. Certain salines given as drugs are also got rid of by the lining membrane of the bowel.

The *Liver* as a channel of excretion has been already considered.

(D. N. P.)

Chemistry of Animal Body.

The following is an account of the chemistry of some of the more important substances that occur in the animal body:—

A. Anastates. — Substances which take part in the constructive (anabolic) processes in protoplasm:—

1. *Carbohydrates.*—These are aldehydes or ketones, and derivatives of these formed by polymerization and dehydration. They are for the most part derived from the members of the paraffin series, containing six carbon atoms (hexoses); but derivatives of the pentatomic alcohol (pentoses) have been derived from nucleins. The hexoses are derived from three hexacid alcohols isomeric with one another—mannitol, dulcitol, and sorbitol, $C_6H_{14}O_6$. From the first the sugar mannose is formed; from the second, galactose; and from the third, dextrose. The ketone of mannite is lævulose. Dextrose, or a body closely resembling it, has been prepared synthetically by the polymerization of formaldehyde.

The simplest carbohydrates constitute the group of monosaccharids, of which dextrose, *the* sugar of the animal body, is the most important. They are crystalline substances, readily soluble in water and in hot alcohol, and are fermented by ordinary yeast, yielding alcohol and carbonic acid, and by various micro-organisms, *e.g.*, the *Bacillus lactis*, giving lactic acids. They are readily oxidized in alkaline media; when boiled with caustic potash, they take up oxygen from the air and become brown from the development of acids (Moore's test). If cupric oxide is present, the oxygen is taken from this, and it is reduced to cuprous hydrate (Trommer's and Fehling's test). With phenyl-hydrazin they each form a crystalline compound, an osazone, by which their presence is readily recognized.

Glycuronic acid, $COH-(CH\cdot OH)_4-COOH$, is closely related to dextrose, and on oxidation yields the same acid, saccharic acid, and may be prepared from this by reduction. It does not occur free in the body, but is formed under the administration of various drugs, with which it combines, *e.g.*, camphor, and a large number of aromatic bodies like benzoic acid. These compounds appear in the urine; and since many of them are oxidized when boiled with caustic potash, they reduce Fehling's solution.

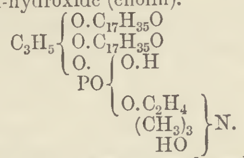
The monosaccharids polymerize with the loss of water, thus—$C_6H_{12}O_6+C_6H_{12}O_6=C_{12}H_{22}O_{11}+H_2O$, and disaccharides are produced. The most important of these are cane sugar (dextrose and lævulose), lactose (dextrose and galactose), and maltose (dextrose and dextrose). These rotate the plane of polarized light to the right, and break up into their component monosaccharids when boiled with an acid. Maltose and lactose are readily oxidized when boiled with an alkali, but cane sugar is not so oxidized.

By further polymerization and loss of water the group of polysaccharids n $(C_6H_{10}O_5)$ is produced, which form a series of bodies commencing with substances of very slightly higher molecular weight than the disaccharids, and extending up to the various starches, &c., which have probably a very large molecule. These most complex molecules are readily broken down by the action of acids, &c., and the series of bodies intermediate between them and the sugars are the dextrins, formed from starch, and the lævulins, formed from inulin. In physiology the most important members of this group are animal starch or glycogen, and vegetable starches and cellulose.

2. *Fats.*—These are ethers, formed by replacing the H of the HO molecule, usually of the triatomic alcohol glycerin, by the radicals of the fatty acids, which are derived by the oxidation of the various alcohols of the paraffin series. The acid with 16 atoms of carbon (palmitic$=C_{16}H_{32}O_2$) and the acid with 18 atoms of carbon (stearic$=C_{18}H_{36}O_2$) enter into the formation of the fat of mammals. Oleic acid ($=C_{18}H_{34}O_2$), a member of the less saturated acid series, is the most abundant acid in the fat. The fats all give a peculiar "oily" sensation, and leave a characteristic stain on various textures. They are insoluble in water, soluble in ether, chloroform, benzene, &c., also in hot alcohol. When dissolved in hot alcohol, palmitin and stearin crystallize out as the alcohol cools in the so-called margarin crystals. The melting-point varies according to the fatty acid which is present; thus olein melts at 5° C., palmitin at 45° C., and stearin at about 60° C. The olein at the temperature of the human body holds the two other fats in solution. They are readily split into glycerin and the characteristic fatty acid, and these may be broken down into fatty acids lower in the series under the action of putrefactive organisms, thus:—

$$\underset{\text{Propionic acid.}}{C_3H_6O_2}+O_3 \;=\; \underset{\text{Acetic acid.}}{C_2H_4O_2}+CO_2+H_2O.$$

In the body of man and other animals certain fats occur which are ethers of other alcohols than glycerin. Thus lanolin is the ether of the monatomic alcohol cholesterin ($C_{26}H_{43}OH$), which is soluble in ether and in hot alcohol, and crystallizes from the latter in characteristic rhombic plates. Lanolin, which occurs in the secretion of the sebaceous glands, combines with water and resists putrefaction in a marked manner. Spermaceti is the palmitate of cetyl alcohol, and beeswax the ether of cerotyl alcohol with cerotic acid. Lecithin is a fat in which one molecule of the radical of the fatty acid is replaced by phosphoric acid linked to trimethyl-oxyethyl-ammonium-hydroxide (cholin).



It is soluble in alcohol and ether, and swells up in water. It readily splits up into glycero-phosphoric acid, fatty acids, and cholin.

3. *Proteids.*—These bodies are of unknown constitution, but they contain the elements carbon, hydrogen, oxygen, nitrogen, and usually sulphur (sometimes also phosphorus in about the same percentage amounts), and give certain characteristic reactions. They constitute by far the greater part of the solids of all matter which has been living, and it is for this reason that they are named Proteids, or first substances. Drechsel gives the percentage composition thus:—

C	50·0 to 55·0
H	6·8 ,, 7·3
N	15·4 ,, 18·2
O	22·8 ,, 24·0
S	0·4 ,, 5·0

The nature of the compounds formed with metals, and the difficulty with which they dialyse through animal membranes, indicate that the proteid molecule is very large. Drechsel studied the magnesia compound of one of the vegetable proteids, and puts the *molecular weight* at 2757, while another investigation of a similar compound of ordinary albumen indicated a molecular weight of 1496. All that is known of the empirical formula is that in albumen it is not smaller than $C_{72}H_{112}N_{18}O_{22}S$, and very possibly the molecule is three times as large. What the constitution of the simplest possible proteid molecule may be has not been determined. We know that when the molecule is broken down, certain products are constantly formed. Among these are: Amido-acids of the fatty acid series, *e.g.*, leucin (amido-caproic acid); amido acids of the benzene series, *e.g.*, tyrosin; and certain ureides, having six carbon atoms, *e.g.*, lysatinin. According to Kossel, the simplest type of proteid is to be found in a series of bodies which are linked with nucleic acid in spermatozoa. These Protamins, when decomposed, take up water and yield the bases above referred to. They do not, however, yield the amido acids which are derived from ordinary proteids, and Kossel regards these as existing in "side chains" to the elementary protamin molecule. The proteids may be recognized by a number of *tests*, of which the most generally useful is the Xanthoproteic reaction. When boiled with nitric acid they decompose, with the formation of certain aromatic bodies, which give a brilliant orange colour with ammonia.

The proteids form a series of polymerization products of their *simplest molecule*, and the various members of the series differ from one another in their solubility and in their rate of diffusion.

Of the "simple proteids," (*a*) *peptones* are the lowest members in the series. They are very soluble, dialyse readily, are not coagulated by heat, and are not precipitated from their solution by saturation with ammonium sulphate. They polymerize, to form a series of (*b*) *proteoses*, which are not coagulated by heat and are precipitated in a saturated solution of ammonium sulphate. The lower members of the series, those most near the peptones, which are not precipitated by sodium chloride, are called the *deutero-proteoses*. The higher members, which are precipitated by that salt, are the *protoproteoses*. (*c*) *Native proteids*, on coagulation by heat, form *coagulated proteids*, and are precipitated by saturated ammonium sulphate. They do not readily dialyse through an animal membrane. When acted upon by acids or by digestive juices, they break down into proteoses, and finally into peptones. Two varieties are known: *Albumens*, which are soluble in distilled water, and are not so readily precipitated by neutral salts as the second variety; and *Globulins*, insoluble in distilled water, soluble in weak solution of neutral salts, and readily precipitated by stronger solutions.

The members of these various groups of proteids tend to link to various other bodies, to form what may be called the "combined proteids." According to the nature of the molecule with which they are linked, these may be classified into the following groups:—(*a*) *Glycoproteids*—a number of proteids, on treatment with acid, yield various sugar-like bodies, and some investigators have thought that there is a carbohydrate element in the proteid molecule. But since from many of the proteids no sugary substance can be prepared, we must consider that the carbohydrate molecule is simply linked to the proteid, possibly forming what Kossel has called a side chain. One of the best marked of this group is Mucin, the substance which gives viscosity to the saliva. (*b*) *Ferro-proteids*—proteids combined with an iron-containing molecule. The best-known of these is the colouring matter of the blood, hæmoglobin, which consists of about 96 per cent. of a globulin linked with about 4 per cent. of hæmatin. (For the chemistry of hæmoglobin see PIGMENTS, below.) (*c*) *Phospho-proteids*—proteids combining with a phosphorus-containing molecule—may be divided into two classes: *Nucleins*, where the proteid is linked to nucleic acid, which on decomposition yields phosphoric acid and the purin bases; and *Pseudo-nucleins*, which on decomposing yield a proteid and a phosphorus-containing acid, the latter readily splitting, to yield phosphoric acid but no purin bases. (*d*) *Phospho-ferro-proteids*, in which the proteid is linked to both a phosphorus and an iron-containing molecule, are illustrated by the vitellin of the yolk of egg. (*e*) *Sulpho-proteids* are proteids to which a considerable amount of sulphur—3 to 5 per cent.—in loose combination is attached. Keratin, the substance composing horn and the outer layer of the skin, is of this nature. (*f*) *Acid and Alkaline Proteids*—Acids and alkalis form combinations with proteids, which are of importance in the process of digestion.

Two peculiar modifications of this proteid group do not find a definite place in this classification:—(*α*) *Elastin*, the substance composing elastic fibrous tissue, which has all the characters of an insoluble proteid, but is free from sulphur; and (*β*) *Collagen*, the substance composing white fibrous tissue, which may be regarded as a combination between a proteid and amido-acetic acid (glycocoll). It yields this latter substance in large amount when heated with an acid. Collagen readily combines with water, to form the well-known gelatin, and with chondroitinsulphuric acid, to form chondrin, the substance of cartilage. This acid is a compound of sulphuric acid with chondroitin, $C_{18}H_{27}NO_{14}$, which decomposes into acetic acid and chondrosin, and which yields, on further decomposition, glycuronic acid and glycosamin.

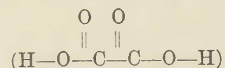
B. Catastates, the substances formed by catabolism of protoplasm in the body, and not further used by it as sources of energy.

I. *Non-Nitrogenous Bodies of the Fatty Acid Series.*

1. *Carbon di-oxide* ($O=C=O$), the substance in which the greater part of the carbon is excreted in the expired air.

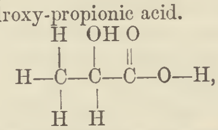
2. *Fatty acids.*—

Oxalic acid,



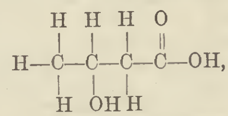
is found in urine as the oxalate of lime. It is chiefly derived from the oxalates in the food, but there is some evidence that it is formed in proteid catabolism.

Lactic acid is a hydroxy-propionic acid.



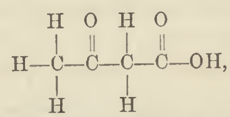
It occurs in the animal body in two isomeric forms. Ordinary lactic acid is obtained by the lactic acid fermentation of sugars, as in the souring of milk. It is a fluid of syrupy consistence, and is optically inactive. Sarcolactic acid is the acid formed in muscle. It is a syrupy fluid, which rotates the plane of polarized light to the right.

β Oxybutyric acid,



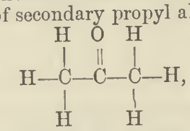
is found in the urine in starvation, in diabetes, and in certain other pathological conditions. It is derived from the decomposition of proteids.

Aceto-acetic acid,



occurs in the urine in the same condition as oxybutyric acid.

Aceton (the ketone of secondary propyl alcohol),



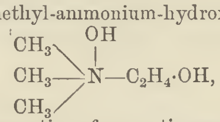
occurs in the urine along with the last two in the same circumstances.

II. *Nitrogenous Substances not of the Benzene Series.*

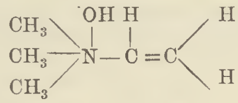
(1) *Ammonia and the Amines.*—

Ammonia (NH_3) is formed in the tissues and in the intestine, probably as the lactate. It is constantly present in the urine in small quantities, and its amount is increased under various pathological conditions of the metabolism.

Hydroxy-ethyl-trimethyl-ammonium-hydroxide (cholin),

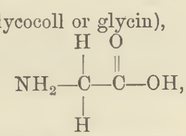


is formed in the disintegration of nerve tissues, being liberated from the lecithin molecule. It is a toxic substance. Neurine appears also to be formed.



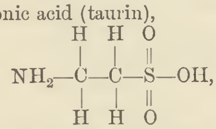
(2) *Amido Acids.*—

Amido-acetic acid (glycocoll or glycin),



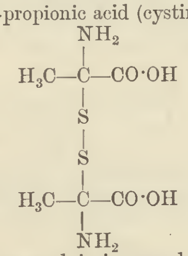
occurs in combination with cholic acid, forming the glycocholic acid of the bile.

Amido-ethyl-sulphonic acid (taurin),



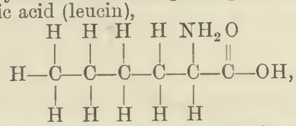
occurs in combination with cholic acid, forming the taurocholic acid of the bile. In the bile acids these are linked with cholic acid, $C_{24}H_{40}O_5$, a substance of unknown constitution.

Disulphide of amido-propionic acid (cystin),



occurs in traces in urine, and is increased in certain pathological conditions. It crystallizes in hexagonal plates.

α Amido-caproic acid (leucin),

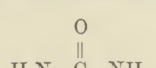


is formed in the pancreatic digestion of proteids, and appears in the urine in certain conditions. It crystallizes in characteristic oily-looking spheres.

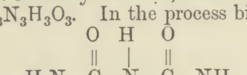
Di-amido-caproic acid (lysin) is a basic substance, also formed in the decomposition of proteids by pancreatic juice.

(3) *Amides.*—

Carbamide (urea),

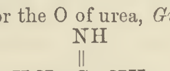


is the chief substance in which nitrogen is excreted in all vertebrates except the sauropsida. It crystallizes in long prisms, and is very soluble in water and alcohol. With nitric and oxalic acid it forms insoluble salts. It readily takes up water, to form carbonate of ammonia. When heated dry it forms cyanic acid, CN·OH, which polymerizes to cyanuric acid, $C_3N_3H_3O_3$. In the process biuret is formed.



With caustic potash and sulphate of copper this strikes a pink colour. With sodium hypobromite in excess of alkali, or under the action of nitrous acid, urea splits into nitrogen, carbonic acid, and water.

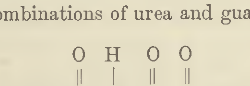
By substituting NH for the O of urea, *Guanidin* is formed.



It does not occur in the body, but is the basis of various important substances.

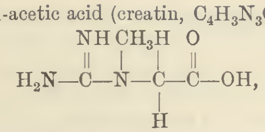
(4) *Ureides* are combinations of urea and guanidin with acids.

Oxaluric acid,

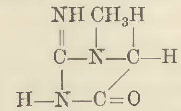


occurs in small traces in urine.

Methyl-guanidin-acetic acid (creatin, $C_4H_3N_3O_2$),



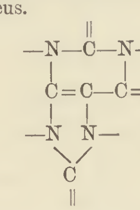
is a constant constituent of muscle. Creatinin is creatin which has lost a molecule of water and assumed a ring structure—



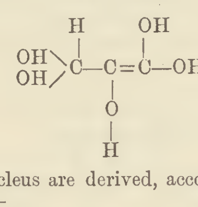
It is a normal constituent of the urine, and is crystalline and a powerful base.

Methyl - guanidin - propionic acid (lysatin) and lysatinin, $C_6H_{13}N_3O_2$, are homologues of creatin and creatinin, formed from proteids in pancreatic digestion.

(5) *Diureides* are formed of two molecules of urea linked through an acid chain. The most important are the Purin bases, derived from a double ring of five carbon and four nitrogen atoms, called by Fischer the Purin Nucleus.

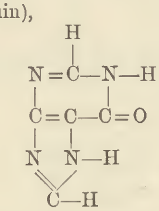


The hypothetical bond here is acrylic acid—an unsaturated propionic acid,

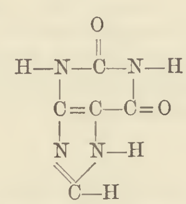


From the Purin Nucleus are derived, according to the degree of oxidation of the acid—

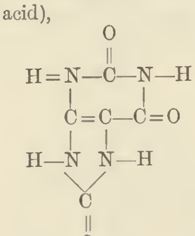
Oxypurin (hypoxanthin),



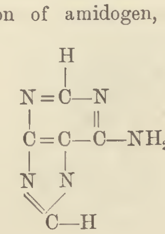
dioxypurin (xanthin),



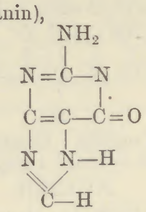
and trioxypurin (uric acid),



By the introduction of amidogen, amino-purin (adenin) is formed,

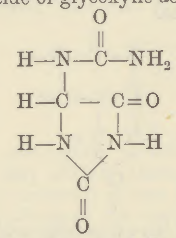


and amino-oxypurin (guanin),



Hypoxanthin and xanthin occur in small quantities in urine and in various organs. Uric acid, a dibasic acid ($NaH\bar{U}\cdot H_2\bar{U}$), is a soluble crystalline substance which occurs in small quantities, probably as sodium quadrurates, in the urine of mammals, and in large quantities in the urine of birds and reptiles. In birds, at least, it is in part formed in the liver from lactate of ammonia. In part it may be derived from the decomposites of nucleic acid. In mammals this is probably its chief source. Adenin was obtained by Kossel from the pancreas. Guanin is very widely distributed throughout the animal kingdom, occurring in the urine of birds, in the scales of fishes, and in many tissues, as the pancreas, liver, &c.

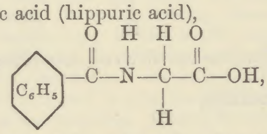
Allantoin is the diureide of glycoxylic acid.



It is a characteristic constituent of the allantoic and amniotic fluids and of fœtal urine, occurring also in the urine of the dog after the administration of uric acid and of nuclein. It crystallizes in small hexagonal prisms.

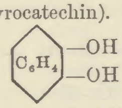
III. *Benzene Derivatives.*

Benzamido-acetic acid (hippuric acid),



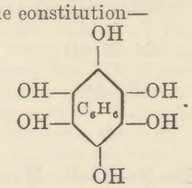
is formed by the union of benzoic acid and amido-acetic acid in the body. The former is derived from the food, the latter is formed in the body from proteids.

Ortho-dioxy-benzene (pyrocatechin).

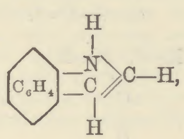


occurs as an ethereal compound with sulphate of potassium, $OH\cdot C_6H_4\cdot O\cdot SO_2OK$. Urine containing this, if exposed to air, especially if it be alkaline, becomes greenish brown or almost black. When boiled with an alkali, it reduces cupric hydrate.

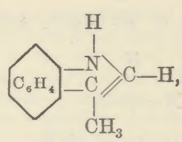
Inosite is a substance which used to be called muscle sugar, but which has probably the constitution—



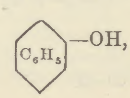
Indol,



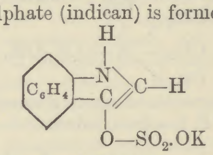
scatol (methyl indol),



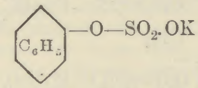
and phenol,



are substances formed by the action of putrefactive organisms upon proteids in the intestine. When absorbed, each is linked to sulphate of potassium, the two former after oxidation. Thus from indol, potassium indoxyl sulphate (indican) is formed—

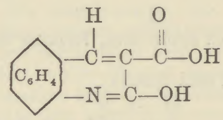


From scatol the scatoxyl sulphate of potassium is similarly produced; and from phenol, potassium phenyl sulphate—

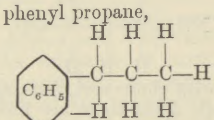


These are excreted in the urine. Indican when oxidized yields indigo blue, while the scatoxyl sulphate yields a reddish pigment.

Oxy-quinoline-carboxylic acid (kynurenic acid) has probably the formula—

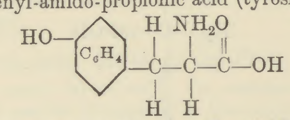


and is a derivative of phenyl propane,



It occurs in the urine of the dog, from which it may be crystallized in long white needles by evaporating and acidulating.

a Hydroxy-phenyl-amido-propionic acid (tyrosin),



is a product of the pancreatic digestion of proteids which crystallizes in sheaves of small acicular crystals, which are found in the urine in certain pathological conditions of the liver.

Pigments.

In this class are grouped, somewhat artificially, a number of substances, characterized by giving, even when present in very small quantities, to the tissue or fluid in which they occur a more or less marked colour. Their chemical nature is, generally speaking, little understood. They may be divided into lipochromes, blood pigments, and the waste pigments of the urine, fæces, and bile.

Lipochromes form a large group of pigments, varying from yellow to red in colour, and very widely distributed in plants and animals. Their name is due to their frequent association with fat. Their chemistry has been most carefully investigated in the carotin of the carrot; and, according to Ehring, they are of the nature of cholesterin fats, but it is very probable that other members of the series have a different chemical nature. Many of these pigments are readily bleached by light, and it is probable that the visual purple (rhodopsin) which occurs in the outer segments of the rods of the retina belongs to this class.

Blood Pigments.—The pigment of the blood, hæmoglobin, is a compound of about 96 per cent. of a globulin with about 4 per cent. of a brown pigment, Hæmatin. The latter contains iron, and has the formula $C_{34}H_{35}N_4FeO_5$. It gives a different spectrum in acid and in alkaline solutions, and in alkaline solution it can take up and give off oxygen. By mineral acids the iron may be removed, leaving a purplish pigment, Hæmatoporphyrin, which has no power of taking up or giving off oxygen. This pigment is, under certain conditions, formed in the body and excreted in the urine. It is closely allied to the bile pigments. Hæmoglobin, as pointed out in the section on RESPIRATION, readily takes up oxygen, to form two compounds: one—very unstable—Oxy-hæmoglobin, of a bright red colour; the other, very stable, of a brown colour, Methæmoglobin. It also forms compounds with other gases, most notably with carbon monoxide.

Waste Pigments.—A. *Of Bile.*—The bile contains a set of pigments closely allied to hæmatoporphyrin, of which the best known is Bilirubin, the probable formula of which is $C_{16}H_{18}N_2O_3$, but the constitution of which is unknown. It is an orange-brown substance which crystallizes in rhombic plates, and is very readily oxidized, forming a series of pigments. One of these, Biliverdin, $C_{16}H_{18}N_2O_4$, has a green colour and gives the characteristic hue to the bile of herbivora.

B. *Of Urine.*—Our knowledge of the chemical affinities of most of these pigments is very deficient. We know that normal yellow urine may undergo changes in colour on standing, and we know that in the fresh condition it does not give any definite bands in the spectrum. From this fresh urine a pigment, Urochrome, may be extracted, a brown hygroscopic substance which gives no definite spectral bands. By treating pure urochrome with a mild reducing agent, such as aldehyde, another colouring matter is developed, which gives a very definite band near Fraunhofer's line F in the spectrum. This is Urobilin, a pigment which, either in the coloured form or as a colourless material capable of yielding the coloured form, is present in the urine in health in small quantities, and in certain pathological conditions in larger amounts. It is probably identical with the pigment of the fæces, and with the Hydrobilirubin (probable formula $C_{32}H_{40}N_4O_7$) which Maly prepared from bilirubin. Uroerythrin is the pink pigment which gives the characteristic colour to deposits of urates. It is extremely unstable, and its chemical nature is unknown. Hæmatoporphyrin is normally excreted in very small quantities in the urine, but in certain pathological conditions it is increased, and gives to the urine a dark brown colour. Its chemical affinities have been already indicated.

The following table of the pigments of the blood, bile, urine, and fæces, shows their relations :—

Methæmoglobin. Oxy-hæmoglobin. Carbon-monoxide-hæmoglobin.

Globin. Alkaline—Hæmatin—Acid.

Oxidized. Reduced.

Iron-containing.

Hæmatoporphyrin. Bilirubin. Hydrobilirubin.
Biliverdin. Urobilin.
&c. Urochrome.

Iron-free.

(D. N. P.)

III. Animal Heat.

Experience has long taught mankind that animals can be divided into two classes, the "warm-blooded" and the "cold-blooded." The first group, composed of the higher animals, mammals and birds, is characterized by the possession of a high bodily temperature; whereas the members of the second class, which consists of the lower animals, reptiles, amphibians, fishes, and invertebrate animals, have a temperature practically the same as that of their surroundings. This difference is one that can be recognized by our sensations of heat and cold, and we are conscious that we belong to the warm-blooded class. Our sensations, however, are not an exact guide; we judge our own bodily temperature and that of other objects from the impression of heat or cold imparted to the nerves of our skin. The temperature of the skin may be low, owing to the presence of a smaller quantity of blood than usual; and hence will arise the impression of cold. We feel cold although the general heat of our body may be perfectly normal. A patient in the shivering stage of a fever looks cold and feels cold, although his internal temperature is at fever heat; on the other hand, in the sweating stage he perspires profusely and complains of feeling hot at a time when his internal temperature may be even below the normal point. In the former case the skin is cold and bloodless, owing to the contracted blood-vessels; in the latter the skin is very hot and red, with distended blood-vessels. We need therefore a much more exact measure of heat, and such we have in the thermometer (Thermometry). With that instrument we can compare accurately the temperatures of different animals and of man in health and disease, but it is necessary that care be taken in the selection of the part of the body in which the observation is to be made. The most suitable parts are those which afford a measure of the heat of the internal portions of the body, such as the bowel (*rectum*), the urine as it issues from the body, the arm-pit (*axilla*), the groin, and the mouth. The thermometer should be retained until the column of mercury becomes stationary. By numerous observations upon men and animals, John Hunter showed that the essential difference between the so-called warm-blooded and cold-blooded animals lies in the constancy of the temperature of the former, and in the inconstancy of the temperature of the latter. He defined the two groups as "animals of a permanent heat in all atmospheres" and "animals of a heat variable with every atmosphere."

In the following table are compared the internal temperatures of man and some of the warm-blooded animals :—

Animal.		Average Rectal Temperature. Deg. C.	(Deg. F.)	Range of Temperature in Health. Deg. C.	(Deg. F.)
Mammals	Man	37·0	(98·60)	36·2–37·8	(97·1–100)
	Horse	37·9	(100·2)	36·1–38·6	(97 –101·5)
	Cow	38·6	(101·5)	37·7–39·6	(99·8–103·3)
	Sheep	40·0	(104·0)	38·5–41·8	(101·3–107·2)
	Dog	38·6	(101·5)	37·1–39·9	(98·8–103·8)
	Cat	38·7	(101·7)	37·9–39·7	(100·2–103·4)
	Rabbit	39·2	(102·5)	37·0–40·8	(98·6–105·4)
	Mouse	37·4	(99·3)	36·1–38·6	(97 –101·5)
	Monkey	38·4	(101·1)	36·9–39·7	(98·4–103·4)
Birds	Common Fowl	41·6	(106·9)	40·6–43·0	(105·1–109·4)
	Pigeon	40·9	(105·6)	40·0–42·5	(104·0–108·5)
	Sparrow	42·1	(107·8)	...	

Lower Animals.—Since the temperature of cold-blooded animals varies with and in the same direction as that of their surroundings, its determination would be incomplete without a simultaneous observation of the air or water in which they live.

Animal.	Temperature of Animal. Deg. C.	(Deg. F.)	Temperature of Surroundings. Deg. C.	(Deg. F.)
Python	24·4	(76·0)	15·6	(60·1)
Frog	17·2	(63·0)	16·7	(62·0)
	8·9	(48·0)	6·7	(44·0)
Trout	14·4	(58·0)	13·3	(55·9)
	5·6	(42·0)	4·4	(39·9)
Shark	25·0	(77·0)	23·7	(74·6)
Crab	22·2	(72·0)	22·2	(72·0)
Leech	13·9	(57·0)	13·3	(55·9)
Locust	22·2	(72·0)	16·7	(62·0)

The data contained in this table show that there is no constant temperature for the cold-blooded animals, and that some members of the group often possess an internal heat considerably above that of their surroundings. The temperature of bees in their hives is often many degrees above that of the air outside; a female python maintains a high temperature when she is coiled round her eggs during the period of incubation. In fact, it is now known that there is no hard and fast line between the cold-blooded and warm-blooded animals. As the Darwinian theory of evolution would suggest, there has been a gradual development of the power of maintaining a constant temperature. The lowest mammals, such as the marsupials, possess a temperature much below that of the higher members of the group; thus the echidna has an internal temperature of 27·5° C. (81·5° F.), the duck-billed platypus (*Ornithorhynchus*) one of 32·0° C. (89·6° F.). Hibernating mammals, such as the marmot, hedgehog, and dormouse, during their winter sleep resemble cold-blooded animals; mammals born in a state of immaturity, naked, blind, and helpless—as are rats and rabbits—resemble cold-blooded animals in many respects, and on exposure to even moderate cold cannot maintain their temperature at the constant level characteristic of the adult. The chick, a warm-blooded animal, passes through a cold-blooded stage during its development within the egg.

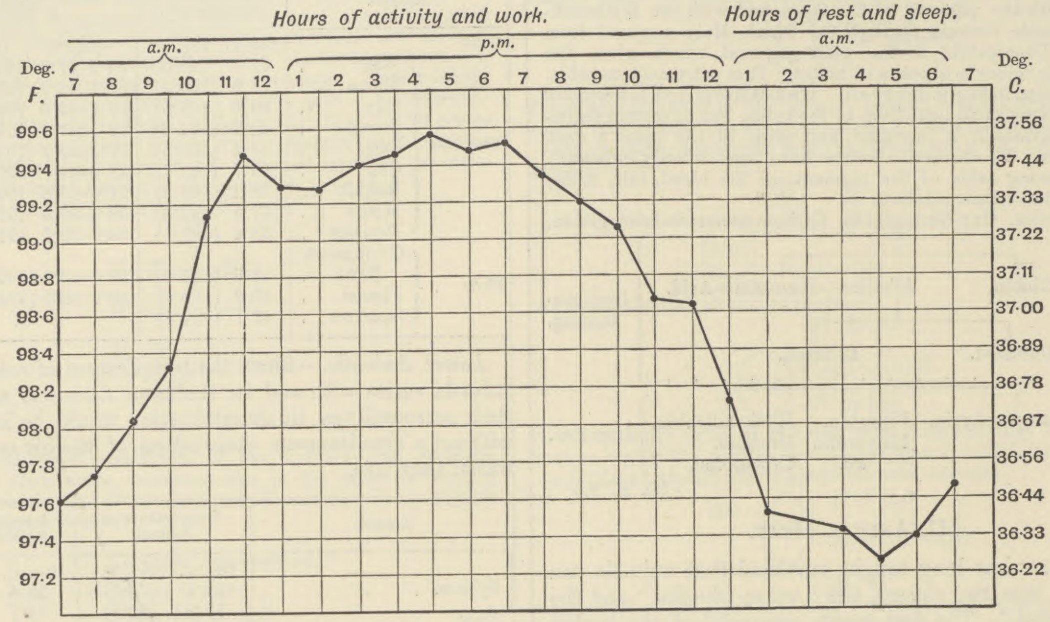
Variations in the Temperature of Man.—A careful study of the internal temperature of man and of other warm-blooded animals shows that the heat of the human body is not absolutely constant even in health, but undergoes slight changes. These fluctuations are caused by various conditions. There is a daily variation in temperature; during the day—the period of activity and work—the heat of the body rises; during the night—the hours of inactivity and sleep—the temperature falls. The range of this variation is about 1·2° C. (2·2° F.), the maximum being generally reached about five o'clock in the afternoon, the minimum about two or three o'clock in the early morning.

Curve of the Daily Variation in the Temperature of a Healthy Man.

Breakfast between	8 a.m. and 9 a.m.	Average mean, 37·01°.
Lunch ,,	1 p.m. and 2 p.m.	Highest mean, 37·54°.
Dinner ,,	7 p.m. and 8 p.m.	Lowest mean, 36·25°.

Tea (about 5 p.m.) not regularly taken.

The causes of this daily variation are to be sought in the greater activity of the body during the day, for if the temperature be observed in men who constantly work by



night and sleep by day, a reversal of the fluctuation is found. This fact alone would suggest that muscular exercise is the important factor in increasing the heat of the body. This source of heat is generally recognized by mankind: in cold weather the body is kept warm by a more energetic walk, by more rapid and more forcible contractions of the muscles than obtain in summer. If this natural safeguard against cold be resisted by an effort of the will, the sensation of cold may become so great and imperative that involuntary contractions of the muscles begin, the teeth chatter, and the body shivers and shakes. This increased muscular activity is accompanied by increased chemical changes and a greater production of heat in the muscles. Thus the injurious effect of cold is resisted. On the other hand, the athlete knows that prolonged and violent muscular effort would raise the temperature of the body so much as to cause great discomfort or actual injury, if he did not increase greatly the loss of heat from his body by discarding much of his ordinary clothing. Muscular exercise even under these conditions increases the internal heat of the body; the rectal temperature rises to 38° C. (100·4° F.) without causing any distress or discomfort. This increased heat from muscular work is most important, although often overlooked. It is responsible for much of the "falling out" and so-called "sunstroke" in soldiers marching in close order and unsuitable clothing on a hot day. The immediate effect of food is a slight rise in the internal temperature of the body. Mental work is accompanied by a slight fall in temperature, owing probably to the concomitant decrease in muscular activity. The temperature of the air has little or no effect upon the internal heat of the body; in the height of summer and the depth of winter, in the tropics with a temperature of 40° C. (104° F.) in the shade, and in the Arctic regions with the thermometer indicating fifty degrees of frost, the temperature of healthy men is practically the same.

Limits compatible with Life.—Although the temperature of warm-blooded animals is so constant during health, in disease great variations above and below the normal occur. In men poisoned by "drink" and exposed to cold, the internal heat of the body may fall as low as 24° C. (75·2° F.), and yet recovery from this unconscious condition may follow careful treatment and nursing. In severe fever the temperature may rise to 45° C. (113° F.) without a fatal result, but above this point death almost invariably occurs. In cold-blooded animals, however, the limits of temperature compatible with life are wider. Fishes and frogs may be frozen and still live if they are carefully thawed. During Franklin's explorations in the Arctic regions, it was observed that a carp, which had been frozen for thirty-six hours, was able after it was thawed to leap about with much vigour.

Regulation of Temperature.—The warm-blooded animals maintain so constant a temperature under such diverse conditions of external heat and cold, that they must possess some power of regulating the internal heat of their bodies. Two processes are comprised, regulation of the production and of the loss of heat. In cold weather the production of heat within the body is increased by greater muscular activity and the consumption of a larger quantity of food; the loss of heat is diminished by a contraction of the cutaneous blood-vessels, the skin becomes pale, and thus less blood is exposed to the cold surroundings. On the other hand, in hot weather muscular activity is less marked, less food is taken, and the body is cooled by the evaporation of sweat and the exposure of more blood in the dilated blood-vessels of the skin. In man the loss of heat is regulated also by the amount and nature of the clothes, and many animals develop special coats of fur for their protection against cold, and shed part of these coats on the approach of warm weather. The perfection of this regulation is shown by the fact already mentioned, that the temperature of man and of other warm-blooded animals is practically the same, whether they are living in the Arctic regions with such severe cold as 55° C. (−67° F.) below zero, or in the tropics with the temperature of the air 59° C. (138° F.). The experiments of Blagden and Fordyce show that even greater heat can be borne for a short time, if the air be dry: they remained fifteen minutes in a dry room heated to 115°–126° C. (239°–259° F.), in which beefsteaks were being cooked by the hot air; they sweated profusely, but their temperature was not raised above the normal.

Nervous Control.—The regulation of temperature is controlled by the nervous system, apparently by the cortical portions of the brain. Drugs, such as alcohol, morphia, chloroform, and ether, which in large doses paralyse or depress the activity of the nervous and muscular systems, disturb the regulation of temperature so much that in some cases the warm-blooded man or animal is reduced to a cold-blooded condition, cannot maintain a constant temperature, and soon dies. The nervous system controls not only the production of heat by impulses carried down the motor nerves to the muscles, but also the loss of heat, regulating through the vaso-motor nerves the diameter of the small blood-vessels, and consequently the distribution of blood to the superficial and deep portions of the body. Further, it controls the discharge of sweat, the evaporation of which cools the body; it adjusts the rapidity and depth of breathing—an important process in the regulation of the loss of heat, for the air driven out of the lungs has been raised almost to the temperature of the body, and is saturated with moisture which has evaporated from the respiratory tract. In some animals this factor is the essential one. Dogs breathe very rapidly, with open mouth and lolling tongue, when they suffer from heat; and if this natural means of cooling be prevented, as by a tight muzzle, their temperature rises much above the normal, and they suffer great discomfort and actual injury.

Sources of Animal Heat.—The real source of animal heat is now known to be a combustion or oxidation within the tissues of the body. The animal takes in food, which on combustion within the tissues of the body manifests its energy chiefly in two forms, heat and motion. Different foods have different values as producers of heat; thus one gramme (15·4 grains) of dry meat produces in the body about 4000 calories, or sufficient heat to raise 4000 cubic centimetres (7 pints) of water one degree; similar weights of dry sugar and fat yield on combustion about 4180 and 9400 calories respectively (see the section on RESPIRATION and the article on DIETETICS). A consideration of the law of conservation of energy would lead to the conclusion that the sole cause of animal heat is a chemical process, a combustion of food substances by the oxygen taken in by the animal. Rubner has shown by prolonged and careful experiments that in animal heat this great law is true. The following values may be given for the heat value of the daily diet of an adult man:—

120 grammes	proteid	× 4000 calories	= 480,000
90 ,,	fat	× 9423 ,,	= 848,070
330 ,,	carbohydrate	× 4182 ,,	= 1,380,060
			2,708,130 calories.

Calculations and experiments show that an adult man produces in twenty-four hours nearly 3,000,000 calories, or enough heat to boil about five or six pints of water; at the same time there is a continuous loss of heat, so carefully regulated that the internal temperature of the body remains constant.

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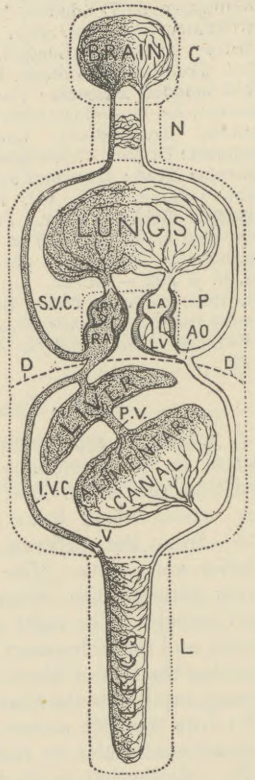
IV. VASCULAR SYSTEM.

General principles of the circulation.

A schematic representation is given of the circulatory system in the accompanying diagram. (For the detailed structure see *Ency. Brit.*, 9th ed., vol. xxiv.) The venous blood flows into the right auricle (RA) from the superior vena cava and the inferior vena cava. The right ventricle (RV) drives through the lungs the blood received from the right auricle. The right auriculo-ventricular valve, or tricuspid, and the pulmonary semi-lunar valve are represented directing the flow of blood in this direction. From the pulmonary capillaries the blood returns by the pulmonary veins (PV) into the left auricle (LA), and so through the left auriculo-ventricular or mitral valve into the left ventricle (LV). By the left ventricle the blood is driven through the aortic semi-lunar valve, and is distributed to the systemic arteries, and so to the capillaries of the various organs and back to the veins. The muscular wall of the auricles and that of the right ventricle are, as represented in the diagram, much thinner than that of the left ventricle. This is so, because the energy required of the left ventricle must exceed that of the right ventricle, inasmuch as the resistance in the systemic system exceeds that in the pulmonary circuit. The pulmonary vessels are of greater diameter, and the circulation through them is aided by the respiratory movements. The large arteries are of less capacity than the corresponding veins, and their walls are essentially extensile and elastic. The pulmonary arteries are especially extensile.

The elastic coefficients of the several layers of the coat of an artery increase from within out, and thus great strength is obtained with the use of a small amount of material. Over-expansion of the arteries is checked by an external coat of inextensile connective tissue. The elasticity of a healthy artery is almost perfect, while the breaking strain is very great and far above that exerted by the blood pressure. The small arteries and arterioles are essentially muscular tubes, and can, under the influence of the central nervous system, vary considerably in diameter. The "tone" of these vessels also directly depends on the quality and pressure of the blood. The arterioles open into the capillaries, and these are so numerous that each organ may be regarded as a sponge full of blood. The skeletal muscles and the muscular walls of the viscera at each contraction express the blood within them, and materially influence the circulation. The whole muscular system, as well as the heart, must therefore be regarded as a pump to the vascular system. The capillary wall is composed of a single layer of flattened cells, separating the blood within from the tissues without. Through this layer, which is of extraordinary tenuity, there takes place an exchange of material between the blood and the tissues, an exchange which does not exactly follow any of the known laws of filtration, osmosis, or diffusion, but depends on the physico-chemical conditions which characterize the living state of the cells. These conditions still await elucidation. The capillaries, in spite of the extreme tenuity of their walls, can, owing to their small diameter ($\frac{1}{100}$ mm.), withstand more than double the blood-pressure produced by the systole of the heart. (The circular tension equals the lateral pressure multiplied by the radius; the longitudinal tension is equal to half this product.) The veins are of larger calibre than the corresponding arteries, and have tough and inextensile walls. Their walls are muscular, and contract on local stimulation. There is no clear evidence, except in the case of the portal vein, that the veins are directly controlled by the central nervous system. The veins are not, as a rule, distended with blood to their full potential capacity. The latter is so great that the whole blood of the body can collect within the veins.



Scheme of the circulation of the blood in man, standing erect. The venous system is stippled. C, rigid cranial wall; N, muscles and cutaneous wall of neck; T, thoracic wall; A, muscular and cutaneous wall of abdomen; D, diaphragm; L, muscles and cutaneous wall of limbs; P, pericardium; AO, aorta; S.V.C, I.V.C, venae cavae; P.V, portal vein; V, valves in veins of neck, or legs; RA, LA, right and left auricles; RV, LV, right and left ventricles.

The heart and lungs are placed within the thoracic cavity (T), the floor of which is formed by the muscular diaphragm (D); the heart is itself enclosed in a tough inextensile bag, *the pericardium* (P), the function of which is to check over-dilatation of the heart. The pericardium bears to the muscular wall of the heart the same relation as the leather case of a football does to the bag within. The abdominal organs and blood-vessels are encompassed by the muscular wall of the abdomen (A), and may be regarded as enclosed in a sphere of muscle. Above is the dome of the diaphragm (T), and below the basin-like levator ani, closing the outlet of the pelvis; in front are the recti muscles, behind the quadrati lumborum and the spine; while the oblique and transverse muscles complete the wall at either side. The brain is enclosed in a rigid and unyielding box of bone—*the cranium*, while the limbs are encompassed by the extensile and, in health, taut and elastic skin.

If the vascular system were formed of wide tubes, free from constrictions, each systolic pulse-wave would travel with so great a velocity that the whole system would reach the same pressure before the next systole of the heart occurred. This is not so, for the friction of the blood flowing through the arterioles prevents it from passing through with anything like the velocity of the pulse-wave. The pulse-wave travels, in fact, 8 metres per second, while the blood in the arteries travels $\frac{1}{3}$ metre. The resistance to flow is chiefly situated, not in the capillaries, but in the small arteries, where the velocity is high; for "skin friction"—that is, the friction of the moving concentric layers of blood against one another and against the layer which wets the wall of these blood-vessels is proportional to the surface area and to the viscosity of the blood—is nearly proportional to the square of the velocity of flow, and is inversely proportional to the sectional area of the vessels. Owing to the resistance to the capillary outflow, the large arteries are expanded by each systolic output of the heart, and the elasticity of their walls comes into play, causing the outflow to continue during the succeeding diastole of the heart. The conditions are such that the intermittent flow from the heart is converted into a continuous flow through the capillaries. If the arteries were rigid tubes, it would be necessary for the heart to force on the whole column of blood at one and the same time; but, owing to the elasticity of these vessels, the heart is saved from such a prolonged and jarring strain, and can pass into diastolic rest, leaving the elasticity of the distended arteries to maintain the flow. As a result of disease, the elastic tissue may degenerate and the arteries become rigid. It has been well said that "a man is as old as his arteries." Besides the saving of heart-strain, there are other advantages in the elasticity of the arteries. It has been found that an intermittently acting pump maintains a greater outflow through an elastic than through a rigid tube; that is to say, if the tubes be of equal bore. Œdema and obstruction to the circulation quickly arise if the blood be delivered to an organ from a constant head of pressure in place of an intermittently acting pump. To maintain an efficient artificial circulation through a "surviving organ," the period of systole must be made, as in nature, half as short as the period of diastole, so delicately attuned are the finer vessels to this periodic wave motion.

Suppose, in an animal lying in the horizontal posture, the heart be arrested, *e.g.*, by stimulation of the vagus nerve, then the arteries, owing to their elastic resilience and contractility, continue to drive the blood through the capillaries. The blood, under the influence of gravity, collects in the venous system, fills the right side of the heart, and congests in the capillaries in the most dependent parts of the body. So soon as the heart starts again to beat, the blood is taken from the venous system and piled up in the arteries, for at each systole of the heart a greater quantity of blood is driven into the arteries than can escape through the capillaries. With each succeeding systole, therefore, the blood-pressure mounts in the arteries, while the venous pressure cannot sink below the atmospheric pressure, in spite of the continued abstraction of blood, for the flaccid walls of the veins collapse. After the first few strokes of the heart, a condition of equilibrium is established as the outflow through the capillaries, during the period of each cardiac cycle, becomes equal to the volume of blood expelled by the heart at each systole. The continuous flow of blood thus established through the capillaries is due to the difference between the blood-pressure in the arteries and that in the veins. The energy imparted to the mass of blood expelled at each systole is spent in overcoming the resistance and is dissipated into heat. The potential energy of the blood is indicated by the lateral pressure; the kinetic energy varies as the square of the velocity of flow. The lateral pressure is reduced from 110 mm. of mercury in the arteries to 30–40 mm. in the capillaries, while the velocity of flow diminishes from 300 mm. per second in the arteries to 1 mm. per second in the capillaries. The kinetic energy of the systolic output is thus reduced to $(\frac{1}{300})^2$ of its value in the aorta. In the veins the lateral pressure continues to fall, while the velocity increases until in the venæ cavæ it reaches a value not less than half that in the aorta. The increase of kinetic energy in the veins is due partly to the change of potential into kinetic energy, but chiefly results from other sources of energy, such as the compressive action of the skeletal muscles, the influence of gravity, and the action of the respiratory pump.

In each unit of time the same quantity of blood must, on the average, flow through the lesser and greater circuit, for otherwise the circulation would not continue. Likewise, the average velocity at any part of the vascular system must be inversely proportional to the total cross-section at that part. In other words, where the bed is wider, the stream is slower; the total sectional area of the capillaries is roughly estimated to be 700 times greater than that of the aorta or venæ cavæ. Any general change in velocity at any section of this circuit tells both backwards and forwards on the velocity in all other sections, for the average velocity in the arteries, veins, and capillaries, these vessels being taken respectively as a whole, depends always on the relative areas of their total cross-sections.

The velocity of flow can be determined in any organ by injecting salt solution into an artery, and observing, with the aid of a Wheatstone's bridge arrangement, the galvanometric change in electrical resistance which occurs in the corresponding vein when the salt solution reaches it. The moment of injection and that of the alteration in resistance are observed with a stop-watch (Stewart).

The venous side of the vascular system, owing to the great capacity of the veins, is not filled to distension, while many of the capillaries in each organ are empty and collapsed, except at those periods of vaso-dilatation and hyperæmia which accompany extreme activity of function. The vascular system cannot be regarded as a closed system, for the blood-plasma, whenever the capillary pressure is increased, transudes through the capillary wall into the tissue-spaces and enters the lymphatics. Thus, if fluid be transfused into the circulatory system, it not only collects in the capacious reservoirs of the veins and capillaries—especially in the lungs, liver, and abdominal organs—but leaks into the tissue-spaces. Hence the pressure in the vascular system cannot be raised above the normal for any length of time by the injection of even enormous quantities of fluid. The lymphatics of tissue-spaces must be regarded as part of the vascular system. There is a constant give and take between the blood-plasma and the tissue lymph. If the fluid part of the blood be increased, then the capillary transudation becomes greater, and the excess of fluid is excreted from the kidneys and glands of the alimentary canal. If the fluid part of the blood diminish, then fluid passes from the tissue-spaces into the blood, and the sensation of thirst arises, and more drink is taken. The vascular system is especially constructed so that considerable changes of pressure may be brought about in the arterial section, without any (or scarcely any) alteration of the pressures in the venous or pulmonary sections of the circulatory system. A high-pressure main (the arteries) runs to all the organs, and this is supplied with taps; for by means of the vaso-motor nerves which control the diameter of the arterioles, the stream can be turned on here or there, and any part flushed with the blood, while the supply to the remaining parts is kept under control. Normally, the sum of the resistances which at any moment opposes the outflow through the capillaries is maintained at the same value, for the vascular system is so co-ordinated by the nervous system that dilatation of the arterioles in any one organ is compensated for by constriction in another. Thus the arterial pressure remains constant, except at times of great activity.

The mean arterial pressure can be measured in man with considerable accuracy by means of the sphygmometer of Hill and Barnard. Fluid pressure is applied to the radial or brachial artery by an apparatus which indicates on a scale the size of the pulse-oscillations and the pressure employed to compress the artery. The pressure is read on the scale at the point where the pulse-oscillations appear to be maximal, for the wall of the artery oscillates most freely when the mean pressure within and without the artery are the same. The measurements are made with the arm on the same level as the heart, in order to avoid the influence which gravity exerts on the blood pressure. The normal mean arterial pressure is 100–110 mm. Hg. In a healthy man it is slightly higher in the erect than in the recumbent posture. The pressure rises to 120–150 mm. of mercury during bodily exertion or mental excitement, and falls to 95–100 mm. during rest in the recumbent posture or during sleep. By the same instrument the venous pressure can be ascertained. The instrument is applied to one of the veins at the back of the hand, the vein emptied, and the pressure noted at which the vein fills with blood.

The Circulation during Muscular Activity.—The great splanchnic area of arterioles acts as "the resistance box" of the arterial system. By the constriction of these arterioles during mental or muscular activity the blood-current is switched off the abdominal organs on to the brain and muscles, while by dilating during rest and digestion they produce the contrary effect. The constriction of the splanchnic vessels does not sensibly diminish the capacity of the total vascular system, for the veins possess little elasticity. Thus variations of arterial pressure, brought about by constriction or dilatation of the arterial system, produce little or no effect on the pressure in the great veins or pulmonary circuit. Owing to this fact, the diastolic, or filling, pressure of the heart varies but slightly, while the arterial pressure is, at times of great effort, considerably raised, both by the increased energy of the heart and by vaso-constriction. It is obviously of the utmost importance that the heart should not be over-dilated by an increased filling pressure during the period of diastole.

When a man strains to lift a heavy weight he closes the glottis, and by contracting the muscles which are attached to the thorax, raises the intrathoracic pressure. The rise of intrathoracic pressure aids the pericardium in supporting the heart, and prevents over-dilatation by resisting the increase in blood pressure. This increase results from the powerful and sustained contraction of the abdominal and other skeletal muscles. In the diagram it is clear that the contraction of T will counteract the contraction of A. At the same time the rise of intrathoracic pressure supports the lungs, and prevents the blood, driven out from the veins, from congesting within the pulmonary vessels. Over-dilatation both of the heart and lungs being thus prevented, the blood expressed from the abdomen is driven through the lungs into the left ventricle, and so into the arteries. So long as the general and intense muscular spasms continue, there is increased resistance to the outflow of the blood through the capillaries both of the abdominal viscera and the limbs. The arterial pressure rises, therefore, and the flow of blood to the central nervous system is at first greatly increased. The rise of the intrathoracic and intra-abdominal pressures, and the sustained contraction of the skeletal muscles, alike hinder the return of venous blood from the capillaries to the heart, and, owing to this, the face and limbs become congested until the veins stand out as knotted cords. It is obvious that at this stage the total capacity of the vascular system is greatly diminished, and the pressure in all parts of the system is raised. It is during such a muscular effort that a degenerated vessel in the brain is prone to rupture and occasion apoplexy. The venous obstruction quickly leads to diminished diastolic filling of the heart, and to such a decreased velocity of blood-flow that the effort is terminated by the lack of oxygen in the brain. During any violent exercise, such as running, the skeletal muscles alternately contract and expand, and the full flood of the circulation flows through the locomotor organs. The stroke of the heart is then both more energetic and more frequent, and the blood circulates with increased velocity. Under these conditions the filling of the heart is maintained by the pumping action of the skeletal and respiratory muscles. The abdominal wall is tonically contracted, and the reserve of blood is driven from the splanchnic vessels to fill the dilated vessels of the locomotor organs. The thorax is tonically elevated and the thoracic cavity enlarged, so that the pulmonary vessels are dilated. At each respiration the pressure within the thoracic cavity becomes less than that of the atmosphere, and the blood is aspirated from the veins into the right side of the heart and lungs; conversely, at each expiration the thoracic pressure increases, and the blood is expressed from the lungs into the left side of the heart. While the respiratory pump at all times renders important aid to the circulation of the blood, its action becomes of supreme importance during such an exercise as running. The runner pants for breath, and this not only increases the intake of oxygen, but maintains the diastolic filling of the heart. It is of the utmost importance that man should grasp the fact that the circulation of the blood depends not only on the heart, but on the vigour of the respiration and the activity of the skeletal muscles. Muscular exercise is for this reason a *sine quâ non* for the maintenance of vigorous mental and bodily health. Under the influence of the muscular system comes not only the blood but the lymph. The lymphatics form a subsidiary system of small valved vessels, and drain the tissues of the excess of lymph, which transudes from the capillaries of the organs during functional activity, or in consequence of venous obstruction. The larger lymphatics open into the veins at the root of the neck. It is chiefly by the compressive action of the skeletal and visceral muscles, and the aspirating action of the respiratory pump, that the lymph is propelled onwards. It must be borne in mind that the descent of the diaphragm during inspiration compresses the abdominal organs, and thus aids the aspirating action of the thorax in furthering the return to the heart both of venous blood and of lymph.

Influence of Posture on the Circulation.—The circulation remains efficient not only in the horizontal but also in the erect position, and just as much so when a man, like a gymnast, is ceaselessly shifting the position of his body. Yet in a man standing six feet the hydrostatic pressure of a column of blood reaching from the vertex to the soles of the feet is equal to 14 cm. of mercury. The blood, owing to its weight, continually presses downwards, and under the influence of gravity would sink if the veins and capillaries of the lower parts were sufficiently extensile to contain it. Such is actually the case in the snake or eel, for the heart empties so soon as one of these animals is immobilized in the vertical posture. This does not occur in an eel or snake immersed in water, for the hydrostatic pressure of the column of water outside balances that of the blood within. During the evolution of man there have been developed special mechanisms by which the determination of the blood to the lower parts is prevented, and the assumption of the erect posture rendered possible. The pericardium is suspended above by the deep cervical fascia, while below it is attached to the central tendon of the diaphragm. Almost all displacement of the heart is thus prevented. The pericardium supports the right heart when the weight of a long column of venous blood suddenly bears upon it, as, for example, when a man stands on his head. The abdominal viscera are slung upwards to the spine, while below they are supported by the pelvic basin and the wall of the abdomen, the muscles of which are arranged so as to act as a natural waist-band. In tame hutch rabbits, with large patulous abdomens, death may result in from 15 to 30 minutes if the animals are suspended and immobilized in the erect posture, for the circulation through the brain ceases and the heart soon becomes emptied of blood. If, however, the capacious veins of the abdomen be confined by an abdominal bandage, no such result occurs. Man is naturally provided with an efficient abdominal belt, although this in many is rendered toneless by neglect of exercise and gross or indolent living. The splanchnic arterioles are maintained in tonic contraction by the vaso-motor centre, and thus the flow of blood to the abdominal viscera is confined within due limits. The veins of the limbs are broken into short segments by valves, and these support the weight of the blood in the erect posture. The brain is confined within the rigid wall of the skull, and by this wall are the cerebral vessels supported and confined when the pressure is increased by the head-down posture. Every contraction of the skeletal muscles compresses the veins of the body and limbs, for these are confined beneath the taut and elastic skin. The pressure of the body against external objects has a like result. Guided by the valves of the veins, the blood is by such means continually driven upwards into the venæ cavæ. If the reader hangs one arm motionless, until the veins at the back of the hand become congested, and then either elevates the limb or forcibly clenches the fist, he will recognize the enormous influence which muscular exercise, and continual change of posture, has on the return of blood to the heart. It becomes wearisome and soon impossible for a man to stand motionless. When a man is crucified—that is to say, immobilized in the erect posture—the blood slowly sinks to the most dependent parts, œdema and thirst result, and finally death from cerebral anæmia ensues. In man, standing erect, the heart is situated above its chief reservoir—the abdominal veins. The blood is raised by the action of the respiratory movements, which act both as a suction and as a force pump, for the blood is not only aspirated into the right ventricle by the expansion of the thoracic cavity, but is expressed from the abdomen by the descent of the diaphragm. When a man faints from fear, his muscular system is relaxed and respiration inhibited. The blood in consequence sinks into the abdomen, the face blanches, and the heart fails to fill. He is resuscitated either by compression of the abdomen, or by being placed in the head-down posture. To prevent faintness and drive the blood-stream to his brain and muscles, a soldier tightens his belt before entering into action. Similarly, men and women with lax abdominal wall and toneless muscles take refuge in the wearing of abdominal belts, and find comfort in prolonged immersion in baths. It would be more rational if they practised rope-hauling, and, like fishermen, hardened their abdominal muscles.

The Heart-Beat.—The rhythmic systole and diastoles of the heart are the result of oscillations between processes of catabolism and anabolism, which take place in its chemical structure. The function of the heart is fundamentally an automatic one. The rhythmic beat is not excited by stimulation from without, but is provoked by the chemical condition of the sarcoplasm of the cardiac muscle itself, and this in its turn ultimately, but not immediately, depends on the rate of flow and the quality of the blood which circulates through the coronary vessels. During diastole the production of synthetic compounds—the hypothetical "inogens" of Hermann—is, it is supposed, pushed to the maximal limit of instability until there results, in the ensuing systole, an explosive liberation of energy. The autonomy of the heart is shown by the fact that the mammalian heart continues to beat for hours if fed through the coronary vessels with warm oxygenated defibrinated blood. If oxygen be supplied to the excised heart, at a tension of two atmospheres, a very small quantity of blood is sufficient to maintain activity (Porter). It is clear, therefore, that there is in the heart a large reserve supply of explosive material. Similarly, the excised and bloodless heart of the cold-blooded animal, if merely kept cool and moist, continues to beat for hours and even days. The beat of the heart does not, therefore, depend on excitations received from the central nervous system, and neither does it emanate from a rhythmic activity of these ganglion cells which lie scattered in the cardiac muscle at the base of the heart. That this is so is shown by the fact that every bit of the heart muscle, whether free of ganglion-cells or not, is capable, under suitable conditions, of rhythmic activity (Gaskell, Engelmann, Porter). The inherent power of rhythmic contraction is most clearly seen in the embryonic heart, for the pulsation of the chick's heart becomes visible by the twenty-fourth to the forty-eighth hour of incubation, while the migration of ganglion-cells into the heart from the sympathic system does not take place until the sixth day (His, jun.). In an automatic organ, such as the heart, it is the accumulation of the explosive bioplasm which, in itself, unassisted by any external stimulus, provokes explosion. The anatomical elements of the heart are singly- or doubly-nucleated, branched, and cross-striated muscle-cells. In contradistinction to cross-striated muscle, the structural unit of the heart is not also a functional unit, for the heart-cells are, from the earliest stage of development, joined together by branches into networks and bands so as to form one functional whole, and hence excitation of any one part leads to the contraction of the whole. The first part to begin to functionate in the embryo is the venous end, and the waves of contraction passing thence spread over the developing ventricular segment. The muscle-cells of the ventricles are thicker, less sarcoplasmic, and more clearly striated than the auricular muscle, which is more embryonic in structure. The contraction lasts longer in the ventricular than in the auricular muscle, while the automatic rhythm not only persists longer in the auricles, but is of a greater frequency, as is clearly seen when the cavities of the heart are divided from each other. The venous orifices of the heart are least sensitive to injury, beat longest after death, and are the first to recover after arrest. Owing to the more powerful automatism of the venous extremity, the contraction normally proceeds thence, and, passing as a peristaltic wave over the auricles and ventricles, finally reaches the arterial orifices. This peristaltic form of contraction is invariable in all periods of development and in all hearts both of invertebrate and vertebrate animals. The peristalsis may, with difficulty, be artificially reversed by the application of a powerful rhythmic stimulus to the ventricular end. Antiperistalsis does not, however, take place easily, because the comparatively slow excitation process in the ventricle has little effect on the auricular muscle. The latter, by initiating more rapid contraction-waves, over-dominates the former. The frequency of the whole heart is accelerated by warming the auricles, while the period of systole is alone shortened on warming the ventricles. The segmentation of the cardiac contraction into auricular and ventricular systole depends upon certain muscle-cells, of embryonic type, which bridge the otherwise complete septum of connective tissue that divides the auricles from the ventricles (Kent, His). These fibres are endowed with a sluggish power of conductivity, and hence the peristaltic wave is at this point resisted and retarded. There is no convincing evidence in support of the view that the excitation is transmitted through the heart, and the contraction regulated in sequence, by the nerve ganglia of the heart. The velocity of conduction of the excitation wave (5 metres per second) speaks against this hypothesis, for the rate is six times less rapid than in nerve (Engelmann). By the study of the electrical current—*i.e.*, the current of action which accompanies the systole—with the aid of the capillary electrometer, it has been determined that the contraction of the heart is a simple twitch and not a tetanus (Sanderson and Page, Waller and Reid).

The heart during the period of systole is refractive to artificial excitation, but its susceptibility returns with diastole. The force and amplitude of any cardiac contraction depend on the previous activity of the heart and on such physical conditions as the degree of diastolic filling, the resistance to systolic outflow, temperature, &c., but are independent of the strength of the artificial stimulus so long as the latter is efficient. Owing to the refractory period, the slow rate of contraction, and the independence of the amplitude of contraction on the strength of stimulus, the heart cannot be thrown, by rapidly-repeated excitation, into a complete state of tetanic spasm. The cardiac muscle is rich in sarcoplasm, and on this depends its power of slow, sustained contraction. The heart-muscle besides rhythmically contracting possesses "tone," and this tone varies with the conditions of metabolism, temperature, &c. Chloroform, for example, produces a soft dilated, and strychnine or ammonia a tonically contracted, heart. The auricular muscle in some animals undergoes rhythmic oscillations of tone. The ganglion-cells, which first wander into the embryonic heart several hours after it has started beating, can be removed without disturbing the cardiac rhythm. Extra-cardiac nerves from the vagus and from the sympathetic system end in these ganglia. From these ganglion-cells there pass non-medullated, intracardiac nerve-fibres, which spin a fine-meshed network through all parts of the cardiac muscle. The study of development, and of comparative anatomy, alike show that the nervous system of the heart becomes more complicated with increasing complication of structure. A great many of the cardiac nerve-fibres are centripetal. These fibres pass in the vagus nerves up to the spinal bulb, and reflexly regulate the heart-frequency, the breathing, and the tonus of the blood-vessels. For example, the stimulation of certain fibres, termed *depressor*, causes dilatation of the arterioles and a fall of arterial pressure by inhibiting the tonic action of the vaso-motor centre in the spinal bulb. The depressor fibres come into action when the systolic output is resisted by over-constriction of the arterioles. The centripetal impulses which proceed from the normal heart do not enter into consciousness. The centrifugal cardiac nerves influence the frequency, the force of contraction, and the conductivity of the excitatory wave (chrono-, ino-, and dromo-tropism of Engelmann). The inhibitory fibres running in the vagi arise from a centre in the spinal bulb which is in tonic action and constantly curbs the heart. The function of the vagi is to decrease the frequency, force, and conductivity. The acceleratory and augmentory fibres are likewise in tonic action and antagonize the action of the vagi. These fibres arise from the anterior spinal roots in the upper thoracic region, and form synapses with the ganglion-cells in the first thoracic sympathetic ganglia. The vagus nerve works directly on the cardiac muscle-fibre, and produces, it is supposed, a chemical change whereby the conductivity, the excitability, and force are lowered. After a period of arrest, produced by vagal excitation, the heart beats more strongly, for the process of anabolism is increased thereby. The converse occurs after excitation of the sympathetic fibres. The function of the cardiac nerves is to co-ordinate the beat of the heart with the needs of the body and to co-ordinate the functions of other organs with the needs of the heart. For example, an undue rise of arterial pressure, induced, let us say, by compression of the abdomen, excites the centre of the vagus and produces slowing of the heart and a consequent lowering of arterial pressure. The heart of a mammal, however, continues to functionate after a section of all the branches of the cardiac plexus has been made, so that the nervous control and co-ordination of the heart are not absolutely essential to the continuance of life (Krehl).

The work of the heart, attained by multiplying the volume of the systolic output by the arterial pressure, *i.e.*, the height of the lift, has hitherto been reckoned at too high a rate. The output is not greater than 60–100 c.c. (3 oz.) (Tigerstedt, Zuntz), and the mean arterial pressure in a healthy man, determined by the sphygmometer, is not more than 110 mm. of mercury (L. Hill). The work of the right heart can be reckoned to be $\frac{1}{3}$ that of the left, for the pressure in the pulmonary artery does not exceed 40 mm. The total work of the heart during the day may be taken as equal to 20,000 kilogrm.-metres, and this would be equivalent to 50 Calories out of the total 2500 Calories which a man takes in as food. The total work is increased two or three times over by very severe muscular labour. It has been estimated that the heart requires per diem, to maintain its energy, an amount of solid food (water-free) equal to the weight of solids in the heart itself, *i.e.*, about 60 grms. of sugar or proteid (Stewart). 30 c.c. of blood must be circulated per minute through the coronary arteries of a dog to maintain the vigour of the heart.

Changes of Pressure in the Heart during the Cardiac Cycle.—Much labour has been spent in the contrivance of rapidly-acting spring pressure gauges, freed as far as possible from inertia, in order to investigate the changes of intracardiac pressure, which were first described by Chauveau and Marey (cf. *Ency. Brit.* vol. xxiv. VASCULAR SYSTEM). As the intraventricular pressure may rise 150 mm. of mercury in $\frac{1}{10}$ of a second, it is no easy matter to contrive an instrument which will respond as rapidly and yet yield an accurate result without overshooting the mark. The final result of a most careful inquiry is the confirmation in almost every point of Chauveau and Marey's pressure curves. Hürthle's differential manometer has proved to be an instrument of great value and precision. A double-bored tube cannula is introduced so that one tube reaches the right auricle and the other the right ventricle. In observations on the left side of the heart, one tube is placed in the left ventricle and the other in the aorta, and each of these tubes is brought in connexion with a tambour. The two tambours are placed, one on either side of the fulcrum of a lever. This lever works against a light spring, which in its turn sets in motion a writing-style. The style records the pressure changes on a drum covered with smoked paper. By this means there can be recorded the exact moment at which the auricular pressure exceeds that in the ventricle, that is to say, the moment when the auriculo-ventricular valves open; likewise the moment when the ventricular pressure becomes greater than that in the auricles, and the auriculo-ventricular valves shut. Similarly, there can be recorded the moment when the intraventricular pressure exceeds that in the aorta and the semilunar valves open, and the moment at which the diastole of the ventricle begins, when the aortic pressure becomes the greater, and the semilunar valves shut. The smoothness with which the heart works is shown by the fact that neither the opening nor the closing of the valves is marked by any peak or point on the pressure curves. The first part of the period of ventricular systole is spent in raising the tension of the blood up to and above that in the aorta. All the valves are closed during this period, and the contraction of the ventricular muscle is at this time isometric, for the volume of the ventricle does not alter. The period of rising tension lasts in the dog ·02″–·04″, and varies very little when the output is resisted by a rise in arterial pressure. In other words, the heart can meet greater demands on its power without appreciable loss of time. The period of systolic output lasts from the moment when the semilunar valves open to the moment when they close. This period equals ·178″ to ·195″, and is but slightly altered by variations in arterial pressure or the frequency of the heart. The intraventricular pressure continues to rise during the period of output if the outflow be resisted; on the other hand, it falls if the arterioles are dilated and the outflow unimpeded. When the heart becomes more frequent, as in fever, it is the diastolic or resting period which is especially shortened. A negative pressure (–10 to –30 mm.) appears in the auricles during the period of systolic output, and this is of no little importance, for it materially aids in the filling of the auricles. It is mainly produced by the expulsion of the blood by the left ventricle into the arteries, and so out of the thorax. To take the place of the arterial blood which leaves the thoracic cavity, air passes into the lungs and blood into the auricles. The maximal and minimal pressures have been accurately recorded in the heart by a manometer fitted with a valve arranged so that either only a rise or a fall of pressure is recorded. In the right ventricle of the dog the maximal pressures recorded equalled 35–62 mm. of mercury, in the left ventricle 114–135 mm., in the auricles 2–20 mm. (de Jäger). A negative pressure, of considerable amount but of very fleeting duration, sometimes occurs in the ventricles at the beginning of diastole. This is produced by the elastic rebound of the fleshy columns of the inner wall of the heart, which become pressed together as the blood is wrung out of the ventricular cavities. The entry of the first few drops of blood from the auricles abolishes this negative pressure, and it has no important influence on the filling of the heart.

Valves and Papillary Muscles.—The muscular columns to be seen on the inner walls of the ventricles are attached by inextensile cords (the chordæ tendineæ) to the auriculo-ventricular valve flaps. It has experimentally been determined that the cords are pulled taut synchronously with the ventricular contraction, and so prevent the ballooning out of the valves into the auricles (Roy, Haycraft). The edges of these valves are thin and delicate membranes, and when in apposition are pressed together by the blood in the ventricles. Regurgitation of blood is thus completely prevented. The outer parts of the valves bear the full strain of the intraventricular pressure, and are therefore tough and strong. These parts are supported by the chordæ tendineæ, just as an umbrella is supported by its ribs. A ring of muscle surrounds the auriculo-ventricular orifices, and confines the size of these openings during systole. The auriculo-ventricular valves are floated up and brought into apposition by eddies set up in the blood which streams into the ventricles during the auricular systole. They close without noise or jar at the moment when the intraventricular pressure exceeds in the least degree that in the auricles. The semilunar valves are similarly brought into apposition by eddies, and close without noise or jar at the moment when the intraventricular pressure becomes less than that in the aorta. The arterial orifices are confined by the contraction of the muscle bands which surround them. During the period of systolic output the aortic valve-flaps assume a vertical position in mid-stream, and do not swing back against the orifices of the coronary arteries which lie at the root of the aorta. At the height of systole the flow through the coronary vessels is momentarily checked, for the pressure of the ventricular muscle becomes greater than that in the aorta. The capillaries of the heart muscle become filled with blood during diastole, and this blood is partly expressed into the coronary veins during systole.

The Cardiac Impulse.—The impulse is synchronous with the period of rising tension in the ventricle. It occurs at the point where the ventricular wall touches the parietes of the chest, and is thus felt at a slightly different spot in each position of the body, for, owing to the influence of gravity, different parts of the heart come in contact with the chest-wall in different postures. The cause of the impulse is the sudden hardening of the ventricular muscle. Where the heart touches the chest-wall the latter is driven outwards; at all other points it is sucked inwards, owing to the diminution in the size of the ventricles during the period of systolic output. To obtain a typical cardiogram, the cardiograph must be applied to the exact seat of the impulse. An excellent form of cardiograph has been contrived by Edgren (see Schäfer's *Physiology*, vol. ii. p. 35). The cardiogram is partly a pressure and partly a volume curve. The form of the typical curve resembles that of intraventricular pressure, but it can be endlessly varied by altering the position and pressure of the instrument, and the cardiograph is not therefore a sure or trustworthy guide to any facts concerning the force or extent of the cardiac contraction. By simultaneously recording the impulse curve, the heart sounds, and the pulse curve in the carotid artery, the time relations of the various acts which go to make up the cardiac cycle can be measured in man. The beginning of the impulse curve marks the beginning of the period of rising pressure in the ventricles. The beginning of the ascent of the pulse curve marks the beginning of the period of systolic output. The beginning of the dicrotic notch on the pulse curve marks the end of the period of output and the commencement of ventricular diastole. In making such calculations, a deduction must be made for the time spent in the transmission of the pulse-wave.

The Sounds of the Heart.—The sounds of the heart have been successfully recorded by means of the microphone. Hürthle inserted the microphone in the primary circuit of a Du Bois Raymond induction coil, and placed the nerve of a frog-muscle preparation in the secondary circuit. The muscle, being attached to a lever, recorded its contraction on a revolving drum at the moment when the sound of the heart reached the microphone and closed the primary circuit. A capillary electrometer can be inserted in place of the frog-muscle indicator, and the movements of the electrometer photographed on a sensitized plate moved by clockwork (Einthoven). Each sound gives rise to a succession of vibrations of the mercury meniscus of the capillary electrometer. The first sound is formed of many component tones derived from the sudden tension, and consequent vibration, of the ventricular muscle, and of the auricular-ventricular valves with their chordæ tendineæ. The first sound can be resolved by a trained musical ear into two tones, one deep and the other high. The deeper tone alone is heard on the contraction of the excised and bloodless heart, while the higher tone is produced by throwing the auriculo-ventricular valves into tension (Haycraft). In the cold-blooded animal, such as the turtle, the heart muscle does not become tense rapidly enough to produce a sound (Allen). This sound is not produced by fluid friction as the blood rushes through the arterial orifices, for the velocity of outflow is too small to produce in this way any noise. Nor is it produced by sudden opening of the semilunar valves, for these open quietly and without jar at the moment when the intraventricular pressure rises above that in the aorta.

The second sound of the heart is produced by the tension of the semilunar valves in the aorta and pulmonary artery at the moment when the ventricles pass into diastole. These valves close without any jar or shock so soon as the arterial pressures rise to the slightest degree above that in the ventricles. In the next moment the ventricles dilate, and the valves, no longer supported on one side, become taut. The elastic vibrations of the walls of the distended arteries probably share in the production of this sound.

Vaso-motor System.—The tone of the arteries and veins, just as the permeability of the capillaries, depends on the chemical quality, the pressure, and the velocity of flow of the circulating blood. The tone of the arterioles is secondarily controlled by the vaso-motor nerves, which are in their turn dominated by the vaso-motor centre in the medulla oblongata. The portal venous system is also controlled by vaso-motor nerves, while, as to the rest of the venous system, there is no definite evidence of the existence of any such control. The vaso-motor nerves are of two kinds, vaso-constrictor and vaso-dilator. The vaso-constrictor fibres issue in the anterior spinal roots, from the second thoracic to the second lumbar root, and pass to the sympathetic chain of ganglia. The fibres are of small diameter, and probably arise from cells situated in the lateral horn of the grey matter of the spinal cord. Nicotine paralyses ganglion cells, and by applying this test to the various ganglia, the cell stations of the vaso-constrictor fibres supplying each organ have been mapped out. The vaso-dilator fibres have not so restricted an origin, for they issue in the efferent roots in all parts of the neural axis. The two kinds of nerves, although antagonistic in action, end in the same terminal plexus which surrounds the vessels. The presence of vaso-dilator fibres in the common nerve trunks is masked, on excitation, by the overpowering action of the vaso-constrictor nerves. The latter are, however, more rapidly fatigued than the former, and by this and other means the presence of vaso-dilator fibres can be demonstrated in almost all parts of the body. The nervi-erigentes to the penis and the chorda tympani supplying the salivary glands are the most striking examples of vaso-dilator nerves. The vaso-motor centre exerts a tonic influence over the calibre of the arterial and portal venous systems, and, influenced as it is by afferent impulses received from all parts, reflexly regulates the supply of blood to the organs. Functional activity is accompanied by vaso-dilatation. Stimulation of the afferent nerves of any part excites reflexly vaso-dilatation in that part and constriction in other vascular areas. Paralytic dilatation results on cutting off any part from the influence of the vaso-motor centre, but after a few days local tone returns.

AUTHORITIES.—An exhaustive account of the literature on the circulation of the blood will be found in Tigerstedt's *Lehrbuch der Physiologie des Kreislaufes*, 1893. The following may also be consulted:—Porter's article on the "Circulation" in Howell's *American Text-Book of Physiology*, 1896; Gaskell's article on "Cardiac Muscle," and Leonard Hill's article on the "Vascular Mechanism," in Schäfer's *Text-Book of Physiology*, vol. ii.; and the articles "Circulation," "Cœur," &c., in Richet's *Dictionnaire de Physiologie*. For a general account of the vascular system, Foster's *Text-Book of Physiology*, 6th ed., may be consulted.

(L. E. H.)

V. RESPIRATION.

So far as is known, the intake of oxygen, either free or in combination, and the output of carbonic acid, are an essential part of the life of all organisms. The two processes are so closely associated with one another that they are always included together under the designation of Respiration, which may thus be defined as that part of organic activity which is concerned in the intake of oxygen and output of carbonic acid. According to the evidence at present available, it is only within living cells that the respiratory oxygen is consumed and the carbonic acid formed. The mere conveying of oxygen from the air to these cells, and of carbonic acid from them to the air, is, however, in itself a complex process in the higher animals; and accordingly an account of animal respiration naturally falls into two divisions, the first of which (I.) is concerned with the manner in which oxygen and carbonic acid are conveyed to and from the living tissues, and the second (II.) with the consumption of oxygen and production of carbonic acid by the living tissues themselves. Of these two divisions, the second is in reality the more important; for the conveyance of oxygen and carbonic acid between the air and the tissues is essentially a subsidiary process, the rate of which, as will be shown below, is regulated in accordance with the requirements of the tissues.

I. In the higher vertebrates air is brought into the lungs by the respiratory movements. Oxygen from this air passes through the delicate lining membrane of the air-cells of the lungs into the blood, where it enters into loose chemical combination with the hæmoglobin of the red corpuscles. In this form it is conveyed onwards to the heart, and thence through the arteries to the capillaries, where it again parts from the hæmoglobin, and passes through the capillary walls to the tissues, where it is consumed. Carbonic acid passes out from the tissues into the blood in a corresponding manner, enters into loose combination as bicarbonate, and possibly in other ways, in the blood, and is conveyed by the veins to the lungs, whence it passes out in the expired air. A detailed account of this complex process, together with a sketch of the corresponding processes in lower animals, is given in the article on RESPIRATION in the ninth edition of this work, which need only be supplemented here as regards points which have been further elucidated by recent research.

In certain circumstances the consumption of oxygen and production of carbonic acid by the body are temporarily much increased. Thus during hard muscular work this increase may amount to ten times the normal, or more. It is evident that to meet this increase there must be (1) a large increase in the volume of air breathed, and (2) a similar increase in the rate of circulation of the blood. As regards the first point, we know from analyses that the deficiency of oxygen and excess of carbonic acid in the expired air are nearly the same during muscular exercise as during rest; so that the volume of air breathed is increased about proportionally to the increased respiratory exchange of oxygen and carbonic acid. The increased volume of air breathed is due partly to greater frequency, and partly to greater depth, of the respirations. It has been shown that this alteration in the breathing is brought about by an altered state of the blood reaching the respiratory centre; and formerly it was believed that deficiency of oxygen in this blood is the cause. Deficiency of oxygen does undoubtedly stimulate the respiratory centre, but a study of the effects in man of deficiency of oxygen due to the breathing of air poor in oxygen is sufficient to negative the idea that this is the normal stimulus to the respiratory centre. Simultaneously with the stimulation (which is, moreover, sometimes so feeble as to be scarcely noticeable) there is more or less of mental confusion, impairment of the senses, loss of muscular power, and other alarming symptoms, which certainly do not accompany the normal stimulation of the respiratory centre. Excess of carbonic acid in the air breathed acts far more powerfully and persistently on the respiratory centre than deficiency of oxygen. The phenomena experienced on breathing air containing a sufficient excess to cause panting are, moreover, identical with those observed during panting produced by muscular exercise, so that it seems probable that excess of carbonic acid in the blood bathing the respiratory centre is the real stimulus. It is only, however, *free* carbonic acid that affects the centre. As only a small part of the carbonic acid in the blood is in the free state, the rest being combined with alkalies, the available proportion of which varies greatly at different times, mere determinations of the total proportion of carbonic acid in the arterial blood during rest and during exercise cannot decide the question whether it is the actual stimulus. Some physiologists maintain, on grounds which seem to the present writer insufficient, that the normal stimulus to the respiratory centre is some unknown "product of metabolism." If, either voluntarily or by artificial means, the respiratory movements are increased for a short time, the condition known as *apnœa* follows, the action of the respiratory centre being temporarily suspended. During apnœa the arterial blood contains much less carbonic acid than before, an abnormal amount having been washed out in the lungs by the excessive breathing. The amount of oxygen is, however, practically the same, the arterial blood being saturated under normal conditions, so that with excessive breathing it can take up no more. The main, though not the only, factor in producing apnœa seems to be the deficiency of carbonic acid in the blood. Although the respiratory centre tends to act in the normal rhythmic manner apart from all stimuli through nerves, yet researches have shown that afferent impulses conveyed from the lungs by the vagus nerve play a most important part in regulating the rhythm of the centre. Distension of the lungs arrests inspiration, while collapse of the lungs stimulates it, and this is brought about by stimuli conveyed by the vagus fibres, and caused by the stretching and relaxation of the lungs. When the vagus nerves are severed, the effect is absent, and the respirations are diminished in frequency and are deeper.

As regards the causes of the increased flow of blood which compensates for increased oxygen consumption in the muscles and other tissues, our knowledge is somewhat scanty. It appears that, along with the motor impulses which cause a muscle to contract, there proceed to the arterioles of the muscle vaso-motor impulses, leading to a greatly increased circulation through the muscle. The rush of blood through the working muscles must be compensated for by a corresponding increase in the work of the heart, as there is no fall in blood pressure; but by what means the compensation is brought about is not yet clear.

Until recently it was assumed that practically the whole of the carbonic acid discharged in the breath is brought to the lungs by the venous blood. Experiments made to test this question seem to show, however, that there is a very considerable production of carbonic acid and disappearance of oxygen in the lungs themselves, as much as a third or even half the total carbonic acid produced being under certain conditions formed there. On account of the unpleasant effects produced by the air of crowded rooms, and for other reasons, it was believed that expired air contains, besides carbonic acid, some poisonous substance. A careful investigation of the question has shown that no such substance exists.

Hæmoglobin.—The law according to which the hæmoglobin of the red blood corpuscles enters into combination with, or parts from, oxygen, has recently been more clearly determined. It has been shown that at a constant temperature the *relative* proportion of the hæmoglobin present which will enter into combination, or remain in combination, with oxygen, varies with the partial pressure of the oxygen present. If blood or hæmoglobin solution at a temperature of 37·4° C. (which is about that of the body) be shaken to saturation with pure oxygen at a pressure of 1·2 per cent. of an atmosphere (or at ordinary atmospheric pressure with nitrogen containing 1·2 per cent. of oxygen), half of the hæmoglobin will combine with oxygen, the relative proportions of combined and uncombined hæmoglobin being thus equal, or $\frac{1}{1}$. At a pressure of 2·4 per cent. of an atmosphere the proportion of combined to uncombined hæmoglobin will be $\frac{2}{1}$, so that the hæmoglobin will be two-thirds saturated with oxygen, and so on. In dry air at normal atmospheric pressure the pressure of oxygen is 20·94 per cent. of an atmosphere, so that in blood saturated with air the ratio of combined to uncombined hæmoglobin will be $\frac{17 \cdot 5}{1}$, and the hæmoglobin will thus be 94·6 per cent. saturated. It is evident from these data that, provided that the blood in passing through the lungs is saturated with oxygen at a pressure of 5 or 6 per cent. of an atmosphere of oxygen, the amount of oxygen taken up by the hæmoglobin of the blood will vary but little either with variations of atmospheric pressure or with variations in the percentage of oxygen in the air breathed. Hæmoglobin not only combines with oxygen, but also forms an analogous compound with carbonic oxide. The affinity of the latter gas for hæmoglobin is, however, much more powerful than that of oxygen. When blood is saturated with air containing 0·07 per cent. of carbonic oxide, the hæmoglobin is shared equally between the two gases, and increase of the percentage or partial pressure of either of the gases increases correspondingly its relative share of the hæmoglobin. When carbonic oxide is breathed it passes into the blood, which continues to absorb it until the point is reached at which the pressure of oxygen in the blood passing through the lungs suffices to prevent further absorption. As, however, the hæmoglobin combined with carbonic oxide is useless for the time as an oxygen-carrier, symptoms of lack of oxygen, or death from want of oxygen, may easily be caused by carbonic oxide. When death occurs the blood is usually about 80 per cent. saturated with carbonic oxide, which is the poisonous constituent of lighting-gas, smoke, and the after-damp which causes most of the deaths in colliery explosions. Besides the ordinary oxygen compound of hæmoglobin, there is another oxygen compound known as *Methæmoglobin*, containing the same amount of oxygen, but combined in a different manner. Methæmoglobin has a brown colour, and does not yield its oxygen to a vacuum. It is readily formed by the action of various oxidizing agents, such as ferricyanide of potassium, on hæmoglobin. When the hæmoglobin acted on is already combined in the ordinary way with oxygen or carbonic oxide, the whole of the gas thus combined is set free, and this reaction affords an easy and accurate means of determining the proportion of hæmoglobin in a sample of blood. Methæmoglobin is formed in the living body by the action of various poisons, such as chlorate of potash, amylnitrite, or dinitrobenzol (the chief constituent of the explosive roburite). Since the methæmoglobin thus formed is useless as an oxygen-carrier, symptoms similar to those of carbonic oxide poisoning are produced.

Between the air in the air-cells of the lungs and the blood of the lung-capillaries there intervenes nothing but a layer of very thin, flattened cells, and until recently it was very generally believed that it was by diffusion alone that oxygen passes inwards and carbonic acid outwards through this layer. Similar simple physical explanations of processes of secretion and absorption through living cells have, however, turned out to be incorrect in the case of other organs. It is known, moreover, that in the case of the swimming-bladder of fishes oxygen is secreted into the interior against enormous pressure. Thus, in the case of a fish caught at a depth of 4500 feet, the partial pressure of the oxygen present in the swimming-bladder at this depth was 127 atmospheres, whereas the partial pressure of oxygen in sea water is only about 0·2 atmosphere. Diffusion can therefore have nothing to do with the passage of gas inwards, which is known to be under the control of the nervous system. The cells lining the interior of the swimming-bladder are developed from the same part of the alimentary tract as those lining the air-cells of the lungs, so that it seems not unlikely that the lungs should possess the power of actively secreting or excreting gases. The question whether such a power exists, and is normally exercised, has been investigated by more than one method; and although it is not possible to go into the details of the experiments, there can be no doubt that the balance of the evidence at present available is in favour of the view that diffusion alone is incapable of explaining either the absorption of oxygen or the excretion of carbonic acid through the lining cells of the lungs. The partial pressure of oxygen appears to be always higher, and of carbonic acid often lower, in the blood leaving the lungs than in the air of the air-cells; and this result is inconsistent with the diffusion theory. As to the causes of the passage of oxygen and carbonic acid through the walls of the capillaries of the general circulation, we are at present in the dark. Possibly diffusion may explain this process.

II. Although we cannot trace the exact changes which occur when oxygen passes into living cells, and although, indeed, we have the clearest reasons for believing that it would be impossible to express these changes fully in chemical terms, yet it is possible to obtain a clear general view of both the ultimate destiny of the oxygen and the origin of the carbonic acid. The oxidizable material within the body consists, practically speaking, of proteids (albumen-like substances, with which the collagen of connective tissue may be included), fats, and carbohydrates (sugars and glycogen). All of these substances contain carbon, hydrogen, and oxygen in known, though different proportions, and the former also contains a known amount of nitrogen and a little sulphur. Nitrogen is constantly leaving the body as urea and other substances in the urine and faeces; and a small but easily measurable proportion of carbon passes off in the same manner. The rest of the carbon passes out as carbonic acid in respiration. Now carbohydrates and fats are oxidized completely in the body to carbonic acid and water. This follows from the fact that, practically speaking, no other products into which they might have been converted leave the body except carbonic acid and water. Moreover, a given weight of carbohydrate requires for its oxidation a definite weight of oxygen, and produces a definite weight of carbonic acid. There is thus a definite relation between the weight of oxygen used up and the weight of carbonic acid formed in this oxidation. The same is true for the oxidation of fat, and of proteid, allowing in the latter case for the fact that the nitrogen, together with part of the carbon and hydrogen, passes out as urea, &c., in an incompletely oxidized form. From all this it follows that if we measure over a given period (1) the discharge of nitrogen from the body, (2) the intake of oxygen, and (3) the output of carbonic acid, we can easily calculate exactly what the ultimate destiny of the oxygen has been, and at the ultimate expense of what material the carbonic acid has been formed. What the intermediate stages may have been we cannot say, but this in no way affects the validity of the calculation. If, during the period of measurement, food is taken, the basis of the calculation is still substantially the same, as the oxidizable material in food consists of practically nothing else except proteids, carbohydrates, and fats.

Liberation of Energy.—From experiments made outside the body, we know that in the oxidation of a given weight of proteid, carbohydrate, or fat, a definite amount of energy is liberated. In the article on DIETETICS it has been shown that precisely the same liberation of energy occurs in the living body, due allowance being made for the fact that the oxidation of proteid is not quite complete. The following table shows the respiratory quotients (see RESPIRATION, 9th edition) and energy expressed in units of heat (Calories) liberated per gramme of carbonic acid produced and oxygen consumed in the living body during the oxidation of proteid, fat, and a typical carbohydrate.

Substance oxidized.	Respiratory Quotient.	Calories per gramme of CO_2 produced.	Calories per gramme of oxygen consumed.
Proteid . .	·78	2·78	3·00
Fat . . .	·71	3·35	3·27
Cane-sugar .	1·00	2·59	3·56

In the oxidation of non-living substances the rate varies, within wide limits, according to that at which oxygen is supplied. Thus a fire burns the faster the more air is supplied, and the higher the percentage of oxygen in the air. It was for long believed that in the living body also the rate of oxidation must vary according to the oxygen supply. It has been found, however, that this is not the case. Provided that a certain minimum of oxygen is present in the air breathed, or in the blood supplied to the tissues, it is, practically speaking, indifferent whether the oxygen supply be increased or diminished : only a certain amount is consumed. It might be supposed that the reason for this is that the available oxidizable material in the body is limited, and that if the food supply were increased there would be a corresponding increase in the rate of oxidation. This hypothesis is apparently supported by the fact that, when an increased supply of proteid is given as food, the amount of nitrogen discharged in the urine is almost exactly correspondingly increased, so that evidently the oxidation of proteid increases correspondingly with the supply. Similarly, when carbohydrate food is given, the alteration in the respiratory quotient shows that more carbohydrate than before is being oxidized. Closer investigation in recent times has, however, brought out the very striking fact that, if oxidation be measured in terms of energy liberated by it in the body, it makes but little difference whether the animal is fasting or not. If more proteid or carbohydrate is oxidized at one time, correspondingly less fat is oxidized, but the total energy liberated as heat, &c., in the body is about the same, unless the diet is very excessive, when there is a slight increase of oxidation. Even after many days of starvation, the rate of oxidation per unit of body weight has been found to remain sensibly the same in man. When more food is taken than is required, the excess is stored up, chiefly in the form of fat, into which carbohydrate and possibly also proteid are readily converted in the body. When less food is taken than is needed, the stock of fat is drawn upon, and supplies by far the greater proportion of the energy requirements of the body.

During the performance of muscular work oxidation is greatly increased, and may amount to ten times the normal or more. Even the slight exertion of walking increases oxidation to three times. When the energy represented by the external work done in muscular exertion is compared with the extra energy liberated by oxidation in the body, it is found, as would be expected, that the latter value largely exceeds the former. In other words, much of the energy liberated is wasted as heat. Nevertheless the muscles are capable of working with far less waste than any steam or gas engine. In the work of climbing, for instance, it has been found in the case of man that 35 per cent. of the energy liberated is represented in the work done in raising the body. Muscular work, if at all excessive, leads to fatigue, and consequent rest. On the other hand, unnatural abstinence from muscular activity leads to restlessness and consequent muscular work. Hence on an average of the 24 hours the expenditure of energy by different individuals, with different modes of life, does not as a rule differ greatly.

The rate of oxidation per unit of body-weight varies considerably according to size and age. If we compare different warm-blooded animals, we find that the rate of oxidation is relatively to their weight far higher in the smaller ones. In a mouse or small bird, for instance, the rate is about twenty times as great as in a man. The difference is in part due to the fact that the smaller an animal is the greater is its surface relatively to its mass, and consequently the more heat does it require to keep up its temperature. The smaller animal must therefore produce more heat. Even in cold-blooded animals, however, oxidation appears to be more rapid the smaller the animal. In the case of man oxidation is relatively more than twice as rapid in children as in adults, and the difference is greater than would be accounted for by the difference in the ratio of surface to mass. Allowing for differences in size, oxidation is about equally rapid in men and women.

It was for long believed that the special function of respiratory oxidation was (1) the production of heat, and (2) the destruction of the supposed "waste products." Further investigation has, however, tended to show more and more clearly that in reality respiratory oxidation is an essential and intimate accompaniment of all vital activity. To take one example, secretion and absorption, which were formerly explained as simple processes of filtration and diffusion, are now known to be accompanied, and necessarily so, by respiratory oxidation in the tissues concerned. The respiratory oxidation of an animal is thus a very direct index of the activity of its vital processes as a whole. Looking at what is known with regard to respiratory oxidation, we see that what is most striking and most characteristic in it is its tendency to persist—to remain on the whole at about a normal level for each animal, or each stage of development of an animal. The significance of this cannot be over-estimated. It indicates clearly that just as an organism differentiates itself from any non-living material system by the manner in which it actually asserts and maintains its specific anatomical structure, so does it differentiate itself from any mere mechanism by the manner in which it asserts and maintains its specific physiological activities. This points to a fundamental difference in kind between the two aspects (and they are both of them only abstract aspects) of experience which are respectively represented in the Biological and Physico-chemical sciences, and to the necessity for a clear recognition of the corresponding differences in what are the only practical aims which each of the two groups of sciences can set before itself.

AUTHORITIES.—The reader may be referred to the sections by PEMBREY and by GAMGEE in Schäfer's *Handbook of Physiology*, vol. i. 1898. The following references will give the additional clues requisite for a more special study :—**Production of carbonic acid in the lungs**: BOHR and HENRIQUES. *Archives de la Physiol. norm.*, 1897, pp. 459, 590, and 819. **Supposed poisonous organic matter in expired air** : HALDANE and LORRAIN SMITH. *Journ. of Pathology*, vol. i. pp. 168 and 318, 1893. **Properties of hæmoglobin**: HÜFNER. *Arch. für Anat. und Physiol.*, 1901, Suppl., p. 187. **Cause of exchange of gases in the lungs and swimming-bladder** : Summary by HALDANE. *Science Progress*, 1898, pp. 120 and 237. **Conservation of energy in the living organism** : RUBNER. *Zeitschrift für Biologie*, vol. xxx. p. 73, 1894. **Conditions determining consumption of oxygen in the organism** : PFLÜGER. *Archiv*, vol. x. p. 251, 1875. RUBNER. *Zeitschrift für Biologie*, vol. xix. p. 312, 1883. **Respiration and muscular work in man**: KATZENSTEIN. *Pflüger's Archiv*, vol. 49, p. 330, 1891. **Respiration and size, age, and sex** : MAGNUS-LEVY. *Archiv für Anat. und Physiol.*, 1899, p. 314. (J. S. H.)

VI. Muscle and Nerve.

Muscle.—Among the properties of living material there is one, widely though not universally present in it, which forms the pre-eminent characteristic of muscular cells. This property is the liberation of some of the energy contained in the chemical compounds of the cells in such a way as to give mechanical work. The mechanical work is obtained by movement resulting from a change in, it is supposed, the elastic tension of the living framework of the cell. In the fibrils existing in the cell a sudden alteration of elasticity occurs, resulting in an increased tension on the points of attachment of the cell to the neighbouring elements of the tissue in which the cell is placed. These yield under the strain, and the cell shortens between those points of its attachment. This shortening is called *contraction*. But the volume of the cell is not appreciably altered, despite the change of its shape, for its one diameter increases in proportion as its other is diminished. The manifestations of contractility by muscle are various in mode. By *tonic* contraction is meant a prolonged and equable state of tension which yields under analysis no element of intermittent character. This is manifested by the muscular walls of the hollow viscera and of the heart, where it is the expression of a continuous liberation of energy in process in the muscular tissue, the outcome of the latter's own intrinsic life, and largely independent of any connexion with the nervous system. The muscular wall of the blood-vessels also exhibits tonic contraction, which, however, seems to be mainly traceable to a continual excitation of the muscle cells by nervous influence conveyed to them along their nerves, and originating in the great *vaso-motor centre* in the bulb. In the ordinary striped muscle tissue of the skeletal musculature, *e.g.*, *gastrocnemius*, tonic contraction obtains; but this, like the last mentioned, is not of autochthonous origin in the muscles themselves; it is indirect and *neural*, and appears to be chiefly maintained reflexly. The sensifacient organs of the muscular sense and of the semicircular canals are to be regarded as the sites of origin of this *reflex* tonus of the skeletal muscles. Striped muscles possessing an autochthonous tonus appear to be the various sphincter muscles.

Contractility.

Another mode of manifestation of contractility by muscles is the *rhythmic*. A tendency to rhythmic contraction seems discoverable in almost all muscles. In some it is very marked, for example, in some viscera, the spleen, the bladder, the ureter, the uterus, the intestine, and especially in the heart. In several of these it appears proven that the recurrent explosive liberations of energy in the muscle tissue are not secondary to recurrent explosions in nerve cells, but are attributable to decompositions arising *suâ sponte* in the chemical substances of the muscle cells themselves in the course of their living. Even small strips of the muscle of the heart, if taken immediately after the death of the animal, continue, when kept moist and warm and supplied with oxygen, to "beat" rhythmically for hours. Rhythmic contraction is also characteristic of certain groups of skeletal muscles, *e.g.*, the respiratory. In these the rhythmic activity is, however, clearly secondary to rhythmic discharges of the nerve cells constituting the respiratory centre in the bulb. Such discharges descend the nerve fibres of the spinal cord, and through the intermediation of various spinal nerve cells excite the respiratory muscles through their motor nerves. A form of contraction intermediate in character between the tonic and the rhythmic is met in the auricle of the heart of the toad. These slowly successive phases of increased and of diminished tonus regularly alternate, and upon them are superposed the rhythmic "beats" of the pulsating heart.

The "beat," *i.e.*, the short-lasting explosive contraction, of the heart muscle can be elicited by a single, even momentary, application of a stimulus, *e.g.*, by an induction shock. Similarly, such a single stimulus elicits from a skeletal muscle a single "beat," or, as it is termed, a "twitch." In the heart muscle during a brief period after each beat, that is, after each single contraction of the rhythmic series, the muscle becomes "*inexcitable.*" It cannot then be excited to contract by any agent, though the inexcitable period is more brief for strong than for weak stimuli. But in the great group of the skeletal, voluntary, or striped muscles, a second stimulus succeeding a previous so quickly as to fall even during the continuance of the contraction excited by a first, elicits a second contraction. This second contraction starts from whatever phase of previous contraction the muscle may have reached at the time. A third stimulus excites a third additional contraction, a fourth a fourth, and so on. The increments of contraction become, however, less and less, until the succeeding stimuli serve merely to maintain, not to augment, the existing degree of contraction. We arrive thus by analysis at a summation of "beats" or of simple contractions in the compound, or "tetanic," or summed contraction of the skeletal muscles. The tetanic or summed contractions are more extensive than the simple, both in space and time, and liberate more energy, both as mechanical work and heat. The tension developed by their means in the muscle is many times greater than that developed by a simple twitch.

Muscle cells respond by changes in their activity to changes in their environment, and thus are said to be "excitable." They are, however, less excitable than are the nerve cells which innervate them. The change which excites them is termed a *stimulus*. The least stimulus which suffices to excite is known as the *stimulus of threshold value*. In the case of the heart muscle this threshold stimulus evokes a beat as extensive as does the strongest stimulus; that is, the intensity of the stimulus, so long as it is above threshold value, is not a function of the amount of the muscular response. But in the ordinary skeletal muscles the amount of the muscular contraction is for a short range of quantities of stimulus (of above threshold value) proportioned to the intensity of the stimulus and increases with it. A value of stimulus is, however, soon reached which evokes a *maximal* contraction. Further increase of contraction does not follow further increase of the intensity of the stimulus above that point. Just as in a nerve fibre, when excited by a localized stimulus, the excited state spreads from the excited point to the adjacent unexcited ones, so in muscle the "contraction," when excited at a point, spreads to the adjacent uncontracted parts. Both in muscle and in nerve this spread is termed "*conduction.*" It is propagated along the muscle fibres of the skeletal muscles at a rate of about 3 metres per second. In the heart muscle it travels much more slowly. The disturbance travels as a *wave* of contraction, and the whole extent of the wave-like disturbance measures in ordinary muscles much more than the whole length of any single muscle fibre. That the excited state spreads only to previously unexcited portions of the muscle fibre, shows that even in the skeletal variety of muscle there exists, though only for a very brief time, a period of inexcitability. The duration of this period is about $\frac{1}{500}$ of a second in skeletal muscle.

Excitability.

When muscle that has remained inactive for some time is excited by a series of single and equal stimuli succeeding at intervals too prolonged to cause summation, the succeeding contractions exhibit progressive increase up to a certain degree. The tenth contraction usually exhibits the culmination of this so-called "staircase effect." The explanation may lie in the production of CO_2 in the muscle. That substance, in small doses, favours the contractile power of muscle. The muscle is a machine for utilizing the energy contained in its own chemical compounds. It is not surprising that the chemical substances produced in it by the decomposition of its living material should not be of a nature indifferent for muscular life. We find that if the series of excitations of the muscle be prolonged beyond the short stage of initial improvement, the contractions, after being well maintained for a time, later decline in force and speed, and ultimately dwindle even to vanishing point. This decline is said to be due to *muscular fatigue.* The muscle recovers on being allowed to rest unstimulated for a while, and more quickly on being washed with an innocuous but non-nutritious solution, such as ·6 per cent. NaCl in water. The washing seems to remove excreta of the muscle's own production, and the period of repose removes them perhaps by diffusion, perhaps by breaking them down into innocuous material. Since the muscle produces lactic acids during activity, it has been suggested that acids are among the "fatigue substances" with which muscle poisons itself when deprived of circulating blood. Muscles when active seem to pour into the circulation substances which, of unknown chemical composition, are physiologically recognizable by their stimulant action on the respiratory nervous centre. The effect of the fatigue substances upon the contraction of the tissue is manifest especially in the relaxation process. The contracted state, instead of rapidly subsiding after discontinuance of the stimulus, slowly and only partially wears off, the muscle remaining in a condition of physiological "contracture." The alkaloid veratrin has a similar effect upon the contraction of muscle; it enormously delays the return from the contracted state, as also does epinephrin, an alkaloid extracted from the suprarenal gland.

NERVOUS SYSTEM.—The work of Golgi (Pavia, 1885 and onwards) on the minute structure of the nervous system has led to great alteration of doctrine in neural physiology. It had been held that the branches of the nerve cells, that is to say, the fine nerve fibres—since all nerve fibres are nerve cell branches, and all nerve cell branches are nerve fibres—which form a close felt-work in the nervous centres, there combined into a network actually continuous throughout. This *continuum* was held to render possible conduction in all directions throughout the grey matter of the whole nervous system. The fact that conduction occurred preponderantly in certain directions, was explained by appeal to a hypothetical resistance to conduction which, for reasons unascertained, lay less in some directions than in others. The intricate felt-work has by Golgi been ascertained to be a mere interlacement, not an actual anastomosis network; the branches springing from the various cells remain life-long unattached and unjoined to any other than their own individual cell. Each neuron or nerve cell is a morphologically distinct and discrete unit connected functionally but not structurally with its neighbours, and with its own life and death independently of the destiny of its neighbours. Among the properties of the neuron is conductivity in all directions. But when neurons are linked together it is found that nerve impulses will only pass from neuron A to neuron B, and not from neuron B to neuron A; that is, the transmission of the excited state or nervous impulse, although possible in each neuron both up and down its own cell branches, is only possible from one nerve cell to another in one direction.

Neuron theory.

That direction is the direction in which the nerve impulses flow under the conditions of natural life. The *synapse,* therefore, as the place of meeting of one neuron with the next is called, is said to valve the nerve circuits. This determinate sense of the spread is expressed as *the law of forward direction.* The synapse appears to be a weak spot in the chain of conduction, or rather to be a place which breaks down with comparative ease under stress, *e.g.,* under effect of poisons. The axons of the motor neurons are, inasmuch as they are nerve fibres in nerve trunks, easily accessible to artificial stimuli. It can be demonstrated that they are practically indefatigable—repeatedly stimulated by electrical currents, even through many hours, they, unlike muscle, continue to respond with unimpaired reaction. Yet when the muscular contraction is taken as index of the response of the nerve, it is found that unmistakable signs of fatigue appear even a very brief period after commencement of the excitation of the nerve, and the muscle soon ceases to give any contraction whatever in response to stimuli applied indirectly to it through its nerve. But the muscle will, when excited directly, *e.g.,* by direct application of electric currents, contract vigorously after all response on its part to the stimuli (nerve impulses) applied to it indirectly through its nerve has failed. The inference is that the "fatigue substances" generated in the muscle fibres in the course of their prolonged contraction injure and paralyse the motor end plates, which are places of synapses between nerve cell and muscle cell, even earlier than they harm the contractility of the muscle fibres themselves. The alkaloid curarin causes motor paralysis by attacking in a selective way this junction of motor nerve cell and striped muscular fibre. It seems probable that the practical immunity of nerve fibres from fatigue is associated with their possession of a myelin sheath, for nerve fibres of the non-myelinate kind do not exhibit this immunity. Now, there is a difference between the axon in its course and at its termination, for at the latter it is naked and unsheathed in myelin. It may be that the rapidly fatigable character of the motor end plate is due to the naked non-myelinate condition of the nerve fibre there. The myelin sheath probably prevents fatigue more by ensuring rapid renewal of nerve-conducting material than by mechanical protection; it may be looked on as a nutrient bath in which the core conductor lies immersed.

Peripheral fatigue.

The neuron is described as having a cell body or *perikaryon* from which the cell branches—dendrites and axon—extend, and it is this perikaryon which, as its name implies, contains the nucleus. It forms the trophic centre of the cell, just as the nucleus-containing part of every cell is the trophic centre of the whole cell. Any part of the cell cut off from the nucleus-containing part dies down: this is as true of nerve cells as of amœba, and in regard to the neuron it constitutes what is known as the *Wallerian degeneration.* On the other hand, in some neurons, after severance of the axon from the rest of the cell (spinal motor cell), the whole nerve cell as well as the severed axon degenerates, and may eventually die and be removed. In the severed axon the degeneration is first evident in a breaking down of the naked nerve filaments of the motor end plate. A little later the breaking down of the whole axon, both axis cylinder and myelin sheath alike, seems to occur simultaneously throughout its entire length distal to the place of severance. The complex fat of the myelin becomes altered chemically, while the other components of the sheath break down. This death of the sheath as well as of the axis cylinder shows that it, like the axis cylinder, is a part of the nerve cell itself.

Solidarity of neuron.

In addition to the trophic influence exerted by each part of the neuron on its other parts, notably by the perikaryon on the cell branches, one neuron also in many instances influences the nutrition of other neurons. When, for instance, the axons of the ganglion cells of the retina are severed by section of the optic nerve, and thus their influence upon the nerve cells of the visual cerebral centres is set aside, the nerve cells of those centres undergo secondary atrophy (*Gadden's atrophy*). They dwindle in size; they do not, however, die. Similarly, when the axons of the motor spinal cells are by severance of the nerve trunk of a muscle broken through, the muscle cells undergo "degeneration"—dwindle, become fatty, and alter almost beyond recognition. This trophic influence which one neuron exerts upon others, or upon the cells of an extrinsic tissue, such as muscle, is exerted in that direction which is the one normally taken by the natural nerve impulses. It seems, especially in the case of the nexus between certain neurons, that the influence, loss of which endangers nutrition, is associated with the occurrence of something more than merely the nervous impulses awakened from time to time in the leading nerve cell. The wave of change (nervous impulse) induced in a neuron by advent of a stimulus is after all only a sudden augmentation of an activity continuous within the neuron—a transient accentuation of one (the disintegrative) phase of the metabolism inherent in and inseparable from its life. The nervous impulse is, so to say, the sudden evanescent glow of an ember continuously black-hot. A continuous lesser "change" or stream of changes sets through the neuron, and is distributed by it to other neurons in the same direction and by the same synapses as are its nerve impulses. This gentle continuous activity of the neuron is called its *tonus*. In tracing the tonus of neurons to a source, one is always led link by link against the current of nerve force—so to say, "up stream"—to the first beginnings of the chain of neurons in the sensifacient surfaces of the body. From these, as in the eye, ear, and other sense organs, tonus is constantly initiated. Hence, when cut off from these sources, the nutrition of the neurons of various central mechanisms suffers. Thus the tonus of the motor neurons of the spinal cord is much lessened by rupture of the great afferent root cells which normally play upon them. A prominent and practically important illustration of neural tonus is given by the skeletal muscles. These muscles exhibit a certain constant condition of slight contraction, which disappears on severance of the nerve that innervates the muscle. It is a muscular tonus of central source consequent on the continual glow of excitement in the spinal motor neuron, whose outgoing end plays upon the muscle cells, whose ingoing end is played upon by other neurons—spinal, cerebral, and cerebellar.

Tonic activity of neurons.

It is with the neural element of muscle tonus that *tendon phenomena* are intimately associated. The earliest-studied of these, the "*knee-jerk*," may serve as example of the class. It is a brief extension of the limb at the knee-joint, due to a simple contraction of the extensor muscle, elicited by a tap or other short mechanical stimulus applied to the muscle fibres through the tendon of the muscle. The jerk is obtainable only from muscle fibres possessed of neural tonus. If the sensory nerves of the extensor muscle be severed, the "jerk" is lost. The brevity of the interval between the tap on the knee and the beginning of the resultant contraction of the muscle excludes the possibility of reflex development. A little experience in observations on the knee-jerk imparts a notion of the average strength of the "jerk." Wide departures from the normal standard are met with and are symptomatic of certain nervous conditions. Stretching of the muscles antagonistic to the extensors—namely, of the flexor muscles—reduces the jerk by inhibiting the extensor spinal nerve cells through the nervous impulses generated by the tense flexor muscles. Hence a favourable posture of the limb for eliciting the jerk is one ensuring relaxation of the hamstring muscles, as when the leg has been crossed upon the other. In sleep the jerk is diminished, in deep sleep quite abolished. Extreme bodily fatigue diminishes it. Conversely, a cold bath increases it. The turning of attention towards the knee interferes with the jerk; hence the device of directing the person to perform vigorously some movement, which does not involve the muscles of the lower limb, at the moment when the light blow is dealt upon the tendon. A slight degree of contraction of muscle seems the *substratum* of all attention. The direction of attention to the performance of some movement by the arm ensures that looseness and freedom from tension in the thigh muscles which is essential for the provocation of the jerk. The motor cells of the extensor muscles, when preoccupied by cerebral influence, appear refractory. Ziehen has noted exaltation of the jerk to follow extirpation of a cortical centre.

Although the cell body or perikaryon of the neuron, with its contained nucleus, is essential for the maintenance of the life of the cell branches, it has become recognized that the actual process and function of "conduction" in many neurons can, and does, go on without the cell body being directly concerned in the conduction. Wundt first showed, many years ago, that the nerve impulse travels through the spinal ganglion at the same speed as along the other parts of the nerve trunk—that is, that it suffers no delay in transit through the perikarya of the afferent root-neurons. Bethe has succeeded in isolating their perikarya from certain of the afferent neurons of the antenna of *Carcinus*. The conduction through the amputated cell branches continues unimpaired for many hours. This indicates that the conjunction between the conducting substance of the dendrons and that of the axon can be effected without the intermediation of the cell body. But the proper nutrition of the conducting substance is indissolubly dependent on the cell branches being in continuity with the cell body and nucleus it contains. Evidence illustrating this nexus is found in the visible changes produced in the perikaryon by prolonged activity induced and maintained in the conducting branches of the cell. As a result, the fatigued cells appear shrunken, and their reaction to staining reagents alters, thus showing chemical alteration. Most marked is the decrease in the volume of the nucleus, amounting even to 44 per cent. of the initial volume. In the myelinated cell branches of the neuron, that is, in the ordinary nerve fibres, no visible change has ever been demonstrated as the result of any normal activity, however great—a striking contrast to the observations obtained on the perikarya. The chemical changes that accompany activity in the nerve fibre must be very small, for no measurable production of CO_2 or of heat is observable as the result of the most forced tetanic activity.

Conduction in neurons.

The nerve cells of the higher vertebrata, unlike their blood cells, their connective tissue cells, and even their muscle cells, early, and indeed in embryonic life, lose power of multiplication. The number of them formed is definitely closed at an early period of the individual life; they are like a committee given definite work to do and without power to add to their number. The nerve cells of a centenarian are themselves each individually a hundred years of age. Although, unlike so many other cells, thus early sterile for reproduction of their kind, they retain for longer than most cells a high power of individual growth. They continue to grow, and to thrust out new branches and to lengthen existing branches, for many years far into adult life. They similarly possess power to repair and to regenerate their cell branches where these are injured or destroyed by trauma or disease. This is the explanation of the repair of nerve trunks that have been severed, with consequent degeneration of the peripheral nerve fibres. As a rule, a longer time is required to restore the motor than the sensory functions of a nerve trunk.

Growth in nervous system.

Whether examined by functional or by structural features, the conducting paths of the nervous system, traced from beginning to end, never terminate in the centres of that system, but pass through them. All ultimately emerge as efferent channels. Every afferent channel, after entrance in the central nervous system, subdivides into several; of these some pass to efferent channels soon, others pass farther and farther within the cord and brain before they finally reach channels of outlet. All the longest routes thus formed traverse late in their course the cortex of the cerebral hemisphere. It is this relatively huge development of cortex cerebri which is the pre-eminent structural character of man. This means that the number of "longest routes" in man is, as compared with lower animals, disproportionately great. In the lower animal forms there is no such nervous structure at all as the cortex cerebri. In the frog, lizard, and even bird, it is a thin and poorly developed thing. In the marsupials it is more evident, and its excitation by electric currents evokes movements in the musculature of the crossed side of the body. Larger and thicker in the rabbit, when excited it gives rise in that animal to movements of the eyes and of the fore-limbs and neck; but it is only in much higher types, such as the dog, that the cortex yields, under experimental excitation, definitely localized foci, whence can be evoked movements of the fore-limb, hind-limb, neck, eyes, ears, and face. In the monkey the proportions it assumes are vastly greater, and the number of foci, for distinct movements of this and that member, indeed for the individual joints of each limb, are much more numerous, and together occupy a more extensive surface, though relatively to the total surface of the brain a smaller one.

Cerebral cortex.

Experiment shows that in the manlike (anthropoid) apes the differentiation of the foci or "centres" of movement in the motor field of the cortex is more minute still. In them areas are found whence stimuli excite movements even of this or that finger alone, of the upper lip without the lower, of the tip only of the tongue, or of one upper eyelid by itself. The movement evoked from a point of cortex is not always the same; its character is determined by movements evoked from neighbouring points of cortex immediately antecedently. Thus a point A will, when excited soon subsequent to point B, which latter yields protrusion of lips, itself yield lip-protrusion, whereas if excited after C, which yields lip-retraction, it will itself yield lip-retraction. The movements obtained by point-to-point excitation of the cortex are often evidently imperfect as compared with natural movements—that is, are only portions of complete normal movements. Thus among the tongue movements evoked by stigmatic stimulation of the cortex undeviated protrusion or retraction of the organ is not found. Again, from different points of the cortex the assumption of the requisite positions of the tongue, lips, cheeks, palate, and epiglottis, as components in the act of sucking, can be provoked singly. Rarely can the whole action be provoked, and then only gradually, by prolonged and strong excitation of one of the requisite points, *e.g.*, that for the tongue, with which the other points are functionally connected. Again, no single point in the cortex evokes the act of ocular convergence and fixation. All this means that the execution of natural movements employs simultaneous co-operative activity of a number of points in the motor fields on both sides of the brain together.

The accompanying simple figure indicates better than any verbal description the topography of the main groups of foci in the motor field of a manlike ape (chimpanzee). It will be noted from it that there is no direct relation between the extent of a cortical area and the mass of muscles which it controls. The mass of muscles in the trunk is greater than in the leg, and in the leg is greater than in the arm, and in the arm is many times greater than in the face and head; yet for the last the cortical area is the most extensive of all, and for the first-named is the least extensive of all.

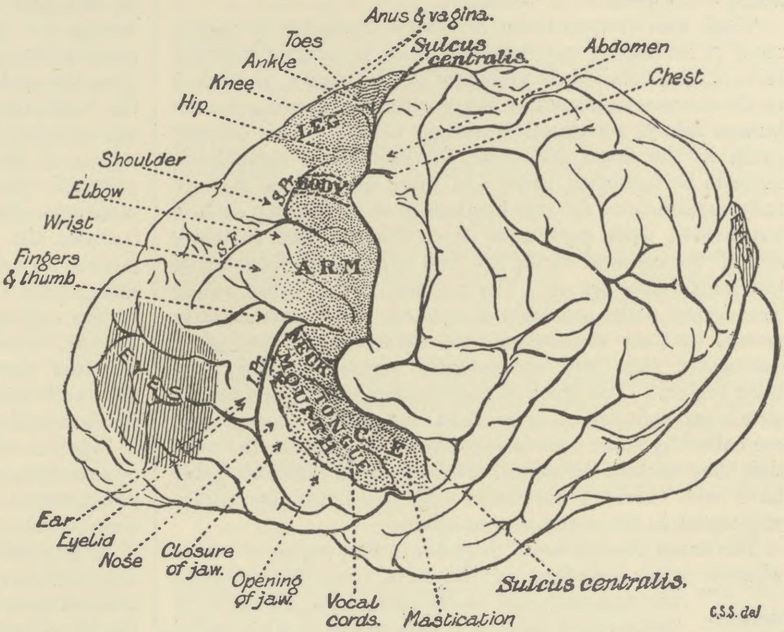


Diagram of the Topography of the Main Groups of Foci in the Motor Field of Chimpanzee.

The motor field of the cortex is, taken altogether, relatively to the size of the lower parts of the brain, larger in the anthropoid than in the inferior monkey brains. But in the anthropoid brain still more increased even than the motor field are the great regions of the cortex outside that field, which yields in definite movements under electric excitation, and are for that reason known as "inexcitable." The motor field, therefore, though absolutely larger, forms nevertheless a smaller fraction of the whole cortex of the brain than in the lower forms. The statement that in the anthropoid (orang-outan) brain the groups of foci in the motor fields of the cortex are themselves separated one from another by surrounding inexcitable cortex, has been made and was one of great interest, but has not been confirmed by subsequent observation. That in man the excitable foci of the motor field are islanded in inexcitable surface similarly and even more extensively, was a natural inference, but it had its chief basis in the observations on the orang, now known to be erroneous; unless direct confirmatory evidence is forthcoming from observations on the human brain itself, the supposition must be abandoned.

In the diagram there is indicated the situation of the cortical centres for movement of the vocal cords. Their situation is at the lower end of the motor field. That they should lie there is interesting, because that place is close to one known in man to be associated with management of the movements concerned in speech. When that area in man is injured, the ability to utter words is impaired. Not that there is paralysis of the muscles of speech, since these muscles can be used perfectly for all acts other than speech. The area in man is known as the motor centre for speech; in most persons it exists only in the left half of the brain and not in the right. In a similar way damage of a certain small portion of the temporal lobe of the brain produces loss of intelligent apprehension of words spoken, although there is no deafness and although words seen are perfectly apprehended. Another region, "the angular region," is similarly related to intelligent apprehension of words seen, though words heard are apprehended perfectly.

When this differentiation of cortex, traceable by experiment to its highest expression in man, is collated with the facts of the detailed development of the cortex as studied in the successive phases of its growth and ripening in the human infant, a suggestive analogy is seen. The nervous paths in the brain and cord, as they attain completion, come to be furnished more and more with fibres that are fully myelinate. At the beginning of its history each is unprovided with myelinate nerve fibres. The excitable foci of the cerebral cortex are well myelinated long before the unexcitable are so. The regions of the cortex, whose conduction paths are early completed, may be arranged in groups by their connexions with sense-organs: eye-region, ear-region, skin and somæsthetic region, olfactory and taste region. The areas of intervening cortex, arriving at structural completion later than the above *sense-spheres*, are called by some *association-spheres*, to indicate the view that they contain the neural mechanisms of reactions (some have said "ideas") associated with the sense perceptions elaborated in the several sense-spheres.

Sensori-motor centres.

The name "motor area" is given to that region of cortex whence motor reactions of the facial and limb muscles are regularly and easily evoked, as Ferrier's investigations showed. This region is often called the *sensori-motor cortex*, and the term *somæsthetic* has also been used and seems very appropriate. It has been found that disturbance of sensation, as well as disturbance of movement, is often incurred by its injury. Patients in whom, for purposes of diagnosis, it has been electrically excited, describe, as the initial effect of the stimulation, tingling and obscure but locally-limited sensations, referred to the part whose muscles a moment later are thrown into co-ordinate activity. The distinction, therefore, between the movement of the eyeballs, elicited from the occipital (visual) cortex, and that of the hand, elicited from the cortex in the region of the central sulcus (somæsthetic), is not a difference between motor and sensory, for both are sensori-motor in the nature of their reactions; the difference is only a difference between the kind of sense and sense-organ in the two cases, the muscular apparatus in each case being an appanage of the sensual.

That the lower types of vertebrate, such as fish, *e.g.*, carp, possess practically no cortex cerebri, and nevertheless execute "volitional" acts involving high co-ordination and suggesting the possession by them of *associative memory*, shows that for the existence of these phenomena the cortex cerebri is in them not essential. In the dog it has been proved that after removal from the animal of every vestige of its cortex cerebri, it still executes habitual acts of great motor complexity requiring extraordinarily delicate adjustment of muscular contraction. It can walk, run, and feed; such an animal, on wounding its foot, will run on three legs, as will a normal dog under similar mischance. But signs of associative memory are almost, if not entirely, wanting. Throughout three years such a dog failed to learn that the attendant's lifting it from the cage at a certain hour was the preliminary circumstance of the feeding-hour; yet it did exhibit hunger, and would refuse further food when a sufficiency had been taken. In man, actually gross sensory defects follow even limited lesions of the cortex. Thus the rabbit and dog are not absolutely blinded by removal of the entire cortex, but in man destruction of the occipital cortex produces total blindness, even to the extent that the pupil of the eye does not respond when light is flashed into the eye.

Cerebellum.

Examination of the cerebellum by the method of Wallerian degeneration has shown that a large number of spinal and bulbar nerve cells send branches up into it. These seem to end, for the most part, in the grey cortex of the median lobe, some, though not the majority, of them decussating across the median line. The organ seems also to receive many fibres from the parietal region of the cerebral hemisphere. From the organ there emerge fibres which cross to the opposite red nucleus, and directly or indirectly reach the thalamic region of the crossed hemisphere. The pons or middle peduncle, which was regarded, on the uncertain ground of naked-eye dissection of human anatomy, as commissural between the two lateral lobes of the cerebellum, is now known as constituting chiefly a cerebro-cerebellar decussating path. Certain cerebellar cells send processes down to the cell-group in the bulb known as the nucleus of Deiters, which latter projects fibres down the spinal cord. Whether there is any other or direct emergent path from the cerebellum into the spinal cord is a matter on which opinion is divided.

Injuries of the cerebellum, if large, derange the power of executing movements, without producing any detectable derangement of sensation. The derangement gradually disappears, unless the damage to the organ be very wide. A reeling gait, oscillations of the body which impart a zigzag direction to the walk, difficulty in standing, owing to unsteadiness of limb, are common in cerebellar disease. On the other hand, congenital defect amounting to absence of one cerebellar hemisphere has been found to occasion practically no symptoms whatsoever. Not a hundredth part of the cerebellum has remained, and yet there has existed ability to stand, to walk, to handle and lift objects in a fairly normal way, without any trace of impairment of cutaneous or muscular sensitivity. The damage to the cerebellum must, it would seem, occur not very slowly in order to occasion marked derangement of function, and then the derangement falls on the execution of movements. One aspect of this derangement, named by Luciani *astasia*, is a tremor heightened by or only appearing when the muscles enter upon action—"intention tremor." Vertigo is a frequent result of cerebellar injury: animals indicate it by their actions; patients describe it. To interpret this vertigo, appeal must be made to disturbances, other than cerebellar, which likewise occasion vertigo. These include, besides ocular squint, many spatial positions and movements unwonted to the body: the looking from a height, the gliding over ice, sea-travel, to some persons even travelling by train, or the covering of one eye. Common to all these conditions is the synchronous rise of perceptions of spatial relations between the self and the environment which have not, or have rarely, before arisen in synchronous combination. The tactual organs of the soles, and the muscular sense organs of limbs and trunk, are originating perceptions that indicate that the self is standing on the solid earth, yet the eyes are at the same time originating perceptions that indicate that the solid earth is far away below the standing self. The combination is hard to harmonize at first; it is at least not given as *innately* harmonized. Perceptions regarding the "me" are notoriously highly charged with "feeling," and the conflict occasions the feeling insufficiently described as "giddiness." The cerebellum receives paths from most, if not from all, the afferent roots. With certain of these it stands associated most closely, namely, with the vestibular, representing the sense organs which furnish data for appreciation of positions and movements of the head, and with the channels, conveying centripetal impressions from the apparatus of skeletal movement. Disorder of the cerebellum sets at variance, brings discord into, the space-perceptions contributory to the movement. The body's movement becomes thus imperfectly adjusted to the spatial requirements of the act it would perform.

In the physiological basis of sense exist many impressions which, apart from and devoid of psychical accompaniment, reflexly influence motor (muscular) innervation. It is with this sort of habitually apsychical reaction that the cerebellum is, it would seem, employed. That it is apparently devoid of psychical concomitant need not imply that the impressions concerned in it are crude and inelaborate. The seeming want of reaction of so much of the cerebellar structure under artificial stimulation, and the complex relay system revealed in the histology of the cerebellum, suggest that the impressions are elaborate. Its reaction preponderantly helps to secure co-ordinate innervation of the skeletal musculature, both for maintenance of attitude and for execution of movements. So far as the geotropism and stereotropism of the animal can be "centred" at any one limited field of the central nervous system, that field is cerebellar.

Sleep.—The more obvious of the characters of sleep are essentially nervous. In deep sleep the threshold-value of the stimuli for the various senses is very greatly raised, rising rapidly during the first hour and a half of sleep, and then declining with gradually decreasing decrements. The muscles become less tense than in their waking state: their tonus is diminished, the upper eyelid falls, and the knee-jerk is in abeyance. The respiratory rhythm is less frequent and the breathing less deep; the heart-beat is less frequent; the secretions are less copious; the pupil is narrow; in the brain there exists arterial anæmia with venous congestion, so that the blood-flow there is less than in the waking state.

Theories of sleep.

It has been suggested that the gradual cumulative result of the activity of the nerve cells during the waking day is to load the brain tissue with "fatigue-substances" which clog the action of the cells, and thus periodically produce that loss of consciousness, &c., which is sleep. Such a drugging of tissue by its own excreta is known in muscular fatigue, but the fact that the depth of sleep progressively increases for an hour and more after its onset prevents complete explanation of sleep on similar lines. It has been urged that the neurons retract during sleep, and that thus at the synapses the gap between nerve cell and nerve cell becomes wider, or that the supporting cells expand between the nerve cells and tend to isolate the latter one from other. Certain it is that in the course of the waking day a great number of stimuli play on the sense organs, and through these produce disintegration of the living molecules of the central nervous system. Hence during the day the assimilatory processes of these cells are overbalanced by their wear and tear, and the end-result is that the cell attains an atomic condition less favourable to further disintegration than to reintegration. That phase of cell life which we are accustomed to call "active" is accompanied always by disintegration. When in the cell the assimilative processes exceed dissimilative, the external manifestations of energy are liable to cease or diminish. Sleep is not exhaustion of the neuron in the sense that prolonged activity has reduced its excitability to zero. The nerve cell just prior to sleep is still well capable of response to stimuli, although perhaps the threshold-value of the stimulus has become rather high, whereas after entrance upon sleep and continuance of sleep for several hours, and more, when all spur to the dissimilation process has been long withheld, the threshold-value of the sensory stimulus becomes enormously higher than before. The exciting cause of sleep is therefore no complete exhaustion of the available material of the cells, nor is it entirely any paralysing of them by their excreta. It is more probably abeyance of external function during a periodic internal assimilatory phase.

Two processes conjoin to initiate the assimilatory phase. There is close interconnexion between the two aspects of the double activity that in physiological theory constitute the chemical life of protoplasm, between dissimilation and assimilation. Hering has long insisted on a self-regulative adjustment of the cell metabolism, so that action involves reaction, increased catabolism necessitates after-increase of anabolism. The long-continued incitement to catabolism of the waking day thus of itself predisposes the nerve cells towards rebound into the opposite phase; the increased catabolism due to the day's stimuli induces increase of anabolism, and though recuperation goes on to a large extent during the day itself, the recuperative process is slower than, and lags behind, the disintegrative. Hence there occurs a cumulative effect, progressively increasing from the opening till the closing hours. The second factor inducing the assimilative change is the withdrawal of the nervous system from sensual stimulation. The eyes are closed, the maintenance of posture by active contraction is replaced by the recumbent pose which can be maintained by static action and the mere mechanical consistence of the body, the ears are screened from noise in the quiet chamber, the skin from localized pressure by a soft, yielding couch. The effect of thus reducing the excitant action of the environment is to give consciousness over more to mere revivals by memory, and gradually consciousness lapses. A remarkable case is well authenticated, where, owing to disease, a young man had lost the use of all the senses save of one eye and of one ear. If these last channels were sealed, in two or three minutes' time he invariably fell asleep.

Narcotics.

If natural sleep is the expression of a phase of decreased excitability due to the setting in of a tide of anabolism in the cells of the nervous system, what is the action of narcotics? They lower the external activities of the cells, but do they not at the same time lower the internal, reparative, assimilative activity of the cell that in natural sleep goes vigorously forward preparing the system for the next day's drain on energy? In most cases they seem to lower both the internal and the external activity of the nerve cells, to lessen the cell's entire metabolism, to reduce the speed of its whole chemical movement and life. Hence it is not surprising that often the refreshment, the recuperation, obtained from and felt after sleep induced by a drug amounts to nothing, or to worse than nothing. But very often refreshment is undoubtedly obtained from such narcotic sleep. It may be supposed that in the latter case the effect of the drug has been to ensure occurrence of that second predisposing factor mentioned above, of that withdrawal of sense impulses from the nerve centres that serves to usher in the state of sleep. In certain conditions it may be well worth while by means of narcotic drugs to close the portals of the senses for the sake of thus obtaining stillness in the chambers of the mind; their enforced quietude may induce a period in which natural rest and repair continue long after the initial unnatural arrest of vitality due to the drug itself has passed away.

Hypnotism.—The physiology of this group of "states" is, as regards the real understanding of their production, eminently vague. The conditions which tend to induce them contain generally, as one element, constrained visual attention prolonged beyond ordinary duration. Symptoms attendant on the *hypnotic* state are closure of the eyelids by the hypnotizer without subsequent attempt to open them by the hypnotized subject; the pupils, instead of being constricted, as for near vision, dilate, and there sets in a condition superficially resembling sleep. But in natural sleep the action of all parts of the nervous system is subdued, whereas in the hypnotic the reactions of the lower, and some even of the higher, parts are exalted. Moreover, the reactions seem to follow the sense impressions with such fatality, that, as an inference, absence of will-power to control them or suppress them is suggested. This reflex activity with "paralysis of will" is characteristic of the *somnambulistic* state. The threshold-value of the stimuli adequate for the various senses may be extraordinarily lowered. Print of microscopic size may be read; a watch ticking in another room can be heard. Judgment of weight and texture of surface is exalted; thus a card can in a dark room be felt and then re-selected from the re-shuffled pack. Akin to this condition is that in which the power of maintaining muscular effort is in creased; the individual may lie stiff with merely head and feet supported on two chairs; the limbs can be held outstretched for hours at a time. This is the *cataleptic* state, the phase of hypnotism which the phenomena of so-called "animal hypnotism" resemble most. A frog or fowl or guinea-pig held in some unnatural pose, and retained so forcibly for a time, becomes "set" in that pose, or rather in a posture of partial recovery of the normal posture. In this state it remains motionless for various periods. This condition is more than usually readily induced when the cerebral hemispheres have been removed. The decerebrate monkey exhibits "cataleptoid" reflexes. Father Kircher's *experimentum mirabile* with the fowl and the chalk line succeeds best with the decerebrate hen. The attitude may be described as due to prolonged, not very intense, discharge from reflex centres that regulate posture and are probably intimately connected with the cerebellum. A sudden intense sense stimulus usually suffices to end this tonic discharge. It completes the movement that has already set in but had been checked, as it were, half-way, though tonically maintained. Coincidently with the persistence of the tonic contraction, the higher and volitional centres seem to lie under a spell of inhibition; their action, which would complete or cut short the posture-spasm, rests in abeyance. Suspension of cerebral influence exists even more markedly, of course, when the cerebral hemispheres have been ablated.

But a potent—according to some, the most potent—factor in hypnotism, namely, *suggestion*, is unrepresented in the production of so-called animal hypnotism. We know that one idea suggests another, and that volitional movements are the outcome of ideation. If we assume that there is a material process at the basis of ideation, we may take the analogy of the concomitance between a spinal reflex movement and a skin sensation. The physical "touch" that initiates the psychical "touch" initiates, through the very same nerve channels, a reflex movement responsive to the physical "touch," just as the psychical "touch" may be considered also a response to the same physical event. But in the decapitated animal we get, we have good arguments for belief, the reflex movement alone as response; the psychical touch drops out. Could we assume that there is in the adult man reflex machinery which is of higher order than the merely spinal, which employs much more complex motor mechanisms than they, and is connected with a much wider range of sense organs; and could we assume that this reflex machinery, although usually associated in its action with memorial and volitional processes, may in certain circumstances be sundered from these latter and unattendant on them—may in fact continue in work when the higher processes are at a standstill—then we might imagine a condition resembling that of the somnambulistic and cataleptic states of hypnotism.

Such assumptions are not wholly unjustified. Actions of great complexity and delicacy of adjustment are daily executed by each of us without what is ordinarily understood as volition, and without more than a mere shred of memory attached thereto. To take one's watch from the pocket and look at it when from a familiar clock-tower a familiar bell strikes a familiar hour, is an instance of a habitual action initiated by a sense perception outside attentive consciousness. We may suddenly remember dimly afterwards that we have done so, and we quite fail to recall the difference between the watch time and the clock time. In many instances hypnotism seems to establish quickly reactions similar to such as usually result only from long and closely attentive practice. The sleeping mother rests undisturbed by the various noises of the house and street, but wakes at a slight murmur from her child. The ship's engineer, engaged in conversation with some visitor to the engine-room, talks apparently undisturbed by all the multifold noise and rattle of the machinery, but let the noise alter in some item which, though unnoticeable to the visitor, betokens importance to the trained ear, and his passive attention is in a moment caught. The warders at an asylum have been hypnotized to sleep by the bedside of dangerous patients, and "suggested" to awake the instant the patients attempt to get out of bed, sounds which had no import for them being inhibited by suggestion. Warders in this way worked all day and performed night duty also for months without showing fatigue. This is akin to the "repetition" which, read by the schoolboy last thing overnight, is on waking "known by heart." Most of us can wake somewhere about a desired although unusually early hour, if overnight we desire much to do so.

Two theories of a physiological nature have been proposed to account for the separation of the complex reactions of these conditions of hypnotism from volition and from memory. Heidenhain's view is that the cortical centres of the hemisphere are inhibited by peculiar conditions attaching to the initiatory sense stimuli. Preyer's view is that the essential condition for initiation is fatigue of the will-power under a prolonged effort of undivided attention.

Hypnotic somnambulism and hypnotic catalepsy are not the only or the most profound changes of nervous condition that hypnosis can induce. The physiological derangement which is the basis of the abeyance of volition may, if hypnotism be profound, pass into more widespread derangement, exhibiting itself as the *hypnotic lethargy*. This is associated not only with paralysis of will but with profound anæsthesia. Proposals have been made to employ hypnotism as a method of producing anæsthesia for surgical purposes, but there are two grave objections to such employment. In order to produce a sufficient degree of hypnotic lethargy the subject must be made extremely susceptible, and this can only be done by repeated hypnotization. It is necessary to hypnotize patients every day for several weeks before they can be got into a degree of stupor sufficient to allow of the safe execution of a surgical operation. But the state itself, when reached, is at least as dangerous to life as is that produced by inhalation of ether, and it is more difficult to recover from. Moreover, by the processes the subject has gone through he has had those physiological activities upon which his volitional power depends excessively deranged, and not improbably permanently enfeebled.

(C. S. S.)

VII. Special Senses.

Touch.—The sense of touch depends upon pressure. When we touch a body, a pressure is exerted. This pressure reacts on nerve-endings in the epidermis or skin, nervous impulses are generated, and when these react, the brain sensations of "touch" are the result (see 9th edition, article Touch, vol. xxiii. p. 478). Research shows that the sensation may be referred to parts of the skin which do not contain the special end organs associated with this sense, and that filaments in the Malpighian layer (the layer immediately above the papillæ of the true skin) may form the anatomical basis of the sense. The skin may be regarded, also, as an extensive surface containing nervous arrangements by which we are brought into relation with the outer world. Accordingly, touch is not the only sensation referred to the skin, but we also refer sensations of temperature (heat and cold), and often those peculiar sensations which we call pain.

Temperature sensations.

Sensations of heat and cold are chiefly referred to the skin, and only partially to some mucous membranes, such as those of the alimentary canal. Direct irritation of a nerve does not give rise to these sensations. Thus, if we plunge the elbow into hot water, or into ice-cold water, we may have feelings of heat or of cold referred to the parts immersed, but we do not experience heat or cold by irritating the ulnar nerve, which lies here just below the skin. When the change of temperature affects the nerve, there is a painful sensation referred to the extremities of the nerve on the ulnar side of the arm and hand. The exposed pulp of a diseased tooth, when irritated by hot or cold fluids, gives rise to pain, not to sensations of temperature. It has now been ascertained that there are minute areas on the skin in which sensations of heat and cold may be more acutely felt than in adjoining areas; and, further, that there are points stimulated by addition of heat, hot spots, while others are stimulated by withdrawal of heat, cold spots.

A simple method of demonstrating this phenomenon is to use a solid cylinder of copper, eight inches in length by half an inch in thickness, and sharpened at one end to a fine pencil-like point. Dip the pointed end into very hot water, close the eyes, and touch parts of the skin. When a hot spot is touched, there is an acute sensation of burning. Such a spot is often near a hair. Again, in another set of experiments, dip the copper pencil into ice-cold water and search for cold spots. When one of these is touched, a sensation of cold, as if concentrated on a point, is experienced. Thus it may be demonstrated that in a given area of skin there may be hot spots, cold spots, and touch spots.

Cold spots are more abundant than hot spots. The spots are arranged in curved lines, but the curve uniting a number of cold spots does not coincide with the curve forming a chain of hot spots. By Weber's method (see TOUCH, 9th edition, vol. xxiii. p. 480) it will be found that we can discriminate cold spots at a shorter distance from each other than hot spots. Thus on the forehead cold spots have a minimum distance of 8 mm., and hot spots 4 mm.; on the skin of the breast, cold spots 2 mm., and hot spots 5 mm.; on the back, cold spots 1·5 mm., and hot spots 4 to 6 mm.; on the back of the hand, cold spots 3 mm., and hots spots 4 mm.; on the palm, cold spots 8 mm., and hot spots 2 mm.; and on the thigh and leg, cold spots 3 mm., and hot spots 3·5 mm. Electrical and mechanical stimulation of the hot or cold spots call forth the corresponding sensation. No terminal organ for discrimination of temperature has yet been found. It will be observed that the sensation of heat or cold is excited by *change* of temperature, and that it is more acute and definite the more sudden the change. Thus discrimination of temperature is similar to discrimination of touch, which depends on more or less sudden change of pressure. The term cold means, physiologically, the sensation we experience when heat is abstracted, and the term heat, the sensation felt when heat is added to the part. Thus we are led to consider that the skin contains at least two kinds of specific terminal organs for sensations of touch and temperature, and two sets of nerve fibres which carry the nervous impulses to the brain. In all probability, also, these fibres have different central endings, and in their course to the brain run in different tracts in the spinal cord. This will explain cases of disease of the central nervous system in which, over certain areas of skin, sensations of touch have been lost while sensations of temperature and pain remain, or *vice versâ*. Tactile and thermal impressions may influence each other. Thus a leg sent to "sleep" by pressure on the sciatic nerve will be found to be less sensitive to heat, but distinctly sensitive to cold. In some cases of disease it has been noticed that the skin is sensitive to a temperature above that of the limb, but insensitive to cold. Again, a weight is always felt to be heavier when it is cold than when it is hot, and the minimum distance at which two compass points are felt is diminished when *one* point is warmer than the other. It is highly probable that, just as we found in the case of touch (pressure), the terminal organs connected with the sense of temperature are the fine nerve filaments that have been detected in the deeper strata of the Malpighian region of the epidermis, immediately above the true skin, and it is also probable that certain epidermic (epithelial) cells in that region play their part in the mechanism.

Sensations of touch (pressure) and of temperature are not, however, the only sensations referred to the skin. We may also experience in that organ the peculiar class of sensations called pain. Sensations of a painful character may also, in certain circumstances, be referred to the viscera, and to mucous and serous surfaces. Pain is not a sensation excited by irritating the end organs either of touch or of temperature, nor even by irritating directly the filaments of a sensory nerve. Even if sensory nerves are cut or bruised, as in surgical operations, there may be no sensations of pain; and it has been found that muscles, vessels, and even the viscera, such as the heart, stomach, liver, or kidneys, may be freely handled without giving rise to any feeling of pain, or indeed to any kind of sensation. These parts, in ordinary circumstances, appear to be insensitive, and yet they contain afferent nerves. If the sensibility of these nerves is heightened, or possibly if the sensitiveness of the central terminations of the nerves is raised, then we may have sensations to which we give the name of pain. In like manner the skin is endowed with afferent nerves, distinct from these ministering to touch and to temperature, along which nervous impulses are constantly flowing. When these nervous impulses reach the central nervous system, in ordinary circumstances they do not give rise to changes that reach the level of consciousness, but they form, as it were, the warp and woof of our mental life, and they also affect metabolisms, that is to say, nutritive changes in many parts of the body. They may also, as is well known, affect unconsciously such mechanisms as those of the action of the heart, the calibre of the blood-vessels, and the movements of respiration. If, however, their plane of activity is raised, as by intermittent pressure, or by inflammatory action, or by sudden changes of temperature, as in burning, scalding, &c., such nervous impulses give rise to pain. Sometimes pain is distinctly located, and in other cases it may be irradiated in the nerve centres, and referred to areas of skin or to regions of the body which are not really the seat of the irritation. Thus irritation of the liver may cause pain in the shoulder; disease of the hip-joint often gives rise to pain in the knee; and renal colic, due to the passage of a calculus down the ureter, to severe pain even in the abdominal walls. It is also noticeable that a sensation of pain gives us no information as to its cause; we simply have an agonizing sensation in a part to which, hitherto, we probably referred no sensations. The acuteness or intensity of pain depends partly on the intensity of the irritation, and partly on the degree of excitability of the sensory nerves at the time. Sometimes, for example, the excitability of sensory nerves may be so high that a whiff of air may cause acute distress. If only a few nerves are affected, the pain is acute and piercing; but if many nerves are involved, it may be more massive and diffuse in character. The quality of pain, whether it is gnawing, dull, boring, piercing, shooting, depends on the nature of the irritation, and on whether the irritation is constant or intermittent (see TOUCH, vol. xxiii. p. 482).

Pain.

Smell.—It has not yet been decided whether the sense of smell depends, in the first instance, on a chemical or on a physical process. All that can be said is that sensory impulses are excited when odoriferous particles come into contact with the free ends of peculiar rod-like cells found in the olfactory mucous membrane (see ANATOMY, vol. i. p. 885; also SMELL, vol. xxii. p. 167). The free olfactory surface is always covered with a thin layer of fluid, and it is clear that all odoriferous matters must be dissolved in this fluid so as to reach the rod-cells. There is here an analogy with the conditions found in the sense of taste, where sapid substances must be soluble in the fluid of the mouth. The intensity of the sensation of smell depends on the size of the area of the olfactory membrane affected: the greater the area the more intense the sensation. On this principle an olfactometer may be constructed by which the intensities of different odours may be compared. Thus the odoriferous value of a substance may be expressed by the smallest superficial area, impregnated with the odoriferous matter, over which the air must pass to give rise to a distinct sensation. The minimal quantity of material, as in the case of musk, is extremely small.

No progress has been made in establishing any connexion between the chemical nature of a substance and the odour it may excite. There is a relation between the molecular weight of a gas and the presence or absence of odour. Gases of less than a certain molecular weight are odourless, and it is significant that to some persons hydrocyanic acid, which has a low molecular weight, gives rise to no sensation of smell. It has also been pointed out that chemical compounds of elements belonging to the same group, according to the well-known periodic law, have sometimes odours of a similar character (Foster's *Physiology*, part iv. p. 1505).

As a rule, we experience odours by the simultaneous use of both nostrils. Stimulation of either nostril would give rise to the sensation, while there is a fusion of sensations when both are affected. If, by means of a tube, an odour is conveyed into one nostril, while an odour of a different kind is directed into the other, there may be either a compound sensational effect, a sort of double-odour, or one odour may so predominate as entirely to destroy the other. The fusion of odours is not complete, and it is similar to the effect of combining, say blue and red, in stereoscopic vision. When one odour destroys the other, the obliteration must take place in the cerebral centre. It is not unlikely that when one odour predominates among many, this may be due not to any chemical action of one substance over another, but that the missing sensations may be accounted for by their failure to excite the olfactory region of the cerebrum in the presence of a stronger stimulus.

Taste.—The structure of the terminal organ of taste has already been fully described (see TASTE, 9th ed., vol. xxiii. p. 79). Evidence is accumulating that taste depends on nervous impulses excited by chemical change. Substances that have taste must be soluble, and they are brought into contact with delicate hair-like processes in the taste goblets (taste-buds), or with filaments ending on the free mucous surface between epithelial cells. Chemical changes are in all probability set up in these taste cells, or in the processes connected with them. Some progress has been made in the attempt to establish a connexion between the chemical composition of sapid substances and the different kinds of taste to which they may give rise. Thus acids are usually sour; alkaloids have a peculiar soapy taste; salts may be sweet, like sugar of lead, or bitter, like sulphate of magnesia; soluble alkaloids, such as quinine or strychnine, are usually bitter; and the higher alcohols are more or less sweet. Substances which taste sweet or bitter often contain definite groups in the molecule, especially the hydroxyl (HO) and amido (NH_2) groups. By altering the chemical composition of a substance having a characteristic taste (changing the position or relations of the radicles), the substance may become tasteless or intensely bitter. The sensation of taste may also be excited mechanically, as by smartly tapping the tongue, or by the stimulus of a continuous current (see art. TASTE, p. 80). In the latter case electrolytic change may be the exciting cause; but that the sense organs may be stimulated electrically is proved by the fact that very rapidly-interrupted induced currents, which produce little or no electrolysis, may also excite taste. Sensations of taste are heightened by increasing the area of the tongue affected, and by mechanical stimulation, as when the tongue is pressed against the lips, cheeks, or palate. A temperature of about 40° C. is most favourable, either extreme heat or cold apparently benumbing the sense for a time. Gustatory sensations affect each other: that is to say, a strong taste will affect the taste of another body taken immediately after it. Thus sweetness will modify bitterness, and sourness will modify both. Moreover, the application of a sapid substance to the tongue will affect taste in other parts. If the same taste is excited on each side of the tongue, although there are two sets of gustatory nerves, one for each lateral half, the sensations are blended into one; while if two different substances, say one sweet and the other bitter, are simultaneously applied, one to each side, there is not a blending of the sensation, but the observer can distinctly differentiate the one from the other.

As a general rule, bitter tastes are most acute at the back of the tongue, near the circumvallate papillæ, and sweet tastes at the lip, but there are considerable individual variations. Some persons taste both bitter and sweet substances best at the back, while others taste bitter things at the lip. Many experience salt tastes best at the tip, and acid tastes at the sides of the tongue. When we consider that there are three kinds of papillæ on the surface of the tongue, filiform, fungiform, and circumvallate (see ANATOMY), one would almost expect to meet with different degrees of sensitiveness to different tastes, even while we admit that the papillæ may also have to do with sensations of touch and of temperature. By experimenting with fine capillary tubes containing sapid substances, observations have been made with individual papillæ. Some are found to be sensitive to many tastes, others to two or three, others to only one, while others are insensitive to taste altogether. Again, it has been found that a mixture of sapid substances, say of quinine and sugar, may taste sweet when applied to one papilla and bitter when applied to another. The inference must be that there are special terminal organs for different tastes. This is supported by some interesting experiments made by Shore (*Journal of Physiology*, 1891). Assuming that there are different kinds of taste cells, it might be possible to paralyse some without affecting others, and thus different sensations of taste might be discriminated. This has been done by the use of the leaves of a common Indian plant, *Gymnema sylvestre.* If some of these be chewed, it has been found that bitters and sweets are paralysed (neither quinine nor sugar giving rise to sensation), while acids and salines are unaffected. Again, certain strengths of decoctions of the leaves appear to paralyse sweets sooner than bitters. These observations show the existence of different taste cells for sweets, bitters, acids, and salines; and it is clear that the region of the tongue most richly supplied with taste cells sensitive to sweets will respond best to sweet substances, while another region, supplied by taste cells sensitive to bitters, will respond best to bitter substances. In like manner the argument may be applied to other tastes. Suppose, again, a set of taste cells sensitive to bitter substances: it is conceivable that in whatever way these were irritated, a bitter taste would result. If so, a substance which, applied to one part of the tongue, would cause a sweet sensation, might cause a bitter if applied to a part of the tongue richly supplied with taste cells sensitive to bitters. This may explain why sulphate of magnesia excites at the root of the tongue a bitter taste, while applied to the lip it causes a sweet or an acid taste. Saccharine, a peculiar bromine derivative, in like manner is sweet to the lip and bitter to the back of the tongue. It has also been found that if the sweet and bitter taste cells are paralysed by *Gymnema*, electrical irritation of the lip by a weak interrupted current does not give rise to an acid taste mixed with sweet, as it usually does, but to sensations somewhat different, and which may be described as metallic or salt or acid. This experiment indicates that the action of the interrupted current on the terminal organ is analogous to the action of sweet or bitter substances. No direct observations of importance have yet been made on single circumvallate papillæ. Further experiments with capillary tubes show that fungiform papillæ destitute of taste buds, and areas of the surface of the tongue having neither papillæ nor taste buds, may still, when stimulated by sapid substances, give rise to tastes.

Nerves of the tongue.

The distribution of nerves to the tongue is very complicated. The motor nerve, that is, the nerve that excites and governs the movement of the tongue, is the ninth cranial, known as the hypoglossal. The sensory nerves are usually described as two in number, the anterior two-thirds of the tongue being supplied by the gustatory or lingual branches of the fifth cranial nerve, and the posterior third (the situation of the circumvallate papillæ) by the glosso-pharyngeal nerves. The lingual branch of the fifth nerve contains both ordinary sensory and gustatory filaments, and the glosso-pharyngeal supplies the circumvallate papillæ and taste buds. Another nerve, however, has to be considered, namely, the chorda tympani, a branch given off by the facial nerve during the passage of the latter through a canal in the petrous portion of the temporal bone known as the aqueduct of Fallopius. Loss of taste on one side of the tongue has been observed in cases of disease of the ear involving the chorda nerve. This, however, is not conclusive evidence that the chorda contains gustatory filaments, as the loss of taste following its injury may be due to the removal of its influence over the nutrition of the mucous membrane of the organ. If the mucous membrane deteriorated from faulty nutrition, then loss of taste might be due to that cause. On the other hand, there are good grounds for the view that the gustatory filaments, both of the lingual branch of the fifth and of the glosso-pharyngeal itself, come primarily from the roots of the fifth nerve. It is true that there is no direct evidence that irritation of the proximal end of the fifth nerve, after it had been divided, gives rise to sensations of taste. Clinical evidence, however, shows that disease of this nerve within the cranial cavity causes loss of taste in one lateral half of the tongue, both lip and back, but no case has been recorded of disease of the glosso-pharyngeal being followed by this result (M'Kendrick and Snodgrass, *Physiology of the Senses*, p. 78).

Mechanism of accommodation.

Vision.—The mechanism of vision has been described in the article Eye, 9th ed., vol. viii. p. 816. The mechanism by which the anterior surface of the lens becomes more convex when we look at objects within a range of say 70 yards to 10 inches, is usually described as consisting of a contraction of the fibres of the ciliary muscle by which the ciliary processes of the choroid are pulled forwards, thus releasing the tension of the anterior layer of the capsule of the lens (the layer in front of the lens), and allowing the lens to bulge forwards by its elasticity. Thus rays of light from an object within the range above indicated, becoming more and more divergent as the object approaches the eye, are brought to a focus on the retina, and distinct vision is secured. By this mechanism the radius of curvature of the anterior surface of the lens, as the eye accommodates from the far to the near point, may shorten from 10 mm. to 6 mm., as determined by Helmholtz. The ciliary muscle, however, contains two sets of fibres, the longitudinal or meridional, which run from before backwards, and the circular or equatorial (Müller's muscle), which run, as their name indicates, around the band of longitudinal fibres forming the muscle. Direct observation on the eye of an animal immediately after death shows that stimulation of the ciliary nerves actually causes a forward movement of the ciliary processes, and there can be little doubt that the explanation above given applies to man, probably most mammals, and to birds and most reptiles. In birds, which are remarkable for acuteness of vision, the mechanism is somewhat peculiar. In them the fibres of the ciliary muscle have a strong attachment posteriorly, and when these contract they pull back the inner posterior layers of the cornea, and thus relax that part of the ciliary zone called the ligamentum pectinatum. In a state of rest this structure in the bird's eye is tense, but in accommodation it becomes relaxed. Thus by a somewhat different mechanism in the bird, accommodation consists in allowing the anterior surface of the lens to become more and more convex. In reptiles generally the mechanism resembles that of the bird; but it is said that in snakes and amphibia there is a movement forwards of the lens as a whole, so as to catch rays at a less divergent angle. When the eye is directed to a distant object, such as a star, the mechanism of accommodation is at rest in mammals, birds, reptiles, and amphibia, but in fishes and cephalopods the eye at rest is normally adjusted for near vision. Consequently accommodation in the latter is brought about by a mechanism that carries the lens as a whole backwards. There is still some difficulty in explaining the action of the equatorial (circular) fibres. Some have found that the increased convexity of the anterior surface of the lens takes place only in the central portions of the lens, and that the circumferential part of the lens is actually flattened, presumably by the contraction of the equatorial fibres. Seeing, however, that the central part of the lens is the portion used in vision, as the pupil contracts during accommodation, a flattening of the margins of the lens can have no optical effect. Further, another explanation can be offered of the flattening. As just stated, during accommodation the pupil contracts, and the pupillary edge of the iris, thinned out, spreads over the anterior surface of the capsule of the lens, which it actually touches, and this part of the iris, along with the more convex central part of the lens, bulges into the anterior chamber, and must thus displace some of the aqueous humour. To make room for this, however, the circumferential part of the iris, related to the ligamentum pectinatum, moves backwards very slightly, while the flattening of the circumferential part of the lens facilitates this movement. Nor must we suppose that the longitudinal and equatorial fibres of the iris always act independently. It is more probable that the muscle acts as a whole. Thus, for man and the higher animals, the explanation of the mechanism of accommodation as propounded by Helmholtz is correct.

Sensations of colour.

Under Eye, 9th ed., vol. viii. p. 824, a short account is given of one theory by which an attempt is made to explain the perception of colour. This theory, originally proposed by Thomas Young and advocated by Helmholtz and Clerk Maxwell, is not, however, the only theory of colour vision. Another, enunciated by Hering, has received large support, more especially from physiologists. We shall here give a brief statement upon this important question. Colour, on the most likely hypothesis as to the physical nature of light, depends on the rate of vibration of the luminiferous ether, and white light is a compound of all the colours in definite proportion. When a surface reflects solar light into the eye without affecting this proportion, it is white, but if it absorbs all the light so as to reflect nothing, it appears to be black. If a body held between the eye and the sun transmits light unchanged, and is transparent, it is colourless, but if translucent it is white. If the medium transmits or reflects some rays and absorbs others, it is coloured. Thus, if a body absorbs all the rays of the spectrum but those which cause the sensation of green, we say the body is green in colour; but this green can only be perceived if the rays of light falling on the body contain rays having the special rate of vibration required for this special colour. For if the surface be illuminated by any other pure ray of the spectrum, say red, these red rays will be absorbed and the body will appear to be black. As a white surface reflects all the rays, in red light it will be seen to be red, and in a green light, green. Colour depends on the nature of the body and on the nature of the light falling on it, and a *sensation of colour* arises when the body reflects or transmits the special rays to the eye. If two rays of different rates of vibration, that is to say, of different colours, affect a surface of the retina at the same moment, the effects are fused together and we have the sensation of a third colour different from its cause. Thus, if red be removed from the solar spectrum, all the other colours combined cause a sensation of greenish yellow. Under the article EYE, vol. viii. p. 823, a table is given showing the result of mixing the pure colours of the spectrum. Thus red and violet give purple, and yellow and blue, white. Yellow and blue, however, only give white when pure spectral colours are mixed. It is well known that a mixture of yellow and blue *pigments* do not produce white, but green; but, as was explained by Helmholtz, this is because the blue pigment absorbs all the rays at the red end of the spectrum up to the green, while the yellow pigment absorbs all the rays at the violet end down to the green, and as the only rays reflected into the eye are the green rays, the substance appears green. Finally, if colours are painted on a disc in due proportions and in a proper order, the disc will, when quickly rotated, appear white, from the rapid fusion of colour effects.

When two colours produce a sensation of white, they are said to be complementary to each other. Thus red with blue-green will give white, but the whiteness so produced is not so intense as the white caused by the simultaneous action of all the spectral colours. The following list shows characteristic complementary colours, with their wave-lengths (λ) in millionths of a millimetre:—

Red, λ 656.	Blue-green, λ 492.
Orange, λ 608.	Blue, λ 490.
Gold-yellow, λ 574.	Blue, λ 482.
Yellow, λ 567.	Indigo-blue, λ 464.
Greenish yellow, λ 564.	Violet, λ 433.

By combining colours at opposite ends of the spectrum, the effect of the intermediate colours may be produced; but the lowest and the highest, red and violet, cannot thus be formed. These are therefore fundamental or primary colours, colours that cannot be produced by the fusion of other colours. If now to red and violet we add green, which has a rate of vibration about midway between red and violet, we obtain a sensation of white. Red, green, and violet are therefore the three fundamental colours.

Colour physiologically is a sensation, and it therefore does not depend only on the physical stimulus of light, but also on the part of the retina affected. The power of distinguishing colours is greatest when they fall on, or immediately around, the yellow spot, where the number of cones is greatest. In these regions more than two hundred different tints of colour may be distinguished. Outside of this area lies a middle zone, where fewer tints are perceived, mostly confined to shades of yellow and blue. If intense coloured stimuli are employed, colours may be perceived even to the margin of the periphery of the retina, but with weak stimuli coloured objects may seem to be black, or dark like shadows. In passing a colour from the periphery to the centre of the yellow spot, remarkable changes in hue may be observed. Orange is first grey, then yellow, and it only appears as orange when it enters the zone sensitive to red. Purple and bluish green are blue at the periphery, and only show the true tint in the central region. Four tints have been found which do not thus change: a red obtained by adding to the red of the spectrum a little blue (a purple), a yellow of 574·5 λ, a green of 495 λ, and a blue of 471 λ.

Every colour has three qualities: (1) *hue*, or tint, such as red, green, violet; (2) *degree of saturation*, or purity, according to the amount of white mixed with the tint, as when we recognize a red or green as pale or deep; and (3) *intensity*, or luminosity, or brightness, as when we designate the tint of a red rose as dark or bright. Two colours are identical when they agree as to these three qualities. Observation shows, however, that out of one hundred men ninety-six agree in identifying or in discriminating colours, while the remaining four show defective appreciation. These latter are called *colour-blind*. This defect is about ten times less frequent in women. Colour-blindness is congenital and incurable, and it is due to an unknown condition of the retina or nerve centres, or both, and must be distinguished from transient colour-blindness, sometimes caused by the excessive use of tobacco and by disease. When caused by tobacco, the sensation of blue is the last to disappear. Absolute inability to distinguish colour is rare, if it really exists; in some rare cases there is only one colour sensation; and in a few cases the colour-blind fails to distinguish blue from green, or there is insensibility to violet. Daltonism, or red-green blindness, of which there are two varieties, the red-blind and the green-blind, is the more common defect. Red appears to a red-blind person as a dark green or greenish yellow, yellow and orange as dirty green, and green is green and brighter than the green of the yellow and orange. To a green-blind person red appears as dark yellow, yellow is yellow, except a little lighter in shade than the red he calls dark yellow, and green is pale yellow.

"Seeing that green lights imply safety, and red lights danger, on our railways, and that in navigation a green or red light on the port or starboard side shows the course a vessel is taking, it is evident that no one who is red- or green-blind should be employed in the services, and accordingly various tests are now in use for the detection of such defects. The most efficient is the wool-test of Holmgren, which consists of three skeins of wool dyed with *standard test colours*, namely, a light green, a pale purple or pink, and a bright red. Other skeins of reds, oranges, yellows, yellowish greens, pure greens, blue greens, violets, purples, pinks, browns, and greys, all called *confusion colours*, are provided, and the examinee is requested to select one and match it with one of the test colours. Suppose the light green skein is shown first. If the examinee matches greys, brownish greys, yellows, orange, or faint pink with this, he is colour-blind. Then he is shown the purple skein. If he matches with this blue or violet he is red-blind, but if he selects only grey or green, he is green-blind. Finally, he may be shown the red skein, having a bright red colour, like the red flag used on railways. A red-blind person will then match with this, green or shades of brown, which to a normal eye seem darker than red; while, if he be green-blind, he will select shades of these colours which look lighter than red. Violet blindness is recognized by the examinee confusing red and orange with purple" (*Physiology of the Senses*, by M'Kendrick and Snodgrass, 1893, p. 160).

The question now arises, How can we perceive differences in colour? We might suppose a molecular vibration to be set up in the nerve-endings synchronous with the undulations of the luminiferous ether, without any change in the chemical constitution of the sensory surface, and we might suppose that where various series of waves in the ether corresponding to different colours act together, these may be fused together, or to interfere so as to give rise to a vibration of modified form or rate that corresponded in some way to the sensation. Or, to adopt another line of thought, we might suppose that the effect of different rays (rays differing in frequency of vibration and in physiological effect) is to promote or retard chemical changes in the sensory surface, "which again so affect the sensory nerves as to give rise to differing states in the nerves and the nerve centres, with differing concomitant sensations." The former of these thoughts is the foundation of the Young-Helmholtz theory (see EYE, vol. viii. p. 824), while the latter is applicable to the theory of Hering.

According to the Young-Helmholtz theory, there are three fundamental colour sensations, red, green, and violet, by the combination of which all other colours may be formed, and it is assumed that there exist in the retina three kinds of nerve elements, each of which is specially responsive to the stimulus of waves of a certain frequency corresponding to one colour, and much less so to waves of other frequencies and other colours. If waves corresponding to pure red alone act on the retina, only the corresponding nerve element for red would be excited, and so with green and violet. But if waves of different frequencies are mixed (corresponding to a mixture of colours), then the nerve elements will be set in action in proportion to the amount and intensity of the constituent excitant rays in the colour. Thus if all the nerve elements were simultaneously set in action, the sensation is that of white light; if that corresponding to red and green, the resultant sensation will be orange or yellow; if mainly the green and violet, the sensation will be blue and indigo. Then red-blindness may be explained by supposing that the elements corresponding to the sensation of red are absent; and green-blindness, to the absence of the elements sensitive to green. If to a red-blind person the green and violet are equal, and when to a green-blind person the red and violet are equal, they may have sensations which to them constitute white, while to the normal eye the sensation is not white, but bluish green in the one case and green in the other. In each case, to the normal eye, the sensation of green has been added to the sensations of red and blue. It will be evident, also, that whiteness to the colour-blind eye cannot be the same as whiteness to the normal eye. No doubt this theory explains certain phenomena of colour-blindness, of after-coloured images, and of contrast of colour, but it is open to various objections. It has no anatomical basis, as it has been found to be impossible to demonstrate the existence of three kinds of nerve elements, or retinal elements, corresponding to the three fundamental colour sensations. Why should red to a colour-blind person give rise to a sensation of something like green, or why should it give rise to a sensation at all? Again, and as already stated, in cases of colour-blindness due to tobacco or to disease, only blue may be seen, while it is said that the rest of the spectrum seems to be white. It is difficult to understand how *white* can be the sensation if the sensations of red and green are lost. On the other hand, it may be argued that such colour-blind eyes do not really see white as seen by a normal person, and that they only have a sensation which they have been accustomed to call white. According to this theory, we never actually experience the primary sensations. Thus we never see primary red, as the sensation is more or less mixed with primary green, and even with primary blue (violet). So with regard to primary green and primary violet. Helmholtz, in his last work on the subject, adopted as "the three primary colours a red bluer than spectral red, (*a*) a green lying between 540 λ and 560 λ (*b*, like the green of vegetation), and a blue at about 470 λ (*c*, like ultramarine), all, however, much more highly saturated than any colours existing in the spectrum" (Foster's *Physiology*, part iv. p. 1345).

In *Handbuch der Physiologischen Optik* (Hamburg and Leipzig, 1896) Helmholtz pointed out that luminosity or brightness plays a more important part in colour perception than has been supposed. Each spectral colour is composed of certain proportions of these fundamental colours, or, to put it in another way, a combination of two of them (*a* and *b*) added to a certain amount of white (*c*). Thus 100 parts of green are composed of 15 of *a*, 51 of *b*, and 34 of *c*; or, to take other examples, spectral red will contain, per cent., 42 of *a*, 7 of *b*, and 51 of white; yellow, 11 of *a*, 14 of *b*, and 75 of white; and blue, 2 of *a*, 11 of *c*, and 87 of white. The white gives brightness. "According to this view, it is not necessary to suppose that in the red-blind the red-perceiving elements are awanting, or that in the green-blind the green-perceiving elements are absent, but that these elements may be stimulated with intensities different from those affecting the normal eye. Suppose that in the eye of a colour-blind person the curves of intensity representing the red and green coincided, or, in other words, that the elements responsive to red and green in the abnormal eye were stimulated intensities equal to that of red in a normal eye, the sensation would be yellow, as we find to be the case in so-called green-blindness. Again, if in a similar way the red curve coincided as regards intensity with the green, the general effect would be that of a red-blind person, the red end of the spectrum would appear to be green and no red would be visible" (M'Kendrick and Snodgrass, *op. cit.* p. 169).

Hering's theory proceeds on the assumption of chemical changes in the retina under the influence of light. It also assumes that certain fundamental sensations are excited by light or occur during the absence of light. These fundamental sensations are white, black, red, yellow, green, and blue. They are arranged in pairs, the one colour in each pair being, in a sense, complementary to the other, as white to black, red to green, and yellow to blue. Hering also supposes that when rays of a certain wave-length fall on visual substances assumed to exist in the retina, destructive or, as it is termed, catabolic changes occur, while rays having other wave-lengths cause constructive or anabolic changes. Suppose that in a red-green substance catabolic and anabolic changes occur in equal amount, there may be no sensation, but when waves of a certain wave-length or frequency cause catabolic changes in excess, there will be a sensation of red, while shorter waves and of greater frequency, by exciting anabolic changes, will cause a sensation of green. In like manner, catabolism of a yellow-blue visual substance gives rise to a sensation we call yellow, while anabolism, by shorter waves acting on the same substance, causes the sensation of blue. Again, catabolism of a white-black visual substance gives white, while anabolism, in the dark, gives rise to the sensation of blackness. Thus blackness is a sensation as well as whiteness, and the members of each pair are antagonistic as well as complementary. In the red end of the spectrum the rays cause catabolism of the red-green substance, while they have no effect on the yellow-blue substance. Here the sensation is red. The shorter waves of the spectral yellow cause catabolism of the yellow-blue material, while catabolism and anabolism of the red-green substance are here equal. Here the sensation is yellow. Still shorter waves, corresponding to green, now cause anabolism of the red-green substance, while their influence on the yellow-blue substance, being equal in amount as regards catabolism and anabolism, is neutral. Here the sensation is green. Short waves of the blue of the spectrum cause anabolism of the yellow-blue material, and as their action on the red-green matter is neutral, the sensation is blue. The very short waves at the blue end of the spectrum excite catabolism of the red-green substance, and thus give violet by adding red to blue. The sensation orange is experienced when there is excess of catabolism, and greenish blue when there is excess of anabolism in both substances. Again, when all the rays of the spectrum fall on the retina, catabolism and anabolism in the red-green and yellow-blue matters are equal and neutralize each other, but catabolism is great in the white-black substance, and we call the sensation white. Lastly, when no light falls on the retina, anabolic changes are going on and there is the sensation of black.

Hering's theory accounts satisfactorily for the formation of coloured after-images. Thus, if we suppose the retina to be stimulated by red light, catabolism takes place, and if the effect continues after withdrawal of the red stimulus, we have a positive after-image. Then anabolic changes occur under the influence of nutrition, and the effect is assisted by the anabolic effect of shorter wave-lengths, with the result that the negative after-image, green, is perceived. Perhaps the distinctive feature of Hering's theory is that white is an independent sensation, and not the secondary result of a mixture of primary sensations, as held by the Young-Helmholtz view. The greatest difficulty in the way of the acceptance of Hering's theory is with reference to the sensation of black. Black is held to be due to anabolic changes occurring in the white-black substance. Suppose that anabolism and catabolism of the white-black substance are in equilibrium, unaccompanied by stimulation of either the red-green or yellow-blue substance, we find that we have a sensation of darkness, but not one of intense blackness. This "darkness" has still a certain amount of luminosity, and it has been termed the "intrinsic light" of the retina. Sensations of black differing from this darkness may be readily experienced, as when we expose the retina to bright sunshine for a few moments and then close the eye. We then have a sensation of intense blackness, which soon, however, is succeded by the darkness of the "intrinsic light." The various degrees of blackness, if it is truly a sensation, are small compared with the degrees in the intensity of whiteness. Another difficulty is thus stated by Ladd: "A light composed of red and green may be made to seem to the eye the same as a light composed of yellow and blue. If, then, the eye is fatigued to red, instead of the red-green mixture appearing greenish, and so distinguishable from the yellow-blue mixture, they both appear the same to the fatigued eye" (Ladd, *Outlines of Physiological Psychology*, p. 268). The application of both theories to the phenomena of colour-blindness is fully discussed in Foster's *Physiology*, part iv., 1900, p. 1352.

The movements of the eyes.

The movements of the eye are described in the article Eye, 9th ed. vol. viii. p. 825, but one or two points require further elucidation. It has been shown that the eye may rotate round three possible axes, a vertical, horizontal, and antero-posterior. These movements are effected by four straight muscles and two oblique. The four straight muscles arise from the back of the orbit, and pass forward to be inserted into the front part of the eyeball, or its equator, if we regard the anterior and posterior ends of the globe as the poles. The two obliques (one originating at the back of the orbit) come, as it were, from the nasal side—the one goes above the eyeball, the other below, while both are inserted into the eyeball on the temporal side, the superior oblique above, and the inferior oblique below. The six muscles work in pairs. The internal and external recti turn the eye round the vertical axis, so that the line of vision is directed to the right or left. The superior and inferior recti rotate the eye round the horizontal axis, and thus the line of vision is raised or lowered. The oblique muscles turn the eye round an axis passing through the centre of the eye to the back of the head, so that the superior oblique muscle lowers, while the inferior oblique raises, the visual line. It was also shown by Helmholtz that the oblique muscles sometimes cause a slight rotation of the eyeball round the visual axis itself. These movements are under the control of the will up to a certain point, but there are slighter movements that are altogether involuntary. Helmholtz studied these slighter movements by a method first suggested by Donders. By this method the apparent position of after-images produced by exhausting the retina, say with a red or green object, was compared with that of a line or fixed point gazed at with a new position of the eyeball. The ocular spectra soon vanish, but a quick observer can determine the coincidence of lines with the spectra. After producing an after-image with the head in the erect position, the head may be placed into any inclined position, and if the attention is then fixed on a diagram having vertical lines ruled upon it, it can easily be seen whether the after-image coincides with these lines. As the after-image must remain in the same position on the retina, it will be evident that if it coincides with the vertical lines there must have been a slight rotation of the eyeball. Such a coincidence always takes place, and thus it is proved that there is an involuntary rotation. This minute rotation enables us to judge more accurately of the position of external objects.

The *horopter* is the locus of those points of space which are projected on retinal points. While geometrically it may be conceived as simple, as a matter of fact it is generally a line of double curvature produced by the intersection of two hyperboloids, or, in other words, it is a twisted cubic curve formed by the intersection of two hyperboloids which have a common generator. The curves pass through the nodal point of both eyes. An infinite number of lines may be drawn from any point of the horopter, so that the point may be seen as a single point, and these lines lie on a cone of the second order, whose vertex is the point. When we gaze at the horizon, the horopter is really a horizontal plane passing through our feet. The horopter in this instance is the ground on which we stand. Experiments show "that the forms and the distances of these objects which are situated in, or very nearly in, the horopter, are perceived with a greater degree of accuracy than the same forms and distances would be when not situated in the horopter" (M'Kendrick, *Life of Helmholtz*, 1899, p. 172 *et seq.*).

Hearing.—The mechanism of hearing has been described in the article Ear, vol. vii. p. 591. (Details will be found in the article "Ear" by M'Kendrick in Schäfer's *Text-Book of Physiology*, vol. ii.)

The mechanism of transmission.

The special form of the drum-head attains a maximum of efficiency for tones of the feeblest intensity. When the effect of a sound-wave is transmitted from the drum-head to the internal ear, there is a change in the amount of force expended, and also a change in the amplitude of the movement. The mechanism of the chain of bones, malleus, incus, and stapes, serves the purpose of conveying periodical variations of pressure, occurring in the air, into a minute space or cavity full of fluid, in which we find the terminal structures connected with hearing, and this result is attained with a minimum loss of energy by the chain of bones. The chain is a lever in which the handle of the malleus forms the long arm, the fulcrum is where the short process of the incus abuts against the wall of the tympanum, while the long process of the incus, carrying the stapes, forms the short arm. The mechanism is a lever of the second order. Measurements show that the ratio of the lengths of the two arms is as 1·5 : 1; the ratio of the resulting force at the stapes is therefore as 1 : 1·5; while the amplitudes of the movements at the tip of the handle of the malleus and the stapes is as 1·5 : 1. Hence, while there is a diminution in amplitude there is a gain in power, and thus the pressures are conveyed with great efficiency from the membrana tympani to the labyrinth, while the amplitude of the oscillation is diminished so as to be adapted to the small capacity of the labyrinth. As the drum-head is nearly twenty times greater in area than the membrane covering the oval window, with which the base of the stapes is connected, the energy of the movements of the membrana tympani is concentrated on an area twenty times smaller; hence the pressure is increased thirty-fold ($1·5 \times 20$) when it acts at the base of the stapes. Experiments on the human ear have shown that the movement of greatest amplitude was at the tip of the handle of the malleus, 0·76 mm.; the movement of the tip of the long arm process of the incus was 0·21 mm.; while the greatest amplitude at the base of the stapes was only ·0714 mm. Other observations have shown the movements at the stapes to have a still smaller amplitude, varying from 0·001 to 0·032 mm. With tones of feeble intensity the movements must be almost infinitesimal.

The utricle and saccule.

The sacs of the internal ear, known as the utricle and saccule, receive the impulses of the base of the stapes. Considerable doubt still exists as to their functions. The simplest form of internal ear is a sac containing fluid in which an otolithic mass (ear-stones) is usually immersed, and having on the wall hair-like processes related to the terminations of a nerve. Such internal ears exist in some of the lower invertebrates. In the lower vertebrates (fish) there is a single sac, into which the semicircular canals open; still higher (amphibia), we find the beginning of the cochlear duct; and lastly (birds and mammals), a division of the sac into two, with a much greater development of the cochlear portion. These facts seem to point to the sacs being organs connected with the perception of sounds as sound, without reference to pitch or quality. For the *analysis* of tone a cochlea seems to be necessary. Even in mammals all the parts of the ear may be destroyed or affected by disease, except these sacs, without causing complete deafness. The evidence, however, is by no means satisfactory.

It has been suggested by Lee (*Amer. Jour. of Physiol.* vol. i. No. 1, p. 128) that in fishes the sac has nothing to do with hearing, but serves for the perception of movements, such as those of rotation and translation through space, movements much coarser than those that form the physical basis of sound. He considers, also, that as fishes, with few exceptions, are dumb, they are also deaf. In the fish there are peculiar organs along the lateral line which are known to be connected with the perception of movements of the body as a whole, and Beard (*Zool. Anz. Leipzig*, 1884, Bd. vii. S. 140) has attempted to trace a phylogenetic connexion between the sacs of the internal ear and the organs in the lateral line. According to this view, when animals became air-breathers, a part of the ear (the *papilla acustica basilaris*) was gradually evolved for the perception of delicate vibrations of sound. It may be assumed, however, that even in the higher vertebrates the nerve-endings in the saccule and utricle may still have to do with the perception of the grosser mass movements.

It is by means of the part of the internal ear known as the cochlea that we discriminate pitch, hear beats, and are affected by quality of tone.

The cochlea.

(*a*) *Pitch and Beats.*—The range of pitch appreciated by the human ear is from 30 to 40,000 vibrations per second. When two tones are in unison, they are heard as one sound; but if one is made a little flatter than the other, then a peculiar sensation is experienced, to which we give the name of a beat. The number of beats per second increases in proportion to the difference in frequencies of the two tones, so that beats may be heard so slow as to be only a waxing and waning of the auditory sensation, or they may be so rapid as to be individually indistinguishable, while they still give a feeling of harshness or roughness to the sound. If the number of beats per second is equal to the difference of the frequencies of the tones, and if, as is the case, an interval depends on the ratio of frequencies, it is evident that the number of beats given by two tones nearly in unison will be doubled if the two tones are sounded an octave higher. It is possible by means of beats to measure the sensitiveness of the ear by determining the smallest difference in pitch that may give rise to a beat. In no part of the scale can a difference smaller than 0·2 vibration per second be distinguished. The sensitiveness varies with pitch. Thus at 120 vibs. per second 0·4 vib. per second, at 500 about 0·3 vib. per second, and at 1000, 0·5 vib. per second can be distinguished. This is a remarkable illustration of the great sensitiveness of the ear. When tones of low pitch are produced that do not rapidly die away, as by sounding heavy tuning-forks, not only may the beats be perceived corresponding to the difference between the frequencies of the forks, but also other sets of beats. Thus, if the two tones have frequencies of 40 and 74, a two-order beat may be heard, one having a frequency of 34 and the other of 6, as $74 \div 40 = 1 +$ a positive remainder of 34, and $74 \div 40 = 2 - 6$, or $80 - 74$, a negative remainder of 6. The lower beat is heard most distinctly when the number is *less* than half the frequency of the lower primary, and the upper when the number is greater. The beats we have been considering are produced when two notes are sounded slightly differing in frequency, or at all events their frequencies are not so great as those of two notes separated by a musical interval, such as an octave or a fifth. But Lord Kelvin has shown that beats may also be produced on slightly inharmonious musical intervals (*Proc. Roy. Soc. Ed.* 1878, vol. ix. p. 602). Thus, take two tuning-forks, $ut_2=256$ and $ut_3=512$; slightly flatten ut_3 so as to make its frequency 510, and we hear, not a roughness corresponding to 254 beats, but a slow beat of 2 per second. The sensation also passes through a cycle, the beats now sounding loudly and fading away in intensity, again sounding loudly, and so on. One might suppose that the beat occurred between 510 (the frequency of ut_3 flattened) and 512, the first partial of ut_2, namely ut_3, but this is not so, as the beat is most audible when ut_2 is sounded feebly. In a similar way, beats may be produced on the approximate harmonies 2 : 3, 3 : 4, 4 : 5, 5 : 6, 6 : 7, 7 : 8, 1 : 3, 3 : 5, and beats may even be produced on the major chord 4 : 5 : 6 by sounding ut_3, mi_3, sol_3, with sol_3 or mi_3 slightly flattened, "when a peculiar beat will be heard as if a wheel were being turned against a surface, one small part of which was rougher than the rest" (article by author on the "Ear," in Schäfer's *Text-Book of Physiology*, vol. ii., 1900). These beats on imperfect harmonies appear to indicate that the ear does distinguish between an increase of pressure on the drum-head and a diminution, or between a push and a pull, or, in other words, that it is affected by phase.

(*b*) *Beat Tones.*—Considerable difference of opinion exists as to whether beats can blend so as to give a sensation of tone; but König, by using very pure tones of high pitch, appears to have settled the question. These tones were produced by large tuning-forks. Thus $ut_6=2048$ and $re_6=2304$. Then the beat tone is $ut_3=256$ $(2304-2048)$. If we strike the two forks, ut_3 sounds as a grave or lower beat tone. Again, $ut_6=2048$ and $si_6=3840$. Then $(2048)_2-3840=256$, a negative remainder, ut_3, as before, and when both forks are sounded ut_3 will be heard. Again, $ut_6=2048$ and $sol_6=3072$, and $3072-2048=1024$, or ut_6, which will be distinctly heard when ut_6 and sol_6 are sounded (König, *Quelques expériénces d'acoustique*, Paris, 1882, p. 87).

(*c*) *Analytical Power of the Ear.*—When we listen to a compound tone, we have the power of picking out these partials from the general mass of sound. It is known that the frequencies of the partials as compared with that of the fundamental tone are simple mutiples of the frequency of the fundamental, and also that physically the waves of the partials so blend with each other as to produce waves of very complicated forms. Yet the ear, or the ear and the brain together, can resolve this complicated wave-form into its constituents, and this is done more easily if we listen to the sound with resonators, the pitch of which corresponds, or nearly corresponds, to the frequencies of the partials (see article EAR, *Ency. Brit.* vol. vii. p. 593). Much discussion has taken place as to how the ear accomplishes this analysis. All are agreed that there is a complicated apparatus in the cochlea which presumably may serve this purpose; but while some are of opinion that this structure is probably quite sufficient, others hold that the analysis ultimately takes place in the brain. When a complicated wave falls on the drum-head, it must move out and in in a way corresponding to the variations of pressure, and these variations will, in a single vibration, depend on the greater or less degree of complexity of the wave. Thus a single tone will cause a movement like that of a pendulum, a simple pendular vibration, while a complex tone, although occurring in the same duration of time, will cause the drum-head to move out and in in a much more complicated manner. The complex movement will be conveyed to the base of the stapes, thence to the vestibule, and thence to the cochlea, in which we find the ductus cochlearis containing the organ of Corti, a highly complicated structure composed of epithelium and the nerve-endings of the cochlear nerve. It is to be noted also that the parts in the cochlea are so small as to constitute only a fraction of the wave-length of most tones audible to the human ear. Now it is evident that the cochlea must act either as a whole, all the nerve fibres being affected by any variations of pressure, or the nerve fibres may have a selective action, each fibre being excited by a wave of a definite period, or there may exist small vibratile bodies between the nerve filaments and the pressures sent into the organ. The last hypothesis gives the most rational explanation of the phenomena, and on it is founded a theory generally accepted and associated with the names of Thomas Young and Hermann Helmholtz. It may be shortly stated as follows:—

"(1) In the cochlea there are vibrators, tuned to frequencies within the limits of hearing, say from 30 to 40,000 or 50,000 vibs. per second. (2) Each vibrator is capable of exciting its appropriate nerve filament or filaments, so that a nervous impulse, corresponding to the frequency of the vibrator, is transmitted to the brain—not corresponding necessarily, as regards the number of nervous impulses, but in such a way that when the impulses along a particular nerve filament reach the brain, a state of consciousness is aroused which does correspond with the number of the physical stimuli and with the period of the auditory vibrator. (3) The mass of each vibrator is such that it will be easily set in motion, and after the stimulus has ceased it will readily come to rest. (4) Damping arrangements exist in the ear, so as quickly to extinguish movements of the vibrators. (5) If a simple tone falls on the ear, there is a pendular movement of the base of the stapes, which will affect all the parts, causing them to move; but any part whose natural period is nearly the same as that of the sound will respond on the principle of sympathetic resonance, a particular nerve filament or nerve filaments will be affected, and a sensation of a tone of definite pitch will be experienced, thus accounting for discrimination in pitch. (6) Intensity or loudness will depend on the amplitude of movement of the vibrating body, and consequently on the intensity of nerve stimulation. (7) If a compound wave of pressure be communicated by the base of the stapes, it will be resolved into its constituents by the vibrators corresponding to tones existing in it, each picking out its appropriate portion of the wave, and thus irritating corresponding nerve filaments, so that nervous impulses are transmitted to the brain, where they are fused in such a way as to give rise to a sensation of a particular quality or character, but still so imperfectly fused that each constituent, by a strong effort of attention, may be specially recognized" (article "Ear," by author, Schäfer's *Text-Book*, *loc. cit.*).

The structure of the ductus cochlearis meets the demands of this theory. It is highly differentiated, and it can be shown that in it there are a sufficient number of elements to account for the delicate appreciation of pitch possessed by the human ear, and on the basis that the highly trained ear of a violinist can detect a difference of $\frac{1}{64}$th of a semitone (M'Kendrick, *Trans. Roy. Soc. Ed.*, 1896, vol. xxxviii. p. 780; also Schäfer's *Text-Book*, *loc. cit.*). Measurements of the cochlea have also shown such differentiation as to make it difficult to imagine that it can act as a whole. A much less complex organ might have served this purpose (M'Kendrick, *op. cit.*). The following table, given by Retzius (*Das Gehörorgan der Wirbelthiere*, Bd. ii. S. 356), shows differentiations in the cochlea of man, the cat, and the rabbit, all of which no doubt hear tones, although in all probability they have very different powers of discrimination:—

	Man.	Cat.	Rabbit.
Ear-teeth	2490	2430	1550
Holes in habenula for nerves .	3985	2780	1650
Inner rods of Corti's organ .	5590	4700	2800
Outer rods of Corti's organ .	3848	3300	1900
Inner hair cells (one row) .	3487	2600	1600
Outer hair cells (several rows) .	11,750	9900	6100
Fibres in basilar membrane .	23,750	15,700	10,500

(*d*) *Dissonance.*—The theory can also be used to explain dissonance. When two tones sufficiently near in pitch are simultaneously sounded, beats are produced. If the beats are few in number they can be counted, because they give rise to separate and distinct sensations; but if they are very numerous they blend so as to give roughness or dissonance to the interval. The roughness or dissonance is most disagreeable with about 33 beats falling on the ear per second. When two compound tones are sounded, say a minor third on a harmonium in the lower part of the keyboard, then we have beats not only between the primaries, but also between the upper partials of each of the primaries. The beating distance may, for tones of medium pitch, be fixed at about a minor third, but this interval will expand for intervals on low tones and contract for intervals on high ones. This explains why the same interval in the lower part of the scale may give slow beats that are not disagreeable, while in the higher part it may cause harsh and unpleasant dissonance. The partials up to the seventh are beyond beating distance, but above this they come close together. Consequently instruments (such as tongues, or reeds) that abound in upper partials cause an intolerable dissonance if one of the primaries is slightly out of tune (Sedley Taylor, *Sound and Music*, London, 1873, p. 166 *et seq.*). Some intervals are pleasant and satisfying when produced on instruments having few partials in their tones. These are concords. Others are less so, and they may give rise to an uncomfortable sensation. These are discords. In this way unison, $\frac{1}{1}$, minor third $\frac{6}{5}$, major third $\frac{5}{4}$, fourth $\frac{4}{3}$, fifth $\frac{3}{2}$, minor sixth $\frac{8}{5}$, major sixth $\frac{5}{3}$, and octave $\frac{2}{1}$, are all concords; while a second $\frac{9}{8}$, minor seventh $\frac{16}{9}$, and major seventh $\frac{15}{8}$, are discords. There is no difficulty, on the theory above enunciated, in explaining these facts, because it must respond to the prime tones and partials of both the notes forming the interval; but it is not easy to see why the sensation should be disagreeable when two portions of the basilar membrane sufficiently near are thrown into vibration. Still, similar phenomena occurring in the other senses show that, for some unexplained reason, if two nerves sufficiently near in their central terminations are stimulated, or if they are stimulated intermittently, the sensation is disagreeable. Helmholtz compares the sensation of dissonance to that of a flickering light on the eye. "Something similar I have found to be produced by simultaneously stimulating the skin, or margin of the lips, by bristles attached to tuning-forks giving forth beats. If the frequency of the forks is great, the sensation is that of a most disagreeable tickling. It may be that the instinctive effort at analysis of tones close in pitch causes the disagreeable sensation" (Schäfer's *Text-Book*, *op. cit.* p. 1187).

(*e*) *Combination Tones.*—Frequently, when two tones are sounded, not only do we hear the compound sound, from which we can pick out the constituent tones, but we may hear other tones, one of which is lower in pitch than the lowest primary, and the other is higher in pitch than the higher primary. These, known as combination tones, are of two classes: differential tones in which the frequency is the difference of the frequencies of the generating tones, and summational tones having a frequency which is the sum of the frequencies of the tones producing them. Differential tones, first noticed by Sorge about 1740, are easily heard (Sorge, *Vorgemach musikalischer Composition*, 1740). Thus an interval of a fifth, 2 : 3, gives a differential tone 1, that is, an octave below 2; a fourth, 3 : 4, gives 1, a twelfth below 3; a major third, 4 : 5, gives 1, two octaves below 4; a minor third, 5 : 6, gives 1, two octaves and a major third below 5; a major sixth, 3 : 5, gives 2, that is, a fifth below 3; and a minor sixth, 5 : 8, gives 3, that is, a major sixth below 5. Summational tones, first noticed by Helmholtz, are so difficult to hear, that much controversy has taken place as to their very existence. Some have contended that they are produced by beats. It appears to be proved physically that they may exist in the air outside of the ear (Forsyth and Sowter, *Proc. Roy. Soc.* vol. lxiii. p. 396; and Rücker and Edser, *Phil. Mag.*, April 1895). Further, differential tones may be generated in the middle ear (Preyer, *Wiedemann's Annal.* xxxviii. S. 131). Helmholtz also demonstrated their independent existence, and he states that "whenever the vibrations of the air or of other elastic bodies, which are set in motion at the same time by two generating simple tones, are so powerful that they can no longer be considered infinitely small, mathematical theory shows that vibrations of the air must arise which have the same vibrational numbers as the combination tones" (Helmholtz, *Sensations of Tone*, p. 235). The importance of these combinational tones in the theory of hearing is obvious. If the ear can only analyse compound waves into simple pendular vibrations of a certain order (simple multiples of the prime tone), how can it detect combinational tones, which do not belong to that order? Again, if such tones are purely subjective and only exist in the mind of the listener, the fact would be fatal to the resonance theory. There can be no doubt, however, that the ear, in dealing with them, vibrates in some part of its mechanism with each generator, while it also is affected by the combinational tone itself, according to its frequency. (For a discussion of this question, see Sedley Taylor, *op. cit.* p. 181).

(*f*) *Other Theories.*—In 1865 Rennie objected to the analysis theory, and urged that the cochlea acted as a whole (*Ztschr. f. rat. Med. Dritte Reihe*, Bd. xxiv. Heft 1, S. 12–64). This view was revived by Voltolini (Virchow's *Archiv*, Bd. c. S. 27) some years later, and in 1886 it was strongly urged by Rutherford (*Rep. Brit. Assoc. Ad. Sc.*, 1886), who compared the action of the cochlea to that of a telephone plate. According to this theory, all the hairs of the auditory cells vibrate to every note, and the hair cells transform sound vibrations into nerve vibrations or impulses, similar in frequency, amplitude, and character to the sound vibrations. There is no analysis in the peripheral organ. Waller, in 1891 (*Proc. Physiol. Soc.*, Jan. 20, 1891) suggested that the basilar membrane as a whole vibrates to every note, thus repeating the vibrations of the membrana tympani; and since the hair cells move with the basilar membrane, they produce what may be called pressure patterns against the tectorial membranes, and filaments of the auditory nerve are stimulated by these pressures. Waller admits a certain degree of peripheral analysis, but he relegates ultimate analysis to the brain. These theories, dispensing with peripheral analysis, leave out of account the highly complex structure of the cochlea, or, in other words, they assign to that structure a comparatively simple function, which could be performed by a simple membrane capable of vibrating. We find that the cochlea becomes more elaborate as we ascend the scale of animals, until in man, who possesses greater powers of analysis than any other being, the number of hair cells, fibres of the basilar membrane, and arches of Corti, are all much increased in number (see Retzius's table, *supra*). The principle of sympathetic resonance appears, therefore, to offer the most likely solution of the problem. Theories dispensing with this principle have also been advanced. Hurst's view is that with each movement of the stapes a wave is generated which travels up the scala vestibuli, through the helicotrema into the scala tympani, and down the latter to the fenestra rotunda. The wave, however, is not merely a movement of the basilar membrane, but an actual movement of fluid or a transmission of pressure. As the one wave ascends while the other descends, a pressure of the basilar membrane occurs at the point where they meet; this causes the basilar membrane to move towards the tectorial membrane, forcing this membrane suddenly against the apices of the hair cells, thus irritating the nerves. The point at which the waves meet will depend on the time interval between the waves (Hurst, "A New Theory of Hearing," *Trans. Biol. Soc. Liverpool*, 1895, vol. ix. p. 321). More recently Max Mayer has advanced a theory somewhat similar. He supposes that with each movement of the stapes corresponding to a vibration, a wave travels up the scala vestibuli, pressing the basilar membrane downwards. As it meets with resistance in passing upwards, its amplitude therefore diminishes, and in this way the distance up the scala through which the wave progresses will be determined by its amplitude. The wave in its progress irritates a certain number of nerve terminations, consequently feeble tones will irritate only those nerve fibres that are near the fenestra ovalis, while stronger tones will pass farther up and irritate a larger number of nerve fibres the same number of times per unit of time. Pitch, according to this view, depends on the number of stimuli per second, while loudness depends on the number of nerve fibres irritated. Mayer also applies the theory to the explanation of the powers of the cochlea as an analyser, by supposing that with a compound tone these are at maxima and minima of stimulation. As the compound wave travels up the scala, portions of the wave corresponding to maxima and minima die away in consecutive series, until only a maximum and minimum are left; and, finally, as the wave travels farther, these also disappear. With each maximum and minimum different parts of the basilar membrane are affected, and affected a different number of times per second, according to the frequencies of the partials existing in the compound tone. Thus with a fifth, 2 : 3, there are three maxima and three minima; but the compound tone is resolved into three tones having vibration frequencies in the ratio of 3 : 2 : 1. According to Mayer, we actually hear when a fifth is sounded tones of the relationship of 3 : 2 : 1, the last (1) being the differential tone (*vide supra*). He holds, also, that combinational tones are entirely subjective (Max Mayer, *Ztschr. f. Psycho. und Phys. d. Sinnesorgane*, Leipzig, Bd. xvi. and xvii.; also *Verhandl. d. physiolog. Gesellsch zu.*, Berlin, Feb. 18, 1898, S. 49). Two fatal objections can be urged to these theories, namely, first, it is impossible to conceive of minute waves following each other in rapid succession in the minute tubes forming the scalæ—the length of the scala being only a very small part of the wave-length of the sound; and, secondly, neither theory takes into account the differentiation of structure found in the epithelium of the organ of Corti. Each push in and out of the base of the stapes must cause a movement of the fluid, or a pressure, in the scalæ as a whole.

There are difficulties in the way of applying the resonance theory to the perception of noises. Noises have pitch, and also each noise has a special character; if so, if the noise is analysed into its constituents, why is it that it seems impossible to analyse a noise, or to perceive any musical element in it? Helmholtz assumed that a sound is noisy when the wave is irregular in rhythm, and he suggested that the crista and macula acustica, structures that exist not in the cochlea but in the vestibule, have to do with the perception of noise. These structures, however, are concerned rather in the sense of the perception of equilibrium than of sound (see *Semicircular Canals*). Gray is also of opinion that evidence supports the view that the ear detects difference of phase, which was denied by Helmholtz. Comparing the perception of sound with that of touch, he advances a modification of the resonance theory which appears to meet some of the objections that may be urged against it as it was enunciated by Helmholtz.

Sensitiveness of the ear.

Various physicists have attempted to measure the sensitiveness of the ear by estimating the amplitude of the molecular movements necessary to call forth the feeblest audible sound. Thus Töpler and Boltzmann, on data founded on experiments with organ pipes, state that the ear is affected by vibrations of molecules of the air not more in amplitude than ·0004 mm. at the ear, or 0·1 of the wave-length of green light, and that the energy of such a vibration on the drum-head is not more than $\frac{1}{543}$ billionth kilog., or $\frac{1}{17}$th of that produced upon an equal surface of the retina by a single candle at the same distance (*Ann. d. Phys. u. Chem.*, Leipzig, 1870, Bd. cxli. S. 321). Lord Rayleigh, by two other methods, arrived at the conclusion "that the streams of energy required to influence the eye and ear are of the same order of magnitude." He estimated the amplitude of the movement of the aërial particles, with a sound just audible, as less than the ten-millionth of a centimetre, and the energy emitted when the sound was first becoming audible, at 42·1 ergs. per second. He also states that in considering the amplitude or condensation in progressive aërial waves, at a distance of 27·4 metres from a tuning-fork, the maximum condensation was $= 6{\cdot}0 \times 10^{-9}$ cm., a result showing "that the ear is able to recognize the addition or subtraction of densities far less than those to be found in our highest vacua" (*Proc. Roy. Soc.*, 1877, vol. xxvi. p. 248; *Lond. Edin. and Dub. Phil. Mag.*, 1894, vol. xxxviii. p. 366).

Binaural audition.

Hearing with two ears does not affect the quality of sounds, but it must to some extent affect the intensity with which sounds are perceived. We hear a sound louder with two ears than with one, and there can be no doubt that by having two ears we are enabled to judge of the direction of sound with more accuracy than if we used only one ear. Our judgment as to the direction of sounds is formed mainly from the different degrees of intensity with which they are heard by two ears. Lord Rayleigh states that diffraction of the sound-waves will occur as they pass round the head to the ear farthest from the source of sound; thus partial tones will reach the two ears with different intensities, and thus quality of tone may be affected (*Trans. Music. Soc.*, London, 1876). Silvanus P. Thompson advocates a similar view, and he shows that the direction of a complex tone can be more accurately determined than the direction of a simple tone, especially if it be of low pitch (*Phil. Mag.*, 1882).

The Sense of Equilibrium.—By this term is meant the sense, or series of sensations, by which we have a feeling of security in standing, walking, and indeed in all the movements by which the body is carried through space. Such a feeling of security is necessary both for maintaining any posture, such as standing, or for performing any movement. If this feeling is absent or uncertain, or if there are contradictory sensations, then definite muscular movements are inefficiently or irregularly performed, and the body may stagger or fall. When we stand erect on a firm surface, like a floor, there is a feeling of resistance, due to nervous impulses reaching the brain from the soles of the feet and from the muscles of the limbs and trunk. In walking or running, these feelings of resistance seem to precede and guide the muscular movements necessary for the next step. If these are absent or perverted or deficient, as is the case in the disease known as locomotor ataxia, then, although there is no loss of the power of voluntary movement, the patient staggers in walking, especially if he is not allowed to look at his feet, or if he is blindfolded. He misses the guiding sensations that come from the limbs; and with perhaps the feeling that he is walking on a soft substance, offering little or no resistance, he cannot avoid staggering, and his muscular movements become fitful and irregular. Such a condition may be artificially brought about by washing the soles of the feet with chloroform or ether. And it has been observed to exist partially after extensive destruction of the skin of the soles of the feet by burns or scalds. This shows that tactile impulses from the skin take a share in generating the guiding sensation. In the disease above mentioned, however, tactile impressions may be nearly normal, but the guiding sensation is weak and inefficient, owing to the absence of impulses from the muscles. The disease is known to depend on morbid changes in the posterior columns of the spinal cord, by which impulses are not freely transmitted upwards to the brain. These facts point to the existence of impulses coming from the muscles and tendons. It is now known that there exist in both end-organs in the shape of peculiar spindles, in the substance of muscle, and of little rosettes or coils or loops of nerve fibres in close proximity to tendons. The transmission of such impulses gives rise to what is termed the *muscular sense*, and the guiding sensation which precedes co-ordinated muscular movements largely depends on these impulses. Thus from the limbs streams of nervous impulses pass to the sensorium from the skin and from muscles and tendons; these may or may not arouse consciousness, but they guide or evoke muscular movements of a co-ordinated character, more especially of the limbs.

In animals whose limbs are not adapted for delicate touch nor for the performance of complicated movements, such as some mammals and birds and fishes, the guiding sensations seem to depend largely on the sense of vision. This sense in man, instead of assisting, sometimes disturbs the guiding sensation. It is true that in locomotor ataxia visual sensations may take the place of the tactile and muscular sensations that are absent, and the man can walk without staggering if he is allowed to look at the floor, and especially if he is guided by either longitudinal or transverse straight lines. On the other hand, the acrobat on the wire-rope dare not trust his visual sensations in the maintenance of his equilibrium. He usually keeps his eyes fixed on one point instead of allowing them to wander to objects below him, and his muscular movements are regulated by the impulses that come from the skin and muscles of his limbs. The feeling of insecurity probably arises from a conception of height, and also from a knowledge, the result of experience, that by no muscular movements can a man avoid a catastrophe if he should fall. A bird, on the other hand, depends largely on visual impressions, and it knows by experience that if launched into the air from a height it can fly. Here, probably, is an explanation of the large size of the eyes of birds. Cover the head, as in hooding a falcon, and the bird seems to be deprived of the power of voluntary movement. Little effect will be produced if we attempt to restrain the movements of a cat by covering its eyes. A fish also is readily deprived of the power of motion if its eyes are covered. But both in the bird and in the fish tactile and muscular impressions, especially the latter, come into play in the mechanism of equilibrium. In flight the large-winged birds, especially in soaring, can feel the most delicate wind-pressures, both as regards direction and force, and they adapt the position of their body so as to catch the pressure at the most efficient angle. The same is true of the fish, especially of the flat-fishes. In these animals, and in mammals generally, the sense of equilibrium depends, then, on streams of tactile, muscular, and visual impressions pouring in on the sensorium, and calling forth appropriate muscular movements. It has also been suggested that nervous impulses coming from the abdominal viscera may take part in the mechanism. The presence in the mesentery of felines (cats, &c.) of large numbers of Pacinian corpuscles, which are believed to be modified tactile bodies, favours this supposition. Such animals are remarkable for the delicacy of all these muscular movements, especially those of balancing and leaping.

Semi-circular canals.

There is still another channel by which nervous impulses may reach the sensorium and play their part in the sense of equilibrium, namely, from the semicircular canals, a portion of the internal ear. We have already learned (under *Hearing*) that the appreciation of sound is in reality an appreciation of variations of pressure. We have also seen that the labyrinth consists of the vestibule, the cochlea, and the semicircular canals. There can be no doubt that the cochlea has to do with the reception of sound-waves (variations of pressure) that constitute musical tones. This it accomplishes by the structures in the ductus cochlearis. In the vestibule we find two sacs, the saccule next to and communicating with the ductus cochlearis, and the utricle communicating with the semicircular canals. The base of the stapes communicates pressures to the utricle. The membranous portion of the semicircular canals consists of a tube, dilated at one end into a swelling or pouch, termed the ampulla, and each end communicates freely with the utricle. It is important to note that on the posterior wall of both the saccule and of the utricle there is a ridge or crest, termed in each case the macula acustica, bearing a highly specialized epithelium, and that a similar structure exists in each ampulla. This would suggest that all three structures have to do with hearing; but, on the other hand, there is experimental evidence that the utricle and the canals may transmit impressions that have to do with equilibrium. Pressure of the base of the stapes is exerted on the utricle. This will compress the fluid in that cavity, and tend to drive the fluid into the semicircular canals that communicate with that cavity by five openings. Each canal is surrounded by a thin layer of perilymph, so that it may yield a little to this pressure, and exert a certain pull or pressure on the nerve-endings in each ampulla. Thus nervous impulses may be generated in the ampullæ which are primarily excited at the base of the stapes.

The three semicircular canals lie in the three directions in space, and it has been suggested that they have to do with our appreciation of the direction of sound. But our appreciation of sound is very inaccurate: we look with the eyes for the source of the sound, and instinctively direct the ears or the head, or both, in the direction from which the sound appears to proceed. But the relationship of the canals on the two sides must have some physiological significance. Thus (1) the six canals are sensibly parallel, two and two; or (2) the two horizontal canals are in the same plane, while the superior canal on one side is nearly parallel with the posterior canal of the other. These facts point to the two sets of canals and ampullæ acting as one organ, in a manner analogous to the action of two retinæ for single vision (Crum-Brown, *Nature*, London, 1878, p. 449; also M'Kendrick's *Physiology*, vol. ii. p. 694).

We have next to consider how the canals may possibly act in connexion with the sense of equilibrium. So long ago as 1820, Purkinje (*Med. Jahrb.*, Wien, 1820, Bd. vi.) studied the well-known vertigo that follows rapid rotation of the body in the erect position on a vertical axis. On stopping the rotation there is a sense of rotation in the opposite direction, and this may occur even when the eyes are closed. Purkinje noticed that the position of the imaginary axis of rotation depends on the axis around which the head revolves (M'Kendrick, *op. cit.* vol. ii. p. 701). In 1828 Flourens discovered that injury to the canals causes disturbance of equilibrium and loss of co-ordination, and that sections of the canals produce a rotatory movement of a kind corresponding to the canal that had been divided. Thus division of a membranous canal causes rotatory movements round an axis at right angles to the plane of the divided canal. The body of the animal always moves in the direction of the cut canal (Flourens, *Comptes Rendus*, 11th August 1828, p. 5). Many other observers have corroborated these experiments. Goltz was the first who clearly formulated the conditions necessary for equilibration. He put the matter thus:—(1) A central co-ordinating organ—in the brain; (2) centripetal fibres, with their peripheral terminations—in the ampullæ; and (3) centrifugal fibres, with their terminal organs—in the muscular mechanisms. A lesion of any one of these portions of the mechanism causes loss or impairment of balancing (Goltz, *Archiv f. d. ges. Physiol.*, Bonn, Bd. iii. S. 172). Cyon also investigated the subject, and arrived at the following conclusions:—(1) To maintain equilibrium, we must have an accurate notion of the position of the head in space; (2) the function of the semicircular canals is to communicate impressions that give an accurate representation of this position—each canal having a relation to one of the dimensions of space; (3) disturbance of equilibrium follows section; (4) involuntary movements following section are due to abnormal excitations; (5) abnormal movements occurring a few days after the operation are caused by irritation of the cerebellum (Cyon, *Recherches expérimentales sur les fonctions des canaux semi-circulaires*, Thèse, 1878).

On theoretical considerations of a physical character, Mach, Crum-Brown, and Breuer have advanced theories based on the idea of the canals being organs for sensations of acceleration of movement, or for the sense of rotation (Mach, *Grundlinien der Lehre von den Bewegungsempfendungen*, Leipzig, 1875; Crum-Brown, *Journ. of Physiol. Lond.* vol. viii.; Breuer, *Jahrb. d. Gesellsch. d. Artze*, Wien, 1874–75). Mach first pointed out that Purkinje's phenomena, already alluded to, were in all probability related to the semicircular canals. "He showed that when the body is moved in space, in a straight line, we are not conscious of the velocity of motion, but of variations in this velocity. Similarly, if a body is rotated round a vertical axis, we perceive only angular acceleration and not angular velocity. The sensations produced by angular acceleration last longer than the acceleration itself, and the position of the head during the movements enables us to determine direction" (Schäfer's *Text-Book of Physiology*; article *Hearing*, by author, vol. ii. p. 1200). Both Mach and Goltz state that varying pressures of the fluid in the canals produced by angular rotation produce sensations of movement (always in a direction opposite to the rotation of the body), and that these, in turn, cause the vertigo of Purkinje and the phenomena of Flourens. Mach, Crum-Brown, and Breuer advance hydrodynamical theories—that is to say, they assume that the fluids move in the canals—and the two latter differ from Mach only in details. Goltz, on the other hand, supports a hydrostatical theory—that is to say, he assumes that the phenomena can be accounted for by varying pressures. Crum-Brown differs from Mach and Breuer as follows:—(1) In attributing movement or variation of pressure not merely to the endolymph, but also to the walls of the membranous canals and to the surrounding perilymph; and (2) in regarding the two labyrinths as one organ, all the six canals being required to form a true conception of the rotating motion of the head. He sums up the matter thus: "We have two ways in which a relative motion can occur between the endolymph and the walls of the cavity containing it—(1) When the head begins to move, here the walls leave the fluid behind; (2) when the head stops, here the fluid flows on. In both cases the sensation of rotation is felt. In the first this sensation corresponds to a real rotation, in the second it does not, but in both it corresponds to a real acceleration (positive or negative) of rotation, using the word acceleration in its technical kinematical sense" (Crum-Brown, *Nature*, London, 1878; review of Cyon's Thesis, *loc. cit.*).

Cyon states that the semicircular canals only indirectly assist in giving a notion of spatial relations. "He holds that knowledge of the position of bodies in space depends on nervous impulses coming from the contracting ocular muscles; that the oculomotor centres are in intimate physiological relationship with the centres receiving impulses from the nerves of the semicircular canals; and that the oculomotor centres, thus excited, produce the movements of the eyeballs, which then determine our notions of spatial relations" (Schäfer's *Text-Book*, *loc. cit.* vol. ii. p. 1203). These views are supported by experiments of Lee on dog-fish. When the fish is passively rotated round different axes there are compensating movements of the eyes and fins. "It was observed that if the fish were rotated in the plane of one of the canals, exactly the same movements of the eyes and fins occurred as were produced by experimental operation and stimulation of the ampulla of that canal" (Lee, *Journ. Physiol.*, Camb. and London, vol. xvii. p. 192). Sewall, in 1883, carried out experiments on young sharks and skates, and concluded that there was not sufficient evidence to connect the canals, and indeed the labyrinth, with the sense of equilibrium (Sewall, *Journ. Physiol.*, Camb. and Lond., vol. iv. p. 339). Lee returned to the subject in 1894, and, after numerous experiments on dog-fish, in which the canals or the auditory nerves were divided, obtained strong evidence that the ampullæ contain sense-organs connected with the sense of equilibrium (Lee, *Journ. Physiol.*, Camb. and London, 1894, vol. xv.).

It has been found by physicians and aurists that disease or injury of the canals, occurring rapidly, produces giddiness, staggering, nystagmus (a peculiar twitching movement of the muscles of the eyeballs), vomiting, noises in the ear, and more or less deafness. It is said, however, that if pathological changes come on slowly, so that the canals and vestibule are converted into a solid mass, none of these symptoms may occur. On the whole, the evidence is in favour of the view that from the semicircular canals nervous impulses are transmitted, which, co-ordinated with impulses coming from the visual organs, from the muscles, and from the skin, form the bases of these guiding sensations on which the sense of equilibrium depends. These impulses may not reach the level of consciousness, but they call into action co-ordinated mechanisms by which complicated muscular movements are effected. (J. G. M.)

Physiology of Development. See EMBRYOLOGY.

Physiology of Plants.—The great development of research into the vital phenomena of living organisms, which was a conspicuous feature of the scientific work of the last three decades of the 19th century, has tended to establish and develop the view that physiology should not be divided into two distinct sections, animal and vegetable, but that it exhibits an essential unity, and comprehends the study of all living protoplasm, whether the organisms under observation are simple or complex, and whatever is the nature of the differentiation exhibited by them. The so-called *vegetable physiology*, at the beginning of that period, was in arrear of *animal*, and particularly of *human*, physiology, the study of the latter being followed by many more observers, and from its relative degree of advancement being the more capable of rapid development. It was fully recognized by its followers that the dominating influence in the structure and working of the body was the protoplasm, and the division of labour which it exhibited, with the accompanying or resulting differentiation into various tissues, was the special subject of investigation. Many who followed the study of vegetable structure did not at that time give an equal prominence to this view. The early histological researches of botanists led them to the recognition of the vegetable cell, and the leading writers in the middle of the 19th century pointed out the probable identity of Von Mohl's "protoplasm" with the "sarcode" of zoologists. They laid great stress on the nitrogenous nature of protoplasm, and noted that it preceded the formation of the cell-membrane. But by the ordinary student of thirty years later their work was to some extent overlooked, and the *cell-wall* assumed a prominence to which it was not entitled. The study of the *differentiation* of protoplasm was at that time seldom undertaken, and no particular attention was paid either to fixing it, to enable staining methods to be accurately applied to it, or to studying the action of chemical reagents upon it. It is only comparatively recently that the methods of histological investigation used by animal physiologists have been carefully and systematically applied to the study of the vegetable organisms. They have, however, been attended with wonderful results, and have revolutionized the whole study of vegetable structure. They have emphasized the statements of Von Mohl, Cohn, and other writers alluded to, that the protoplasm is here also the dominant factor of the body, and that all the peculiarities of the cell-wall can only be interpreted in the light of the needs of the living substance.

The Nature of the Organization of the Plant, and the Relations of the Cell-Membrane and the Protoplasm.—This view of the structure of the plant and this method of investigation lead us to a greatly modified conception of its organization, and afford more completely an explanation of the peculiarities of form found in the vegetable kingdom.

The study of simple organisms, many of which consist of nothing but a little mass of protoplasm, exhibiting a very rudimentary degree of differentiation, so far as our methods enable us to determine any at all, shows that the duties of existence can be discharged in the absence of any cell-wall. Those organisms which possess the latter are a little higher in the scale of life than those which remain unclothed by it, but a comparison of the behaviour of the two quickly enables us to say that the membrane is of but secondary importance, and that for those which possess it, it is nothing more than a protective covering for the living substance. Its physical properties, permeability by water, extensibility and elasticity, receive their interpretation in the needs of the latter. We come, accordingly, to regard it as practically an exoskeleton, and its functions as distinctly subordinate to those of the protoplasm which it clothes. If we pass a little higher up the scale of life, we meet with forms consisting of two or more cells, each of which contains a similar minute mass of living substance. A study of them shows that each is practically independent of the others; in fact, the connexion between them is so slight that they can separate and each become free without the slightest disadvantage to another. So long as they are connected together mechanically, they have apparently the power of influencing one another in various ways, and of passing liquid or gaseous materials from one to another. The conjoined organism is, in fact, a colony or association of the protoplasmic units, though each unit retains its independence. When we pass, again, from these to examine more bulky, and consequently more complex, plants, we find that the differences which can be observed between them and the simple lowly forms are capable of being referred to the increased number of the protoplasmic units and the consequent enlarged bulk of the mass or colony. Every plant is thus found to be composed of a number of these protoplasmic units, or, as they may preferably be termed, *protoplasts*, all of which are at first exactly alike in appearance and in properties. This is evident in the case of such plants as have a body consisting of filaments or plates of cells, and is little less conspicuous in those whose mass is but small, though the cells are evidently capable of computation in three dimensions. It does not at first appear to be the same with the bulkier plants, such as the ordinary green herbs, shrubs, or trees, but a study of their early development indicates that they do not at the outset differ in any way from the simple undifferentiated forms. Each commences its existence as a simple naked protoplast, in the embryo-sac or the archegonium, as the case may be. After the curious fusion with another similar protoplast, which constitutes what we call fertilization, the next stage in complexity already noted may be observed, the protoplasm becoming clothed by a cell-membrane. Very soon the single cell gives rise to a chain of cells, and this in turn to a cell mass, the individual units of which are at first quite uniform. With increase of number, however, and consequently enlargement of bulk in the colony, differentiation becomes compulsory. The requirements of the several protoplasts must be met by supplies from without, and, as many of them are deep seated, varieties of need arise, so that various members of the colony are set apart for special duties, masses of them being devoted to the discharge of one function, others to that of another, and so on. Such limitations of the powers and properties of the individuals have for their object the well-being of the community of which those individuals are constituents.

Physiological and Morphological Differentiation.—The first indication of this differentiation in the vegetative body of the plant can be seen not only in the terrestrial green plants which have been particularly referred to, but also in the bulkier sea-weeds. It is an extension of the first differentiation which was observable in the simple protoplasts first discussed, the formation, that is, of a protective covering. *Fucus* and its allies, which form conspicuous members of the larger Algæ, have their external cells much smaller, more closely put together, and generally much denser, than the rest of their tissue. In the lowly as well as the higher green plants we have evidence of specialization of the external protoplasts for the same purpose, which takes various shapes and shows different degrees of completeness, culminating in the elaborate barks which clothe our forest trees.

The second prominent differentiation which presents itself takes the form of a provision to supply the living substance with water. This is a primal necessity of the protoplast, and every cell gives evidence of its need by adopting one of the various ways in which such need is supplied. What little differentiation can be found to exist in the protoplasm of the simple unicellular organism shows the importance of an adequate water supply, and, indeed, the dependence of life upon it. The naked cells which have been alluded to live in water, and call therefore for no differentiation in connexion with this necessity; but those which are surrounded by a cell-wall always develop within themselves a *vacuole* or cavity which occupies the greater part of their interior, and the hydrostatic pressure of whose contents keeps the protoplasm in contact with the membrane, setting up a condition of turgidity.

The need for a constant supply of water is partly based upon the constitution of protoplasm, so far as we know it. The apparently structureless substance is saturated with it; and if once a cell is completely dried, even at a low temperature, in the enormous majority of cases its life is gone, and restoration of water fails to enable it to recover. Besides this intimate relationship, however, we can point to other features of the necessity for a constantly renewed water supply. The protoplasm derives its food from substances in solution in the water; the various waste products which are incident to its life are excreted into it, and so removed from the sphere of its activity. The raw materials from which the food is constructed are absorbed from the exterior in solution in water, and the latter is the medium through which the gaseous constituents necessary for life reach the protoplasm. Moreover, growth is essentially dependent upon water supply. There is little wonder, then, that in a colony of protoplasts such as constitute a large plant, a considerable degree of differentiation is evident, bearing upon the question of water supply. Certain cells of the exterior are set apart for absorption of water from the soil, this being the source from which supplies are derived. Others are devoted to the work of carrying it to the protoplasts situated in the interior and at the extremities of the plant, a *conducting system* of considerable complexity being the result.

Other collections of cells are in many cases set apart for giving rigidity and strength to the mass of the plant. It is evident that as the latter increases in bulk, more and more attention must be paid to the dangers of uprooting by winds and storms. Various mechanisms have been adopted in different cases, some connected with the subterranean and others with the sub-aërial portions of the plant. Another kind of differentiation in such a cell-mass as we are dealing with is the setting apart of particular groups of cells for various metabolic purposes. We have the formation of numerous mechanisms which have arisen in connexion with the question of food supply, which may not only involve particular cells, but also lead to differentiation in the protoplasm of those cells, as in the development of the chloroplastids of the leaves and other green parts.

The inter-relations of the members of a large colony of protoplasts such as constitute a tree, demand much adjustment. Relations with the exterior are continually changing, and the needs of different regions of the interior are continually varying, from time to time. Two features which are essentially protoplasmic assume a great importance when we consider these relations. They are the power of receiving impressions or stimuli from the exterior, and of communicating with each other, with the view of co-ordinating a suitable response. We have nothing structural which corresponds to the former of these. In this matter, differentiation has proceeded very differently in animals and plants respectively, no nerves or sense organs being structurally recognizable. Communication between the various protoplasts of the colony is, however, carried on by means of fine protoplasmic threads, which are continuous through the cell-walls.

All the peculiarities of structure which we encounter consequently support the view with which we started, that the protoplasm of the plant is the dominant factor in vegetable structure, and that there need be but one subject of physiology, which must embrace the behaviour of protoplasm wherever found. There can be no doubt that there is no fundamental difference between the living substance of animals and plants, for many forms exist which cannot be referred with certainty to either kingdom. Free-swimming organisms without cell-membranes exist in both, and from them series of forms can be traced in both directions. Cellulose, the material of which vegetable cell-walls are almost universally composed, at any rate in their early condition, is known to occur, though only seldom, among animal organisms. Such forms as *Volvox* and the group of the *Myxomycetes* have been continually referred to both kingdoms, and their true systematic position is still a subject of controversy. All physiology, consequently, must be based upon the identity of the protoplasm of all living beings.

This method of study has to a large extent modified our ideas of the relative importance of the parts of such an organism as a large tree. The interest with which we regard the latter no longer turns upon the details of the structure of its trunk, limbs, and roots, to which the living substance of the more superficial parts was subordinated. Instead of regarding these as only ministering to the construction of the bulky portions, the living protoplasts take the first place as the essential portion of the tree, and all the other features are important mainly as ministering to their individual well-being and to their multiplication. The latter feature is the *growth* of the tree, the well-being of the protoplasts is its *life* and *health*. The interest passes from the bulky dense interior, with the elaborate features of its cell-walls, to the superficial parts, where its life is in evidence. We see herein the reason for the great subdivision of the body, with its finely cut twigs and their ultimate expansions, the leaves, and we recognize that this subdivision is only an expression of the need to place the living substance in direct relationship with the environment. The formation and gradually increasing thickness of its bark are explained by the continually increasing need of adequate protection to the living cortex, under the strain of the increasing framework which the enormous multiplication of its living protoplasts demands, and the development of which leads to continual rupture of the exterior. The increasing development of the wood as the tree grows older is largely due to the demands for the conduction of water and mineral matters dissolved in it, which are made by the increased number of leaves which from year to year it bears, and which must each be put into communication with the central mass by the formation of new vascular bundles. Similar considerations apply to the peculiar features of the root-system. All these points of structure can only be correctly interpreted after a consideration of the needs of the individual protoplasts, and of the large colony of which they are members.

Gaseous Interchanges and their Mechanism.—Another feature of the construction of the plant has in recent years come into greater prominence than was formerly the case. The organism is largely dependent for its vital processes upon gaseous interchanges. It must receive a large constituent of what ultimately becomes its food from the air which surrounds it, and it must also take in from the same source the oxygen of its respiratory processes. On the other hand, the aërial environment presents considerable danger to the young and tender parts, where the protoplasts are most exposed to extremes of heat, cold, wet, &c. These must in some way be harmonized. No doubt the primary object of the cell-wall of even the humblest protoplast is protection, and this too is the meaning of the coarser tegumentary structures of a bulkier plant. These vary considerably in completeness with its age; in its younger parts the outer cell-wall undergoes the change known as *cuticularization*, the material being changed both in chemical composition and in physical properties. The corky layers which take so prominent a share in the formation of the bark are similarly modified and subserve the same purpose. But these protective layers are in the main impermeable by gases and by either liquid or vapour, and prevent the access of either to the protoplasts which need them. Investigations carried out by Blackman, and by Brown and Escombe, have shown clearly that the view put forward by Boussingault, that such absorption of gases takes place through the cuticular covering of the younger parts of the plant, is erroneous and can no longer be supported. The difficulty is solved by the provision of a complete system of minute intercellular spaces which form a continuous series of delicate canals between the cells, extending throughout the whole substance of the plant. Every protoplast, except in the very young regions, has part of its surface abutting on these, so that its wall is accessible to the gases necessary for its vital processes. There is no need for cuticularization here, as the external dangerous influences do not reach the interior, and the processes of absorption which Boussingault attributed to the external cuticularized cells can take place freely through the delicate cell-walls of the interior, saturated as these are with water. This system of channels is in communication with the outer atmosphere through numerous small apertures, known as *stomata*, which are abundant upon the leaves and young twigs, and gaseous interchange between the plant and the air is by their assistance rendered constant and safe. This system of intercellular spaces, extending throughout the plant, constitutes a reservoir, charged with an atmosphere which differs somewhat in its composition from the external air, its gaseous constituents varying from time to time and from place to place, in consequence of the interchanges between itself and the protoplasts. It constitutes practically the exterior environment of the protoplasts, though it is ramifying through the interior of the plant.

The importance of this provision in the case of aquatic vascular plants of sturdy bulk is even greater than in that of terrestrial organisms, as their environment offers considerable obstacles to the renewal of the air in their interior. They are without stomata on their submerged portions, and the entry of gases can only take place by diffusion from the water through their external cells, which are not cuticularized. Those which are only partially submerged bear stomata on their exposed portions, so that their environment approximates towards that of a terrestrial plant, but the communication even in their case is much less easy and complete, so that they need a much larger reservoir of air in their interior. This is secured by the development of much larger intercellular spaces, amounting to lacunæ or passages of very considerable size, which are found ramifying in different ways in their interior.

Transpiration.—In the case of terrestrial plants, the continual renewal of the water contained in the vacuoles of the protoplasts demands a copious and continuous evaporation. This serves a double purpose, bringing up from the soil continually a supply of the soluble mineral matters necessary for their metabolic processes, which only enter the plant in solutions of extreme dilution, and at the same time keeping the plant cool by the process of evaporation. The latter function has been found to be of extreme importance in the case of plants exposed to the direct access of the sun's rays, the heat of which would rapidly cause the death of the protoplasts were it not employed in the evaporation of the water. Brown and Escombe have shown that the amount of solar energy taken up by a green leaf may often be fifty times as much as it can utilize in the constructive processes of which it is the seat. If the heat were allowed to accumulate in the leaf unchecked, they have computed that its temperature would rise during bright sunshine at the rate of more than 12° C. per minute, with of course very rapidly fatal results. What is not used in the constructive processes is employed in the evaporation of the water, the leaf being thus kept cool. Whether the leaf is brightly or only moderately illuminated, the same relative proportions of the total energy absorbed are devoted to the purposes of composition and construction respectively. This large evaporation, which constitutes the so-called *transpiration* of plants, takes place not into the external air but into this same intercellular space system, being possible only through the delicate cell-walls upon which it abuts, as the external coating, whether bark, cork, or cuticle, is impermeable by watery vapour. The latter ultimately reaches the external air by diffusion through the stomata, whose dimensions vary in proportion as the amount of water in the epidermal cells becomes greater or less.

Mechanism and Function of Stomata.—It is not quite exact to speak of either the gaseous interchanges or the transpiration as taking place through the stomata. The entry of gases into, and exit from, the cells, as well as the actual exhalation of watery vapour from the latter, take place in the intercellular space system of which the stomata are the outlets. The opening and closing of the stomata is the result of variation in the turgidity of their guard cells, which is immediately affected by the condition of turgidity of the cells of the epidermis contiguous to them. The amount of watery vapour in the air passing through a stoma has no effect upon it, as the surfaces of the guard cells abutting on the air chamber are strongly cuticularized, and therefore impermeable. The only way in which their turgidity is modified is by the entry of water into them from the contiguous cells of the general epidermis and its subsequent withdrawal through the same channel. This opening and closing of the stomata must be looked upon as having a direct bearing only on the emission of watery vapour. There is a distinct advantage in the regulation of this escape, and the mechanism is directly connected with the greater or smaller quantity of water in the plant, and especially in its epidermal cells. This power of varying the area of the apertures by which gases enter the internal reservoirs is not advantageous to the gaseous interchanges—indeed, it may be directly the reverse. It may lead to an incipient asphyxiation, as the supply of oxygen may be greatly interfered with and the escape of carbon dioxide may be almost stopped. It may at other times lead to great difficulties in the supply of the gaseous constituents which are used in the manufacture of food. The importance of transpiration is, however, so great, that these risks must be run.

Nature of the Food of Plants.—The recognition of the fundamental identity of the living substance in animals and plants has directed attention to the manner in which plants are nourished, and especially to the exact nature of their food. The idea was till recently currently accepted, that anything which plants absorbed from without, and which went to build up their organic substance, or to supply them with energy, or to exert some beneficial influence upon their metabolism, constituted their *food*. Now, as the materials which plants absorb are carbon dioxide from the air, and various inorganic compounds from the soil, together with water, it is clear that if this view is correct, vegetable protoplasm must be fed in a very different way from animal, and on very different materials. A study of the whole vegetable kingdom, however, throws considerable doubt upon the theory that the compounds absorbed are in the strict sense to be called food. Fungal and phanerogamic parasites can make no use of such substances as carbon dioxide, but draw elaborated products from the bodies of their hosts. Those Fungi which are saprophytic can only live when supplied with organic compounds of some complexity, which they derive from decomposing animal or vegetable matter. Even in the higher flowering plants, in which the processes of the absorption of substances from the environment has been most fully studied, there is a stage in their life in which the nutritive processes approximate very closely to those of the group last mentioned. When the young sporophyte first begins its independent life—when, that is, it exists in the form of the embryo in the seed—its living substance has no power of utilizing the simple inorganic compounds spoken of. Its nutritive pabulum is supplied to it in the shape of certain complex organic substances which have been stored in some part or other of the seed, sometimes even in its own tissues, by the parent plant from which it springs. When the tuber of a potato begins to germinate, the shoots which it puts out derive their food from the accumulated store of nutritive material which has been laid up in the cells of the tuber. If we examine the seat of active growth in a young root or twig, we find that the cells in which the organic substance, the protoplasm, of the plant is being formed and increased, are not supplied with carbon dioxide and mineral matter, but with such elaborated material as sugar and proteid substances, or others closely allied to them.

Identity of the Food of Animals and Plants.—It is evidently to the actual seats of consumption of food, and of consequent nutrition and increase of living substance, that we should turn when we wish to inquire what are the nutritive materials of plants. If we go back to the first instance cited, the embryo in the seed and its development during germination, we can ascertain what is necessary for its life by inquiring what are the materials which are deposited in the seed, and which become exhausted by consumption as growth and development proceed. We find them to consist of representatives of the great classes of food-stuffs on which animal protoplasm is nourished, and whose presence renders seeds such valuable material for animal consumption. They are mainly carbohydrates such as starch and sugar, proteids in the form of globulins or albumoses, and in many cases fats and oils, while certain other bodies of similar nutritive value are less widely distributed.

The differences between the nutritive processes of the animal and the plant are not therefore fundamental, as they were formerly held to be. The general vegetable protoplasm has not the capacity of being nourished by inorganic substances which are denied to the living substance of the animal world. Differences connected with the mode of supply of nutritive material do exist, but they are mainly correlated with the structure of the organisms, which makes the method of absorption different. The cell-walls of plants render the entry of solid material into the organism impossible. The food must enter in solution in order to pass the walls. Moreover, the stationary habit of plants, and the almost total absence of locomotion, makes it impossible for them to seek their food.

The Special Apparatus of Plants for constructing Food.—The explanation of the apparent difference of food supply is very simple. Plants are furnished with a constructive mechanism by which they are enabled to fabricate the food on which they live from the inorganic, gaseous, and liquid matters which they absorb. The fact of such absorption does not render these substances food; they are taken in not as food, but as raw materials to be subjected to the action of this constructive mechanism, and by it to be converted into substances that can nourish protoplasm, both vegetable and animal. It is sometimes forgotten, when discussing questions of animal nutrition, that all the food materials of all living organisms are prepared originally from inorganic substances in exactly the same way, in exactly the same place, and by the same machinery, which is the *chlorophyll apparatus* of the vegetable kingdom. A consideration of these facts emphasizes still more fully the view with which we set out, that all living substance is fundamentally the same, though differentiated both anatomically and physiologically in many directions and in different degrees. All is nourished alike on materials originally prepared by a mechanism attached to the higher vegetable organism, and capable of being dissociated, in theory at least, from its own special means of nutrition, if by the latter term we understand the appropriation by the protoplasm of the materials so constructed.

The possession of this mechanism, which we have alluded to as the chlorophyll apparatus, is limited to those plants which are green, or which have green portions, the colour, of course, being the inherent colour of the mechanism itself. The latter is especially charged with the duty of manufacturing carbohydrates, its action in the formation of proteids being not completely understood. The construction of the latter apparently depends upon a supply of carbohydrate material, together with other constituents, so that indirectly, at least, the chlorophyll apparatus is concerned in their preparation. The formation of fats is still less understood. It appears to be a function of protoplasm itself under certain conditions of nutrition, and therefore removed a little farther from the influence of the chlorophyll machinery.

The story of the construction processes is not, however, complete until we have considered also the groups of plants which contain no chlorophyll apparatus. We have evidence in the case of many of these that the power of construction is not entirely absent from them. Fungi can live, thrive, and grow in nutritive media which contain carbohydrates, together with certain salts of ammonia, but which are free from proteids. As we have seen strong reasons to believe that their protoplasm is like that of animals, and therefore incapable of being nourished by inorganic compounds of nitrogen, we must surmise their possession of a mechanism which can construct proteids if supplied with these nitrogen compounds, together with sugar. We have no apparent differentiation of such a mechanism, and its existence must remain for the present only as a probability, although a strong one. It must exist in the green plant side by side with the chlorophyll apparatus; indeed, this is probable from the fact that a good deal of evidence points to the leaves as the seat of proteid construction. It may be that this power is a particular differentiation of a physiological kind in all vegetable protoplasm, or in that of certain cells. The idea of an identity of protoplasm does not involve a denial of special powers developed in it in different situations, and the possession of such a power by the vegetable cell is not more striking than the location of powers of co-ordination and thought in the protoplasm of cells of the human brain.

The normal green plant is seen thus to be in possession of a complete machinery for the manufacture of its own food. The process of manufacture of carbohydrates, in which are primarily concerned the carbon dioxide of the air and the water of the soil, has been generally spoken of as the *assimilation of carbon dioxide*, a term which the more recent work on the true nature of the food shows to be misleading, and which has already been abandoned by many writers. The carbon dioxide is not *assimilated* by the protoplasm, but is built up into carbohydrates by the chlorophyll apparatus. As the latter is only active under the influence of the radiant energy of light, the term *photosynthesis* has been suggested, to replace the older one.

Photosynthesis.—Though the actual details of this process have been studied by many observers of late years, little substantial progress has been made in ascertaining what they are. The general position has been slightly changed, the appearance of starch in the chlorophyll apparatus bearing now a slightly different interpretation from that formerly in vogue. Its very prompt appearance as soon as the apparatus became active led to the opinion that the work of the latter was only complete when the starch was formed. It appears more likely that the ultimate product is not starch but *sugar*, though what particular sugar is still a matter of controversy. The appearance of the starch is interpreted as the sign of a surplus manufacture: what is produced beyond the immediate requirements of the cell being converted into the insoluble form of starch by the plastids of the chlorophyll apparatus, and so withdrawn from the sphere of action, thereby enabling the construction of further quantities of sugar to take place. Starch, indeed, wherever it appears in the plant, seems to be a reserve store of carbohydrate material deposited where it is found for longer or shorter periods till it is needed for consumption. The readiness with which it is converted into sugar fits it especially for that duty.

Very little progress has been made in the investigation of the stages by which sugar is constructed. The view brought forward originally by Baeyer, that the first step is the decomposition of carbon dioxide into carbon monoxide and oxygen, while water is simultaneously split up into hydrogen and oxygen, and that this is at once followed by the union of the carbon monoxide and hydrogen to form formaldehyde, has only been slightly modified. There is no evidence that carbon monoxide is ever produced; indeed, there are strong reasons for disbelieving that it is. Formaldehyde has been said to be present in leaves during photosynthesis, and certain Algæ have been found capable of forming nutritive substances and storing starch in their cells when supplied with a compound of this body and sodium-hydrogen-sulphite. The evidence for its formation in the ordinary course of photosynthesis is not, however, very strong. The course of photosynthesis has been with tolerable certainty found to lead to the construction of sugar, and the general opinion has been that the sugar is a simple hexose such as glucose, $C_6H_{12}O_6$. Brown and Morris in 1892 advanced strong reasons for thinking that cane sugar, $C_{12}H_{22}O_{11}$, is the first carbohydrate synthesized, and that the hexoses found in the plant result from the decompositions of this. The whole story of the different sugars existing in the plant—their relations, and their several functions—requires renewed investigation.

Symbiosis. — Though green plants thus possess a very complete mechanism for the manufacture of their different food-stuffs, it is not always exercised to the fullest extent. Many of them are known to supplement it, and some almost entirely to replace it, by absorbing the food they need in a fully prepared condition from their environment. It may be that they procure it from decomposing organic matter in the soil, or they may get it by absorption from other plants to which they attach themselves, or they may in rare cases obtain it by preying upon insect life. The power of green plants, not even specialized in any of these directions, to absorb certain carbohydrates, particularly sugars, from the soil was demonstrated by Acton in 1889. Similar observations have been made in the case of various compounds of nitrogen, though these have not been so complex as the proteids. It was formerly the custom to regard as parasites all those plants which inserted roots or root-like organs into the tissues of other plants and absorbed the contents of the latter. The most conspicuous case, perhaps, of all these is the mistletoe, which flourishes luxuriantly upon the apple, the poplar, and other trees. Bonnier has drawn attention to the fact that the mistletoe in its turn, remaining green in the winter, contributes food material to its host when the latter has lost its leaves. The relationship thus existing he showed to be mutually beneficial, each at one time or another supplying the necessities of the other. Such a relationship is known as *symbiosis*, and the large majority of the cases of so-called parasitism among green plants can be referred to it. Bonnier showed that the same relationship could be proved in the cases of such plants as the rattle (*Rhinanthus*), the eye-bright (*Euphrasia*), and other members of the Natural Orders *Scrophulariaceæ* and *Santalaceæ*, which effect a union between their roots and the roots of other plants growing near them. The union taking place underground, while the bulk of both partners in the symbiosis rises into the air, renders the association a little difficult to see, but there is no doubt that the plants in question do afford each other assistance, forming, as it were, a kind of partnership. The most pronounced case of parasitism, that of *Cuscuta*, the dodder, which infests particularly clover fields, appears to differ only in degree from those mentioned, for the plant, bare of leaves as it is, yet contains a little chlorophyll. The advantages it can offer to its host are, however, infinitesimal when compared with the injury it does it. Many other cases of symbiosis have been investigated with some completeness, especially those in which lower plants than the Phanerogams are concerned. The relations of the Alga and the Fungus, which have formed a close associationship in the structure known as the Lichen, were established many years ago. Since about 1880 our knowledge of the species which can enter into such relationships has been materially extended, and the fungal constituents of the Lichens are known to include *Basidiomycetes* as well as *Ascomycetes*.

Mycorhizas.—The most interesting cases, however, in which Fungi form symbiotic relationships with green plants have been discovered in connexion with forest trees. The roots of many of the latter, while growing freely in the soil, are found to be surrounded with a dense feltwork of fungal mycelium, which sometimes forms a mass of considerable size. The plants showing it are not all forest trees, but include also some Pteridophytes and some of the prothallia of the Ferns, Club-mosses, Liverworts, and Horsetails. The true nature of the relationship was first recognized by Pfeffer in 1877, but few cases were known till recent years. Very complete examination, however, has now been made of many instances, and the name *mycorhiza* has been given to the symbiotic union. Two classes are recognized. In the first, which are called *ectotropic*, the fungal filaments form a thick felt or sheath round the root, either completely enclosing it or leaving the apex free. They seldom penetrate the living cells, though they do so in a few cases. The root-hairs penetrate between masses of the hyphæ of the Fungus. This type of mycorhiza is found among the Poplars, Oaks, and Fir trees. The other type is called *endotropic*. The fungal filaments either penetrate the epidermis of the root, or enter it from the stem and ramify in the interior. Some make their way through the cells of the outer part of the cortex towards the root-tip, and form a mycelium or feltwork of hyphæ, which generally occupies two or three layers of cells. From this branches pass into the middle region of the cortex and ramify through the interior half of its cells. They often cause a considerable hypertrophy of the tissue. From the outer cortical mycelium, again, branches pass through the epidermis and grow out in the soil. In such cases the roots of the plants are usually found spreading in soils which contain a large amount of humus, or decaying vegetable matter. The organic compounds of the latter are absorbed by the protruding fungal filaments, which take the place of root-hairs, the tree ceasing to develop the latter. The food so absorbed passes to the outer cortical mycelium, and from this to the inner hyphæ, which appear to be the organs of the interchange of substance, for they are attracted to the neighbourhood of the nuclei of the cells, which they enter, and in which they form agglomerations of interwoven filaments. The prothalli of the Pteridophytes, which form similar symbioses, show a somewhat different mode of arrangement, the Fungi occupying the external or the lower layers of the thalloid body.

The discovery of the widespread occurrence of this mycorhizal symbiosis must be held to be one of the most important results of research upon the nutritive processes of plants during the closing decade of the 19th century. Among green plants the symbionts include Conifers, Orchids, Heaths, Oaks, Poplars, and Beeches, though all do not derive equal advantages from the association. *Monotropas* afford an extreme case of it, having lost their chlorophyll almost entirely, and come to depend upon the Fungi for their nutriment. The fungal constituents vary considerably. Each species of green plant may form a mycorhiza with two or three different Fungi, and a single species of Fungus may enter into symbiosis with several green plants. The Fungi that have been discovered taking part in the union include *Eurotium*, *Pythium*, *Boletus*, *Agaricus*, *Lactarius*, *Penicillium*, and many others of less frequent occurrence. All the known species belong to the *Oomycetes*, the *Pyrenomycetes*, the *Hymenomycetes*, or the *Gasteromycetes*. The habit of forming mycorhizas is found more frequently in warm climates than cold; indeed, the percentage of the flora exhibiting this peculiarity seems to increase with a certain regularity from the Arctic Circle to the Equator.

Fixation of Nitrogen.—Another, and perhaps an even more important, instance of symbiotic association has come to the front during the same period. It is an alliance between the plants of the Natural Order *Leguminosæ* and certain bacterium-like forms which find a home within the tissues of their roots. The importance of the symbiosis can only be understood by considering the relationship in which plants stand with regard to the free nitrogen of the air. Long ago the view that this gas might be the source of the combined nitrogen found in different forms within the plant, was critically examined, particularly by Boussingault, and later by Lawes and Gilbert and by Pugh, and it was ascertained to be erroneous, the plants only taking nitrogen into their substance when it is presented to their roots in the form of nitrates of various metals, or compounds of ammonia. Many writers in recent years, among whom may be named especially Hellriegel and Wilfarth, Lawes and Gilbert, and Schlœsing and Laurent, have shown that the Leguminosæ as a group form conspicuous exceptions to this rule. While they are quite capable of taking up nitrates from the soil where and so long as these are present, they can grow and thrive in soil which contains no combined nitrogen at all, deriving their supplies of this element in these cases from the air. The phenomena have been the subject of very careful and critical examination for many years, and may be regarded as satisfactorily established. The power of fixing atmospheric nitrogen by the higher plants seems to be confined to this solitary group, though it has been stated by various observers with more or less emphasis that it is shared by others. Frank has claimed to have found oats, buckbeans, spurry, turnips, mustard, potatoes, and Norway maples exercising it; Nobbe and others have imputed its possession to *Elæagnus*. There is little direct evidence pointing to this extension of the power, and many experimenters directly contradict the statements of Frank.

The power exercised by the Leguminosæ is associated with the presence of curious tubercular swellings upon their roots, which are developed at a very early age, as they are cultivated in ordinary soil. If experimental plants are grown in sterilized soil, these swellings do not appear, and the plant can then use no atmospheric nitrogen. The swellings have been found to be due to a curious hypertrophy of the tissue of the part, the cells being filled with an immense number of minute bacterium-like organisms of V, X, or Y shape. The development of these structures has been studied by many observers, both in England and on the continent of Europe. They appear to be present in large numbers in the soil, and to infect the Leguminous plant by attacking its root-hairs. One of these hairs can be seen to be penetrated at a particular spot, and the entering body is then found to grow along the length of the hair till it reaches the cortex of the root. It has the appearance of a delicate tube which has granular contents, and is provided with an apex that appears to be open. The wall of the tube is very thin and delicate, and does not seem to be composed of cellulose or any modification of it. Careful staining shows that the granular substance of the interior really consists of a large number of delicate rod-like bodies. As the tube grows down the hair it maintains its own independence, and does not fuse with the contents of the root-hair, whose protoplasm remains quite distinct and separate. After making its way into the interior, the intruder sets up a considerable hypertrophy of the tissue, causing the formation of a tubercle, which soon shows a certain differentiation, branches of the vascular bundles of the root being supplied to it. The rod-like bodies from the interior of the tube, which has considerable resemblance to the zooglœa of many Bacteria, are liberated into the interior of the cells of the tubercle and fill it, increasing by a process of branching and fission. When this stage is reached, the invading tubes and their ramifications frequently disappear, leaving the cells full of the bacterioids, as they have been called. When the root dies later, such of these as remain are discharged into the soil, and are then ready to infect new plants. In some cases the zooglœa thread or tube has not been seen, the organism consisting entirely of the bacterioids.

This peculiar relationship suggests at once a symbiosis, the Fungus gaining its nutriment mainly or entirely from the green plant, while the latter in some way or other is able to utilize the free nitrogen of the air. The exact way in which the utilization or *fixation* of the nitrogen is effected remains undecided. Two views are still receiving certain support, though the second of them appears the more probable. These are: (1) That the green plant is so stimulated by the symbiotic association which leads to the hypertrophy, that it is able to fix the nitrogen or cause it to enter into combination. (2) That the fixation of the gas is carried out by the fungal organism either in the soil or in the plant, and the nitrogenous substance so produced is absorbed by the organism, which is in turn consumed by the green plant. Certain evidence which supports this view will be referred to later.

Whichever opinion is held on this point, there seems no room for doubt that the fixation of the nitrogen is concerned only with the root, and that the green leaves take no part in it. The nodules, in particular, appear to play the important part in the process. Marshall Ward has directed attention to several points of their structure which bear out this view. They are supplied with a regular system of conducting vascular bundles communicating with those of the roots. Their cells during the period of incubation of the symbiotic organism are abundantly supplied with starch. The cells in which the fungoid organism is vigorously flourishing are exceedingly active, showing large size, brilliant nuclei, protoplasm, and vacuole, all of which give signs of intense metabolic activity. The sap in these active tissues is alkaline, which has been interpreted as being in accordance with Lœw's suggestion that the living protoplasm in presence of an alkali and free nitrogen can build up ammonium nitrate, or some similar body. It is, however, at present entirely unknown what substances are formed at the expense of the atmospheric nitrogen.

The idea that the atmospheric nitrogen is gradually being made use of by plants, although it is clearly not easily or commonly utilized, has been growing steadily. Besides the phenomena of the symbiosis just discussed, certain experiments tend to show that we have a constant fixation of this gas in the soil by various Bacteria. Researches which have been carried out since 1885 by

Berthelot, Andrée, Laurent, and Schlœsing, and more recently by Kossowitsch, seem to establish the fact, though the details of the process remain undiscovered. Berthelot imputes it to the action of several species of soil Bacteria and Fungi, including the Bacterium of the Leguminosæ, when the latter is cultivated free from its ordinary host. Laurent and Schlœsing affirm that the free nitrogen of the air can be fixed by a number of humble green plants, principally lowly green Algæ. They must be exposed freely to light and air during the process, or they fail to effect it. Frank has stated that *Penicillium cladiosporioides* can flourish in a medium to which no nitrogen but that of the atmosphere has access. Kossowitsch claims to have proved that fixation of nitrogen takes place under the influence of a symbiosis of certain Algæ and soil Bacteria, the process being much facilitated by the presence of sugar. The Algæ include *Nostoc, Cystococcus, Cylindrospermum*, and a few other forms. In the symbiosis the Algæ are supplied with nitrogen by the bacteria, and in turn they construct carbohydrate material, part of which goes to the microbes. This is supported by the fact that if the mixed culture is placed in the light there is a greater fixation than when it is left in darkness. If there is a plentiful supply of carbon dioxide, more nitrogen is fixed.

Nitrification and Denitrification in the Soil.—Another aspect of the nitrogen question has been the subject of much investigation and controversy since 1877. The round of changes which nitrogenous organic matter undergoes in the soil, and how it is ultimately made use of again by plants, presents some curious features. We have seen that when nitrogenous matter is present in the condition of humus, some plants can absorb it by their roots or by the aid of mycorhizas. But the changes in it in the usual course of nature are much more profound than these. It becomes in the soil the prey of various microbes. Ammonia appears immediately as a product of the disruption of the nitrogen-containing organic molecule. Later, oxidation processes take place, and the ammonia gives rise to nitrates, which are absorbed by plants. These two processes go on successively rather than simultaneously, so that it is only towards the end of the decomposition of the organic matter that nitrification of the ammonia which is formed is set up. In this process of nitrification we can distinguish two phases, first the formation of nitrites, and secondly their oxidation to nitrates. The researches of Warington in England and Winogradsky on the Continent have satisfactorily shown that two distinct organisms are concerned in it, and that probably more than one species of each exists. One of them, comprising the genera *Nitrosomonas* and *Nitrosococcus*, has the power of oxidizing salts of ammonium to the condition of compounds of nitrous acid. When in a pure culture this stage has been reached, no further oxidation takes place. The oxidation of the nitrites into nitrates is effected by another organism, much smaller than the first. The name *Nitrobacter* has been given to this genus, most of our knowledge of which is due to the researches of Winogradsky.

The two kinds of organism are usually both present in the same soil, those of the second type immediately oxidizing the nitrites which those of the first form from ammonium salts. The *Nitrobacter* forms not only cannot oxidize the latter bodies, but they are very injuriously affected by the presence of free ammonia. When cultivated upon a suitable nutritive material in the laboratory, the organism was killed by the presence of ·015 per cent. of this gas, and seriously inconvenienced by one-third as much. Except in this respect, however, the two classes show great similarity. A very interesting peculiarity attaching to them is their distaste for organic nutriment. They can be cultivated most readily on masses of gelatinous silica impregnated with the appropriate compounds of nitrogen, and their growth takes place most copiously in the absence of light. They need a little carbonate in the nutrient material, and the source of the carbon which is found in the increased bulk of the plant is partly that and partly the carbon dioxide of the air.

We have in these plants a power which appears special to them, in the possession of some mechanism for the construction of organic substance which differs essentially from the chlorophyll apparatus of green plants, and yet brings about substantially similar results. The steps by which this carbon dioxide is built up into a compound capable of being assimilated by the protoplasm of the cells, are not known. The energy for the purpose appears to be supplied by the oxidation of the molecules containing nitrogen, so that it is dependent upon such oxidation taking place. Winogradsky has investigated this point with great care, and he has come to the conclusion that about 35 milligrammes of nitrogen are oxidized for each milligramme of carbon absorbed and fixed.

Deposition and Digestion of Reserve Materials in Plants and Animals.—As we have seen, the tendency of recent research is to prove the identity of the mode of nutrition of vegetable and animal organisms. The material on which they feed is of the same description, and its treatment in the body is precisely similar. In both groups we find the presence of nutritive material in two forms, one specially fitted for transport, the other for storage. In the plant the intermittent processes of its manufacture from the raw materials absorbed lead to the accumulation of a constantly increasing surplus, which is continuously being removed from the seats of its construction and deposited for longer or shorter periods in other parts of the structure, usually near the regions at which its ultimate consumption will take place. We have the deposition of starch, aleurone grains, amorphous proteids, fats, &c. &c., in the neighbourhood of growing points, cambium rings, and phellogens; also the more prolonged storage in tubers, seeds, and other reproductive bodies. Turning to the animal, we meet with similar provisions in the storage of glycogen in the liver and other parts, of fat in various internal regions, and so on. In both we find the reserve of food, so far as it is in excess of immediate need, existing in two conditions, the one suitable for transport, the other for storage, and we see continually the transformation of the one into the other. The formation of the storage form at the expense of the travelling stream is due to the activity of some protoplasmic structure—it may be a plastid or the general protoplasm of the cell—and is a process of secretion. The converse process is one of a true digestion, which deserves the name no less because it is intracellular. We find processes of digestion strictly comparable to those of the alimentary canal of an animal in the case of the insectivorous *Nepenthes, Drosera*, and other similar plants, and in the saprophytic Fungi. Those which now concern us recall the utilization of the glycogen of the liver, the stored fats and proteids of other parts of the animal body, being like them intracellular.

Enzymes.—The agents which effect the digestive changes in plants have been studied with much care. They have been found to be mainly enzymes, which are in many cases identical with those of animal origin. A vast number of them have been discovered and investigated, and the majority call for a brief notice. Their number, indeed, renders it necessary to classify them, and rather to look at groups of them than to examine them one by one. They are usually classified according to the materials on which they work, and we may here notice especially four principal groups, the members of which take part in the digestion of reserve materials as well as in the processes of external digestion. These decompose respectively carbohydrates, glucosides, proteids, and fats or oils. The action of the enzyme in nearly every case is one of hydration, the body acted on being made to take up water and to undergo a subsequent decomposition.

Among those which act on carbohydrates the most important are: the two varieties of *diastase*, which convert starch into maltose or malt sugar; *inulase*, which forms fructose from inulin; *invertase*, which converts cane sugar into glucose (grape sugar) and fructose; *glucase* or *maltase*, which produces grape sugar from maltose; and *cytase*, which hydrolyses cellulose. Another enzyme which does not appear to be concerned with digestion so directly as the others is *pectase*, which forms vegetable jelly from pectic substances occurring in the cell-wall.

The enzymes which act upon glucosides are many; the best known are *emulsin* and *myrosin*, which split up respectively *amygdalin*, the special glucoside of certain plants of the *Rosaceæ*; and *sinigrin*, which has a wide distribution among those of the *Cruciferæ*. Others of less frequent occurrence are *erythrozym*, *rhamnase*, and *gaultherase*.

The proteolytic enzymes, or those which digest proteids, are usually divided into two groups, which are represented by the *pepsin* of the stomach of the higher animals and the *trypsin* of their pancreatic juice. The differences between them have recently been shown to be of degree rather than of kind. It is not quite certain whether a pepsin exists in plants, but many trypsins have been discovered. Among them we have the *papäin* of the Papaw fruit (*Carica Papaya*), the *bromelin* of the Pine-apple, and the enzymes present in many germinating seeds, in the seedlings of several plants, and in other parts. Another enzyme, *rennet*, which in the animal body is proteolytic, is frequently met with in plants, but its function has not been ascertained.

The digestion of fat or oil has not been adequately investigated, but its decomposition in germinating seeds has been found to be due to an enzyme, which has been called *lipase*. It splits it into a fatty acid and glycerine, but seems to have no further action. The details of the further transformations have not yet been completely followed.

Oxidases.—Another class of enzymes has been discovered in both animals and plants, but they do not apparently take any part in digestion. They set up a process of oxidation in the substances which they attack, and have consequently been named *oxidases*. Very little is known about them.

In many cases the digestion of reserve food materials is effected by the direct action of the protoplasm, without the intervention of enzymes. This property of living substance can be proved in the case of the cells of the higher plants, but it is especially prominent in many of the more lowly organisms, such as the *Bacteria*. The processes of putrefaction may be alluded to as affording an instance of such a power in the vegetable organisms. At the same time, it must be remembered that the secretion of enzymes by Bacteria is of widespread occurrence.

Supply and Distribution of Energy in Plants.—Since about 1880 considerable attention has been directed to the question of the supply, distribution, and expenditure of energy in the vegetable kingdom. This is an extremely important question, since the supply of energy to the animal world has been found to depend entirely upon the vegetable one. The supply of energy to the several protoplasts which make up the body of a plant is as necessary as is the transport to them of the food they need; indeed, the two things are inseparably connected. The source of energy which is the only one accessible to the ordinary plant as a whole is the radiant energy of the rays of the sun, and its absorption is mainly due to the properties of chlorophyll. This colouring matter, as shown by its absorption spectrum, picks out of the ordinary beam of light a large proportion of its red and blue rays, together with some of the green and yellow. This energy is obtained especially by the chloroplastids, and part of it is at once devoted to the construction of carbohydrate material, being thus turned from the kinetic to the potential condition. The other constructive processes, which are dependent partly upon the oxidation of the carbohydrates so formed, and therefore upon an expenditure of part of such energy, also mark the storage of energy in the potential form. Indeed, the construction of protoplasm itself indicates the same thing. Thus even in these constructive processes there occurs a constant passage of energy backwards and forwards from the kinetic to the potential condition, and *vice versâ*. The outcome of the whole round of changes, however, is the fixation of a certain part of the radiant energy absorbed by the chlorophyll. The rays of the visible spectrum do not supply all the energy which the plant obtains. It has been suggested by several botanists, with considerable plausibility, that the ultra-violet or chemical rays can be absorbed and utilized by the protoplasm without the intervention of any pigment such as chlorophyll. There is some evidence pointing to the existence of this power in the cells of the higher plants. Again, we have evidence of the power of plants to avail themselves of the heat rays. There is no doubt a direct interchange of heat between the plant and the air, which in many cases results in a gain of heat by the plant. Indeed, the tendency to absorb heat in this way, either from the air or directly from the sunlight, has already been pointed out as a danger which needs to be averted by transpiration.

There is probably but little transformation of one form of kinetic energy into another in the plant. It has been suggested that the red pigment *anthocyan*, which is found very commonly in young developing shoots, petioles, and midribs, effects a conversion of light rays into heating ones, so facilitating the metabolic processes of the plant. This is, however, rather a matter of speculation. The various electrical phenomena of plants also are obscure.

Certain plants possess another source of energy which is common to them and the animal world. This is the absorption of elaborated compounds from their environment, by whose decomposition the potential energy expended in their construction can be liberated. Such a source is commonly met with among the Fungi, the insectivorous plants, and such of the higher plants as have a saprophytic habit. This source is not, however, anything new, for the elaborated compounds so absorbed have been primarily constructed by other plants through the mechanism which has just been described.

The question of the distribution of this stored energy to the separate protoplasts of the plant can be seen to be the same problem as the distribution of the food. The material and the energy go together, the decomposition of the one in the cell setting free the other, which is used at once in the vital processes of the cell, being in fact largely employed in constructing protoplasm or storing various products. The actual liberation in any cell is only very gradual, and generally takes the form of heat. The metabolic changes in the cells, however, concern other decompositions side by side with those which involve the building up of protoplasm from the products on which it feeds. So long as food is supplied, the living substance is the seat of transformations which are continually proceeding, being partially decomposed, and again constructed, the new food being incorporated into it. The changes involve a continual liberation of energy, which in most cases is caused by the respiration of the protoplasm and the oxidation of the substances it contains. The need of the protoplasm for oxygen has already been spoken of: in its absence death soon supervenes, respiration being stopped. Respiration, indeed, is the expression of the liberation of the potential energy of the protoplasm itself. It is not certain how far substances in the protoplasm are directly oxidized without entering into the composition of the living substance, though this appears to take place. Even their oxidation, however, is effected by the protoplasm acting as an oxygen carrier.

The supply of oxygen to a plant is thus seen to be as directly connected with the utilization of the energy of a cell as is that of food concerned in its nutrition. If the access of oxygen to a protoplast is interfered with, its normal respiration soon ceases, but frequently other changes supervene. The partial asphyxiation or suffocation stimulates the protoplasm to set up a new and perhaps supplementary series of decompositions, which result in the liberation of energy just as do those of the respiratory process. One of the constant features of respiration, the exhalation of carbon dioxide, can still be observed. This comes in almost all such cases from the decomposition of sugar, which is split up by the protoplasm into alcohol and carbon dioxide. Such decompositions are now generally spoken of as *anaërobic* respiration. The decomposition of the complex molecule of the sugar liberates a certain amount of energy, as can be seen from the study of the fermentation set up by yeast, which is a process of this kind, in that it is intensified by the absence of oxygen. The liberated energy takes the form of heat, which raises the temperature of the fermenting wort. It has been ascertained that in many cases this decomposition is effected by the secretion of an enzyme, which has been termed *zymase.* This body has been prepared from active yeast, and from fruits and other parts which have been kept for some time in the absence of oxygen. The protoplasm appears to be able also to bring about the change without secreting any enzyme.

The Ascent of Water in Trees.—Little advance has been made in the solution of the problem of the ascent of water in tall trees. About 1880 two views were held by different botanists: one was that the water travels in the woody cell-walls of the vascular bundles, mainly under the action of the forces of root-pressure and transpiration, and that the cavities of the vessels contain only air. The other was that the vessels are not empty, but that the water travels in their cavities, which contain columns of water in the course of which are large bubbles of air. On this view the water flows upwards under the influence of variations of pressure and tension in the vessels. Neither hypothesis is satisfactory, and others have been advanced to supplement them, which have more or less weight. Westermaier and Godlewski put forward the view that the living cells of the medullary rays of the wood, by a species of osmosis, act as a kind of pumping apparatus, by the aid of which the water is lifted to the top of the tree, a series of pumping-stations being formed. Though this at first met with some acceptance, Strasburger showed that the action goes on in long lengths of stem the cells of which had been killed by poison or by the action of heat. More recently, Dixon and Joly in Dublin and Askenasy in Germany have suggested the action of another force. They have shown that columns of water of very small diameter can so resist tensile strain that they can be lifted bodily instead of flowing along the channel. They suggest that the forces causing the movement are complex, and draw particular attention to the pull upwards in consequence of disturbances in the leaves. In these we have (1) the evaporation from the damp delicate cell-walls into the intercellular spaces; (2) the imbibition by the cell-wall of water from the vacuole; (3) osmotic action, consequent upon the subsequent increased concentration of the cell sap, drawing water from the wood cells or vessels which abut upon the leaf parenchyma. They do not, of course, deny the co-operation of the other forces which have been suggested, except so far as these are inconsistent with the motion of the water in the form of separate columns rather than a flowing stream. This view requires the existence of certain anatomical arrangements to secure the isolation of the separate columns, and cannot be said to be fully established.

Nervous System of Plants.—Researches made upon the relationship of plants to their environment have been marked by definite results. In this direction, also, there has been a closer approximation of the plant to the animal. The indications of definite sense organs by which particular stimulations were appreciated, or which were said to be the seats of particular irritabilities, had been suggested by 1880, and a few cases were established. It had been shown that the root-tip is sensitive to watery vapour, and turns towards it as growth goes on. This fact has been confirmed and our knowledge of such phenomena extended. The root-tip has been shown to be sensitive to many forms of stimulation. The growing apex of some stems has been shown to have the power of appreciating light, and many parts have been proved to be capable of receiving impressions of contact, or of responding to chemical stimulation. The effect of these various forms of stimulation has been found to be the production of a purposeful response, generally taking the form of a movement of some part of the plant, which is usually situated at some distance from the sensitive part. We have evidence, indeed, of a rudimentary nervous system in which such parts play the *rôle* of organs of special sense, which are clearly differentiated physiologically though not anatomically. The conduction of such stimulation to parts removed some distance from the sense organ suggests paths of transmission comparable to those which transmit nervous impulses in animals. Again, the degree of differentiation is very slight anatomically, but delicate protoplasmic threads have been shown to extend through all cell-walls, connecting together all the protoplasts of a plant. These may well serve as conductors of nervous impulses. The nervous mechanism thus formed is very rudimentary, but in an organism the conditions of whose life render locomotion impossible great elaboration would seem superfluous. There is, however, very great delicacy of perception or appreciation on the part of the sense organ, stimuli being responded to which are quite incapable of impressing themselves upon the most highly differentiated animal.

The power of response is seen most easily in the case of young growing organs, and the parts which show the motor mechanism are mainly the young growing cells. We do not find their behaviour like that of the motor mechanism of an animal. The active contraction of muscular tissue has no counterpart in the plant. The peculiarity of the protoplasm in almost every cell is that it is especially active in the regulation of its permeability by water. Under different conditions it can retain it more strongly or allow it to escape more freely. This regulation of turgor is as characteristic of vegetable protoplasm as contraction is of muscle. The response to the stimulus takes the form of increasing the permeability of particular cells of the growing structures, and so modifying the degree of the turgidity that is the precursor of growth in them. The extent of the area affected and of the variation in the turgor depends upon many circumstances, but we have no doubt that in the process of modifying its own permeability by some molecular change we have the counterpart of muscular contractibility.

Organic Rhythm.—It is a remarkable fact that during the process of growth we meet with rhythmic variation of such turgidity. The existence of rhythm of this kind has been observed and studied with some completeness. It is the immediate cause of the phenomena of circumnutation, each cell of the circumnutating organ showing a rhythmic enlargement and decrease of its dimensions, due to the admission of more and less water into its interior. The restraint of the protoplasm changes gradually and rhythmically. The sequence of the phases of the rhythm of the various cells are co-ordinated to produce the movement. Nor is it only in growing organs that the rhythm can be observed, for many plants exhibit it during a much longer period than that of growth. It is easy to realize how such a rhythm can be modified by the reception of stimuli, and can consequently serve as the basis for the movement of the stimulated organ. This rhythmic affection of vegetable protoplasm can be observed in very many of its functions. What have been described as "periodicities," such as the daily variations of root-pressure, afford familiar instances of it. It reminds us of a similar property of animal protoplasm which finds its expression in the rhythmic beat of the heart and other phenomena.

AUTHORITIES.—SACHS. *Lectures on the Physiology of Plants*, translated by Marshall Ward.—VINES. *Lectures on the Physiology of Plants.*—PFEFFER. *The Physiology of Plants*, translated by Ewart.—REYNOLDS GREEN. *Introduction to Vegetable Physiology: The Soluble Ferments and Fermentation.*—DETMER. *Practical Plant Physiology*, translated by Moor.—DARWIN and ACTON. *Practical Physiology of Plants.*—DAVENPORT, C.B. *Experimental Morphology*, vols. i. and ii.—VERWORN. *General Physiology*, translated by Lee.—BÜTSCHLI. *Investigation on Microscopic Forms and on Protoplasm*, translated by Minchin. (J. R. GR.)

Piacenza (in French *Plaisance*), a fortified town, bishop's see, and capital of the province of Piacenza, Emilia, Italy, on the right bank of the Po, just below the confluence of the Trebbia, 91 miles north-west of Bologna by rail. The public library contains 120,000 volumes, valuable MSS., and numismatic and other collections, amongst them the "finds" of the ancient *Velleia*, 6 miles to the east, which was overthrown by a landslip in 370. Piacenza has an arsenal, a technical school, an arts school, and various industries—iron and brass works, foundries, silk-throwing, manufactures of cardboard boxes, casks and tubs, and hosiery, flour-mills, and printing. It is also an important administrative and military station. Population (1881), 34,987; (1900), 36,064.

Piano.—Since 1885, when the article PIANOFORTE in vol. xix. of this work was published, and the Inventions and Music Exhibition at South Kensington took place, there are few changes of piano structure to record, such as were conspicuous in the interval which had followed the Paris Exhibition of 1867, with the exception of one in metal framing which will be described later. Since 1885 the American system of a metal plate in one casting, and cross- or over-stringing by which the spun bass strings cross the longer steel diagonally, has become general in Europe with the exception of France, where musical taste has remained constant to the older wooden structure and parallel stringing throughout. The greater tenacity of the modern cast-steel wire favours a very much higher tension, and consequent easier production of the higher partials of the notes, permitting a *sostenuto* unknown to Beethoven, Schumann, or Chopin. While in 1862 the highest tension of a concert grand piano worked out at sixteen tons, since 1885 thirty tons has been recorded. Generally speaking, the rise in tension may be expressed musically by the interval of a minor third, to the great advantage of the standing in tune. First shown by the late Henry Steinway in the London Exhibition of 1862, this altered construction attracted extraordinary attention at Paris in 1867, and determined the German direction of manufacture and a few years later the English. What is now particularly noticeable wherever pianos are made, is the higher average of excellence attained in making, as well as in piano-playing. Naturally the artistic quality, the personal note, characterizes all first-class instruments, and permits that liberty of choice which appertains to a true conception of art.

Structural changes.

Much attention has been given of late years to the touch of pianos, to make it less tiring for the modern manipulator, especially since, in 1885–86, Anton Rubinstein went through the herculean feat of seven historical recitals, played consecutively in the capital cities and principal musical centres of Europe. For even this stupendous player a light touch was indispensable. In the competition for power, piano-makers had been gradually increasing the weight of touch to be overcome by the finger, until, to obtain the faintest pianissimo from middle C, at the front edge of the key, from three to four ounces was a not uncommon weight. The Broadwood grand piano which Chopin used for his recitals in London and Manchester in 1848 an instrument that has never been repaired or altered, shows the resistance he required: the middle C sounds at two ounces and a half, and to that weight piano-makers have returned, regarding two ounces and three-quarters as a possible maximum. Owing to the greater substance of the hammers in the bass, the touch will always be heavier in that department, and lighter in the treble from the lesser weight. The shorter leverage of the black keys has of course to be adjusted in balancing to the longer white, the so-called natural, keys. When the player touches the keys farther back, the leverage is proportionately shortened and the weight increased, and there is also an ascending scale in the weight of the player's blow up to the fortissimo sought for. The sum of the aggregate force expended by a pianist in a recital of an hour and a half's duration, if calculated, would be astonishing.

The one important structural change in pianos referred to has been the rejection of support given by metal bars or struts between the metal plate to which the strings are hitched and the wrestplank wherein the tuning-pins are inserted. These bars (see PIANOFORTE, vol. xix.) formed part of William Allen's invention, brought forward by Stodart in 1820, and were first employed for rigidity in place of compensation by the Paris Érards two years later, Broadwood in London introducing about that time the fixed metal plate. The patent, No. 1231, for the barless or open-scale piano, taken out in London in 1888 by H. J. Tschudi Broadwood, is remarkable for simplification of design as well as other qualities.

The increase of resonance.

The problem of resonance—with stringed keyboard instruments, the reinforcement or amplification of sound—has, from the days of the lute- and spinet-makers, been empirical. With lute, guitar, and viol or violin the sound-box comes in, combining in the instrument the distinct properties of string and enclosed air or wind. With the spinet, harpsichord, and piano we have to do chiefly with the plate of elastic wood, to amplify the initial sound of the strings; and the old plan of a thin plate of spruce, put in slightly convex and with an under-barring of wood for tension, has absorbed the attention of piano-makers. The violin belly, with its bass bar and sound post, has relation to it; but the recent invention of the Stroh violin has shown us that the initial string vibrations may be passed through a bridge, be concentrated, and adequately transferred to an aluminium disc not much larger than half a crown. The piano, with its numerous strings, cannot be so reduced, but the reinforcement problem is open to another solution, tentative it is true, but a possible rival. The "Gladiator" soundboard is the invention of Albert Schulz, late director of the piano manufactory of Ritmüller und Söhn of Göttingen. Dr Moser's name has been associated with the inventor's

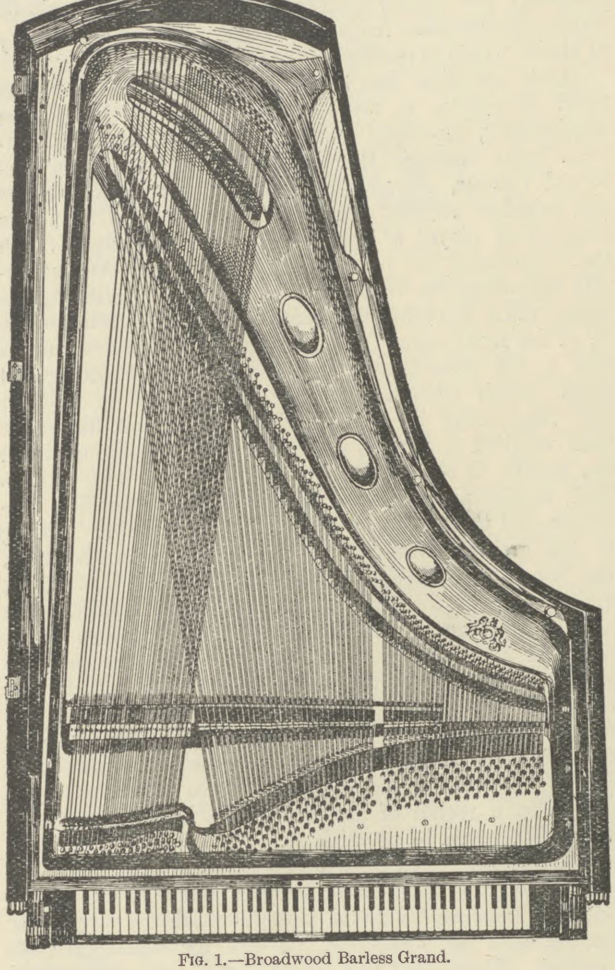


FIG. 1.—Broadwood Barless Grand.

in the English patent. In the "Gladiator" two slabs of wood, with grain of opposed direction to give the necessary tension, are glued together, and the whole system of belly bars is done away with. There is a thinning round the edge, to facilitate promptness of speech. As we are still feeling our way towards an accurate and comprehensive statement of resonance, this invention is one claiming scientific interest, as well as being of possible practical importance.

Repetition.

To return to the touch. The desirability of what is called repetition—that the jack or sticker, which from the depression of the key delivers the blow that raises the hammer to the strings, should never be far away from the notch or nose which receives the impulse—is as much an object of consideration with piano-makers now as it has been since Sebastian Érard began those experiments in 1808 which ended in his famous "double escapement" action. The principle of this grand action, like that of Wornum patented for upright pianos in 1826, has become general. But Joseph Henry Cary in 1853 (patent No. 2283) invented a simple contrivance for repetition in all pianos, neglected at the time, and subsequently repatented and disputed over by others, which has only been preserved in the records of the Patent Office, while the inventor has left no other mark. But the utility of the invention has come to light. It is increasingly used in the actions of upright pianos, and, in combination with the old English grand action (vol. xix. p. 74, Fig. 24), is successfully competing with the Érard action proper, and the simplified Herz-Érard, of late years so very generally employed.

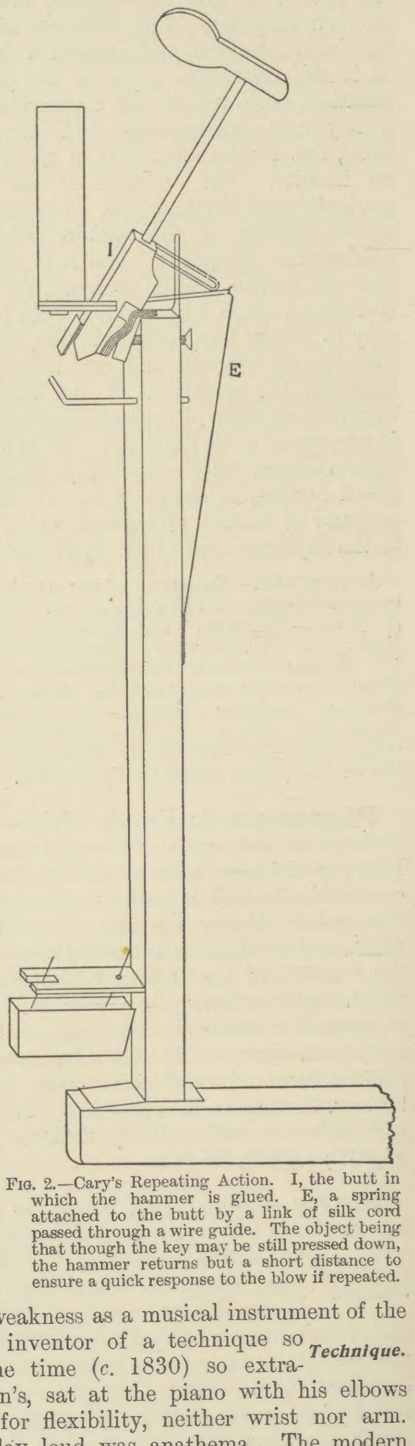


FIG. 2.—Cary's Repeating Action. I, the butt in which the hammer is glued. E, a spring attached to the butt by a link of silk cord passed through a wire guide. The object being that though the key may be still pressed down, the hammer returns but a short distance to ensure a quick response to the blow if repeated.

Technique.

There has been a great change in the freer technique of piano-playing, partly favoured by the development of piano-making, but reacting and obliging the piano-makers to keep their attention incessantly alive to the aim and requirements of the players. It is true that the genius of Beethoven dominates a technique that has become obsolete, and so completely that the adequate performance of his piano works still gives to the sense as well as the intellect the highest pleasure, but his annotations to Cramer's *Studies*, as preserved by Schindler, betray the close touch of the clavichord-player and the student of C. P. E. Bach's *Essay on Clavichord-Playing*, as well as the weakness as a musical instrument of the early piano. The inventor of a technique so original, and at the time (*c.* 1830) so extraordinary, as Chopin's, sat at the piano with his elbows immovable, using, for flexibility, neither wrist nor arm. With Chopin, to play loud was anathema. The modern free style of playing comes from Czerny—whom Beethoven despised as having no legato (*Bildung*),—through Liszt to the Rubinsteins, and to the splendidly equipped performers of our time, to whom the pedal has become indispensable for cantabile and effect.

These great performers are, however, rivalled technically by the recent extraordinary invasion of the American automatic piano-players—the Angelus, Pianola, Apollo, Cecilian, and other varieties of the same idea. The use of the perforated roll acts by means of the ingenious and indeed faultless application of pneumatic leverage to the ordinary piano, doing duty for the pianist's fingers; and it is made possible to play louder or softer, faster or slower, by mechanical arrangement. Such an instrument lacks the player's touch, which is as personal and indispensable for sympathy as the singer's voice or violinist's bow. Still, to a violinist, it is a benefit to have a correct coadjutor in a Beethoven or Brahms sonata with one of these handy companions, just as it is to a singer to have always at command the accompaniments to his or her repertory. The Apollo has the addition of a useful transposing apparatus—an aid, however, that, though often tried, has never yet been adopted; it is possibly too disturbing to the musician's ear. The mechanical tuning-pin is an analogous experiment which comes regularly under notice as the years go by, to be as persistently rejected. The most practical of these tuning inventions was the Alibert, shown in the Inventions Exhibition, 1885. Here, pressure upon the strings above the wrestplank bridge modified their tension after a first rough adjustment to pitch had been effected.

Mechanical playing.

The perforated music-sheet, a mechanism common to piano-playing attachments as well as self-playing pianos, first appears in a French patent, 1842. A United States patent for a keyboard piano-player was issued to E. D. Bootman, 18th December 1860, and the first pneumatic keyboard piano-player was patented in France in 1863 by M. Fourneaux. Between 1879 and 1902 a total of 55 patents had been issued in the States. The first complete automatic piano-player ready for performance was the Angelus (No. 24799, 1897). The specification is from a communication to the British Patent Office by Edward Hollingworth White, of Meriden, New Haven, Connecticut, U.S.A. There is a pneumatic chest, fulcrum bar, finger levers, bellows, and pedals. The whole apparatus is contained in a portable cabinet mounted upon castors, so as to be conveniently moved about a room. The finger levers or key strikers correspond with a considerable portion of the manual keys or clavier of a piano. Thus the automatic piano-player comprises a portable cabinet provided with bellows and operating pedals, a pneumatic actuating mechanism, a tracker adjusted for the use of a perforated music-sheet, a pneumatic motor and winding-roll mechanism to propel the music-sheet, and a series of finger levers operated by the pneumatic mechanism, so projecting as to overhang the piano keyboard and play upon it, with rockers or levers for depressing the piano pedals. Subsequently the apparatus was made capable of accelerating or retarding the tempo at the will of the operator. A roll of music, twelve inches wide and varying in length according to the composition, can be placed in position promptly, and when exhausted can be returned upon its original roll by a simple stop, altogether a triumph of mechanical adjustment. The Pianola followed in 1898, the Apollo 1900. The difference of all these clever contrivances is not conspicuous to the amateur.

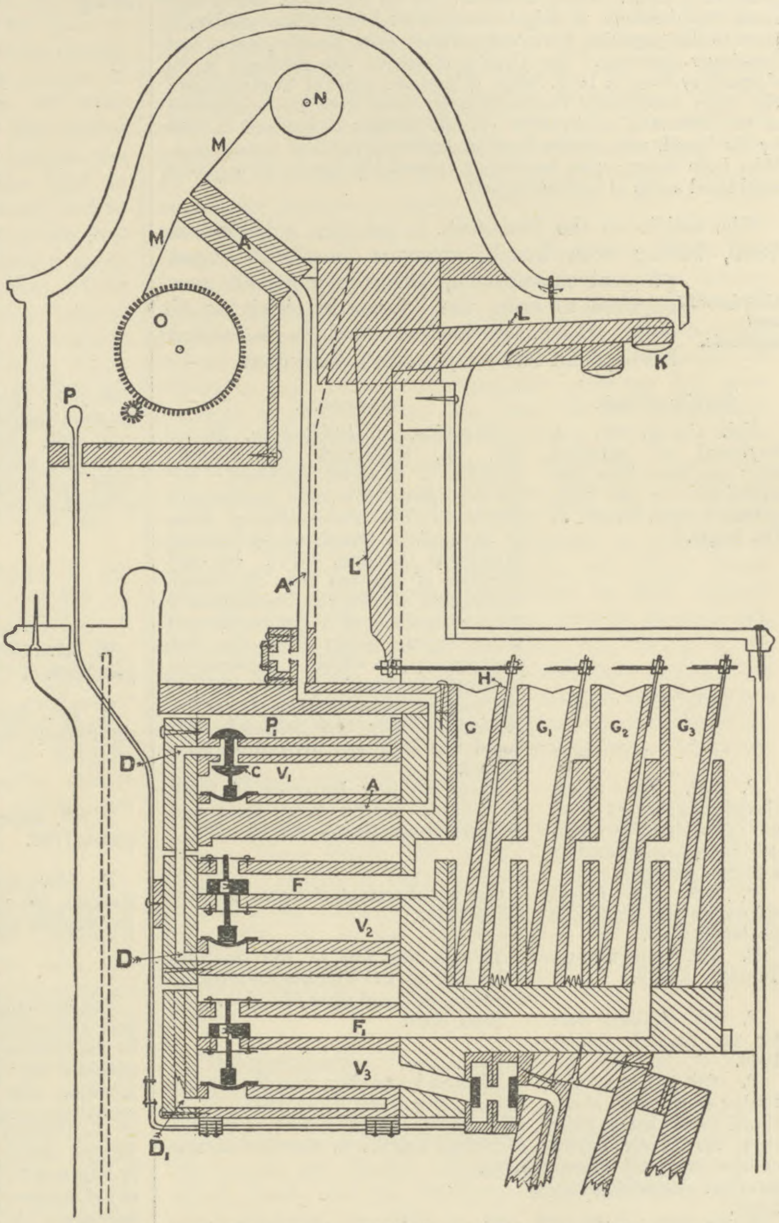


Fig. 3.—Sectional plan of Pianola. MM is the perforated paper, carried on a roll N, and wound upon another roll O by the action of a pneumatic motor. When a perforation comes opposite the orifice of A, the suction bellows in the base of the machine, worked from a treadle by the player's feet, draw in a puff of air which passes along A to the mushroom valve C. The chamber V_1, being in connexion with the suction bellows, is at less than atmospheric pressure, and the result of the air arriving along A is that C rises from its seat. Thereupon communication is opened from the chamber P_1, which is at atmospheric pressure, along the channel D to a second valve E, the chamber above which, V_2, is also under suction. Hence E also rises and opens a way from V_2 by the passage F to the collapsing bellows G; the air-pressure in these being thus reduced, the back H moves to the left, communicating its motion through the lever L to the finger K, which strikes the key of the piano. Similar mechanism, including a mushroom-valve, a secondary pneumatic-valve (of which another may be seen at E_1 in connexion with the passage F_1), and collapsing bellows, as at G_1, G_2, G_3, are provided corresponding to each note of the piano. The time is altered by regulating the suction on the pneumatic motor which unwinds the perforated roll, so that it runs more quickly or slowly as desired. Changes in loudness are attained by means of a handle, P, operating on valves, which increase or diminish the suction in the bellows G, G_1, &c., and therefore the force with which they collapse.

While these allied inventions have had to do with a substitute for touch and the necessity for the persevering acquirement of a difficult technique, another, the Virgil Practice Clavier, so called after the inventor, Mr Almon Kincaid Virgil, an American music teacher, is intended to shorten the period of study by doing away with tone, so that the finger technique is acquired mechanically and unmusically, while value of tone, reading, expression, whatever we understand by musical production exciting our receptivity through the ear, is delayed until the player's hand is formed and considerably developed. The opinion of some of the very greatest pianists is brought forward as approving of the system; in the work, for instance, of Vladimir de Pachmann, whose technique was formed long before the Virgil Clavier came to Europe. Bearing in mind that the minimum weight of the touch of a concert piano is not likely to exceed three and a half ounces, it is hardly likely that these skilled performers use this dumb keyboard with the graduated weight advised for advancing pupils, namely, from five to eight ounces. It is allowed that the lightest possible touch may be used at first. One high recommendation certainly remains after all that may be said regarding Mr Virgil's invention: that it is practically silent, almost noiseless, the up and down clicks that mark the duration of finger attachment being alone audible, a boon to the unwilling hearers of ordinary piano practice, scales, and five-finger exercises. Mr Virgil's invention was produced in its elementary form in 1872, when it bore the name of Techniphone; the more satisfactory Practice Clavier dates from the completion of the invention, about 1890. It was brought to England in 1895 by Mr Virgil, who, assisted by an American pupil of great talent, Miss Julie Geyer, made his theory extensively known by a widely conducted series of lecture-recitals.

The dumb keyboard.

The article on the Pianoforte in vol. xix., published in 1885, having been based, wherever practicable, upon personal examination, few corrections are now required to bring the information in it up to date. Some are, however, due to the record having been less complete then than now.

Corrigenda and addenda.

Earlier Article.	*Corrections.*
Vol. xix. p. 65^{a}. A keyboard of balanced keys may have been first introduced in the little portable organ known as the Regal.	Vitruvius, *de Architectura*, lib. x. cap. xi., translated by Newton, describes a balanced keyboard; but the key apparatus is more particularly shown in *The Pneumatics of Hero of Alexandria*, translated by Bennett Woodcroft (London, 1851). In confirmation of this has been the recent remarkable discovery at Carthage of a terra-cotta model of a Hydraulikon or water organ, dating from the 2nd century A.D., in which a presumably balanced keyboard, if not two, of eighteen or nineteen keys, is shown. It seems likely the balanced keyboard was lost, and afterwards reinvented.
P. 66^{b}. The oldest clavichords extant have no more than two tangents to a note, formed by a pair of strings.	There are now instances of small clavichords having three keys and tangents to one pair of strings.
P. 68^{a}. The oldest spinet we can point out (is dated) 1523.	One was shown at Bologna in 1888 dated 1480.
P. 68^{b}. Spinetta Tavola. Fig. 9.	This is now one of the treasures belonging to the Victoria and Albert Museum, S. Kensington, London.
P. 68^{b}. Earliest date for an English spinet, 1668.	Read 1664.
P. 69^{b}. From the tuning of Handel's clavichord we are led to infer that the nearer halves of the two cut sharps were the chromatic semitones.	We now know they were the further halves; the nearer being employed for the major thirds below, *i.e.*, the dominant fourths to the next natural keys.
P. 69^{a}. Thomas Hitchcock, for whom we have a date 1703.	We have also an early date for him, 1664.
P. 69^{b}. There is an existing example, dating as early as 1526, with the bass keys carried out in long measure.	This date should be 1626—unfortunately this interesting keyboard has been altered by a restorer.
P. 69^{b}. Cristofori . . . the single keyboard.	In the harpsichord Cristofori made for Prince Ferdinand dei Medici in 1702, recently acquired by Mr Stearns, of Detroit, and presented by him to the University of Michigan, U.S.A., there are three keyboards, thus arranged: 1st, highest keyboard, octave string only; 2nd, middle, octave and first unison; 3rd, lowest, both unisons. A harpsichord similarly designed with three keyboards, inscribed Vincentius Sodi Florentinus, Anno Domini 1779, has been presented by Mrs John Crosby Brown to the Metropolitan Museum, New York.
P. 70^{a}. Hans Ruckers . . . we may not withhold from him the credit of introducing the octave string.	The octave string was already in use when Hans Ruckers began his work. The harpsichord as known throughout the 18th century, with piano upper and forte lower keyboard, was the invention of Hans Ruckers' grandson, Jean Ruckers' nephew, Jan Couchet, about 1640. Before that time the double keyboards in Flemish harpsichords were merely a transposing expedient, to change the pitch a fourth, from plagal to authentic and *vice versâ*, while using the same groups of keys. Fortunately there is a harpsichord existing with double keyboards unaltered, date 1638, belonging to Sir Bernhard Samuelson, formerly in the possession of the late Mr Spence, of Florence, made by Jean Ruckers, the keyboards being in their original position. It was not so much invention as beauty of tone which made the Ruckers' harpsichords famous.
P. 70^{b}. Handel had a Ruckers harpsichord.	It is now in Buckingham Palace.
P. 70^{b}. Two pedals were also used, the left-hand one a combination of a unison and lute.	This pedal, with the "machine" stop, reduced the upper keyboard to the lute register, the plectra of which acted upon the strings near the wrest-plank bridge only; the lower keyboard to the second unison. Releasing the machine stop and quitting the pedal restores the first unison on both keyboards and the octave on the lower.
P. 71^{b}. Cristofori pianoforte of 1720.	Is now in the Metropolitan Museum, New York, the gift of Mrs John Crosby Brown.
P. 72^{a}. Frederici upright piano, dated 1745.	An earlier upright grand piano has been discovered by Signor Ponsicchi, of Florence, made by Domenico del Mela, in 1739. The action is an adaptation of Cristofori's.
P. 72^{b}. Zumpe's square piano, 1766.	Fétis narrates that he began the study of the piano on a square piano made by Zumpe in 1762.
P. 73^{b}. Americus Backers, the inventor of the English action.	Backers' "Original Forte Piano" was played at the Thatched House in St James's Street, London, in 1773. Ponsicchi has found a Backers grand piano at Pistoia, dated that year.

The invention of the piano by Cristofori, and he alone, is now past discussion. What is still required to satisfy curiosity would be the discovery of a Fort Bien, or Frederici square piano, said to antedate by a year or two Zumpe's invention of the instrument in London. Also the "old movement" for the long or grand pianos, sometimes quoted in the Broadwood day-books of the last quarter of the 18th century with reference to replacement by the Backers English action. The store or lumber rooms of old country houses in England have produced many interesting and valuable examples of old keyboard instruments. The particular interest of the "old movement" is to see if it was Cristofori's, like the three Silbermann pianos at Potsdam. (A. J. H.)

Piatra, a town in Rumania (Moldavia), on the left bank of the river Bistritza, chief town of the district of Neamtz. It is the seat of a court of first instance, contains seven Orthodox churches, one Roman Catholic church, one Armenian church, and two synagogues. The town is connected with the railway system by a branch line from Bacau. The chief trade is timber and wine, and three fairs are held annually. There are several monasteries in the neighbourhood, namely, those of Bistritza, Bissericani, Pangaratzi, Bulhalmitza, Vinetori, and Almas. Population (1895), 18,000; (1901), 17,391.

Piatti, Carlo Alfredo, Italian violoncellist (1822–1901), born at Bergamo, 8th January 1822, was the son of a violinist and became a pupil at the Conservatorio of Milan. At the age of twelve he appeared at a school concert, and from 1838 onwards he journeyed over Europe, playing with extraordinary success in all the important cities of the Continent. In 1844 he appeared before the London public at a Philharmonic Concert; and in 1859, on the foundation of the Popular Concerts, he took up the work with which he was most intimately connected for thirty-nine seasons, retaining until 1897 the post of first violoncello at these famous chamber concerts, during the latter half of each series. His purely classical style of interpreting the music of the great composers, his wide musical sympathies, and his general culture and charm would have ensured him a high position even without the marvellously finished technical skill, which was kept so wonderfully under control that difficulties seemed not to exist for him. In 1894 the fiftieth anniversary of his first appearance in London was celebrated by a reception given in honour of him and his lifelong friend Joachim, whose first appearance in England was made in the same year as his own. He retired from public life, owing to a severe illness, in 1897, and from that time till his death, which occurred at Bergamo on 19th July 1901, he divided his time between his native town and Cadenabbia. As a composer he attained a wide popularity with his songs, in a popular and graceful style; he did excellent work as an editor; and he was, moreover, an enthusiastic collector and musical antiquary. (J. A. F. M.)

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The dumb keyboard.

Corrigenda and addenda.

The article on the Pianoforte in vol. xix., published in 1885, having been based, wherever practicable, upon personal examination, few corrections are now required to bring the information in it up to date. Some are, however, due to the record having been less complete then than now.

Earlier Article.	*Corrections.*
Vol. xix. p. 65a. A keyboard of balanced keys may have been first introduced in the little portable organ known as the Regal.	Vitruvius, *de Architectura*, lib. x. cap. xi., translated by Newton, describes a balanced keyboard; but the key apparatus is more particularly shown in *The Pneumatics of Hero of Alexandria*, translated by Bennett Woodcroft (London, 1851). In confirmation of this has been the recent remarkable discovery at Carthage of a terra-cotta model of a Hydraulikon or water organ, dating from the 2nd century A.D., in which a presumably balanced keyboard, if not two, of eighteen or nineteen keys, is shown. It seems likely the balanced keyboard was lost, and afterwards reinvented.
P. 66b. The oldest clavichords extant have no more than two tangents to a note, formed by a pair of strings.	There are now instances of small clavichords having three keys and tangents to one pair of strings.
P. 68a. The oldest spinet we can point out (is dated) 1523.	One was shown at Bologna in 1888 dated 1480.
P. 68b. Spinetta Tavola. Fig. 9.	This is now one of the treasures belonging to the Victoria and Albert Museum, S. Kensington, London.
P. 68b. Earliest date for an English spinet, 1668.	Read 1664.
P. 69b. From the tuning of Handel's clavichord we are led to infer that the nearer halves of the two cut sharps were the chromatic semitones.	We now know they were the further halves; the nearer being employed for the major thirds below, *i.e.*, the dominant fourths to the next natural keys.
P. 69a. Thomas Hitchcock, for whom we have a date 1703.	We have also an early date for him, 1664.
P. 69b. There is an existing example, dating as early as 1526, with the bass keys carried out in long measure.	This date should be 1626—unfortunately this interesting keyboard has been altered by a restorer.
P. 69b. Cristofori . . . the single keyboard.	In the harpsichord Cristofori made for Prince Ferdinand dei Medici in 1702, recently acquired by Mr Stearns, of Detroit, and presented by him to the University of Michigan, U.S.A., there are three keyboards, thus arranged: 1st, highest keyboard, octave string only; 2nd, middle, octave and first unison; 3rd, lowest, both unisons. A harpsichord similarly designed with three keyboards, inscribed Vincentius Sodi Florentinus, Anno Domini 1779, has been presented by Mrs John Crosby Brown to the Metropolitan Museum, New York.
P. 70a. Hans Ruckers . . . we may not withhold from him the credit of introducing the octave string.	The octave string was already in use when Hans Ruckers began his work. The harpsichord as known throughout the 18th century, with piano upper and forte lower keyboard, was the invention of Hans Ruckers' grandson, Jean Ruckers' nephew, Jan Couchet, about 1640. Before that time the double keyboards in Flemish harpsichords were merely a transposing expedient, to change the pitch a fourth, from plagal to authentic and *vice versâ*, while using the same groups of keys. Fortunately there is a harpsichord existing with double keyboards unaltered, date 1638, belonging to Sir Bernhard Samuelson, formerly in the possession of the late Mr Spence, of Florence, made by Jean Ruckers, the keyboards being in their original position. It was not so much invention as beauty of tone which made the Ruckers' harpsichords famous.
P. 70b. Handel had a Ruckers harpsichord.	It is now in Buckingham Palace.
P. 70b. Two pedals were also used, the left-hand one a combination of a unison and lute.	This pedal, with the "machine" stop, reduced the upper keyboard to the lute register, the plectra of which acted upon the strings near the wrest-plank bridge only; the lower keyboard to the second unison. Releasing the machine stop and quitting the pedal restores the first unison on both keyboards and the octave on the lower.
P. 71b. Cristofori pianoforte of 1720.	Is now in the Metropolitan Museum, New York, the gift of Mrs John Crosby Brown.
P. 72a. Frederici upright piano, dated 1745.	An earlier upright grand piano has been discovered by Signor Ponsicchi, of Florence, made by Domenico del Mela, in 1739. The action is an adaptation of Cristofori's.
P. 72b. Zumpe's square piano, 1766.	Fétis narrates that he began the study of the piano on a square piano made by Zumpe in 1762.
P. 73b. Americus Backers, the inventor of the English action.	Backers' "Original Forte Piano" was played at the Thatched House in St James's Street, London, in 1773. Ponsicchi has found a Backers grand piano at Pistoia, dated that year.

The invention of the piano by Cristofori, and he alone, is now past discussion. What is still required to satisfy curiosity would be the discovery of a Fort Bien, or Frederici square piano, said to antedate by a year or two Zumpe's invention of the instrument in London. Also the "old movement" for the long or grand pianos, sometimes quoted in the Broadwood day-books of the last quarter of the 18th century with reference to replacement by the Backers English action. The store or lumber rooms of old country houses in England have produced many interesting and valuable examples of old keyboard instruments. The particular interest of the "old movement" is to see if it was Cristofori's, like the three Silbermann pianos at Potsdam. (A. J. H.)

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A. T. Corfe, he went in 1839 to Germany to study under C. H. Rink, Tomaschek, and Reissiger. He was elected Reid Professor of Music in Edinburgh in 1844; but, owing to a disagreement with the authorities concerning the original intentions of the founder of the chair, he resigned in the following year, and definitely adopted Germany as his country about the same time, making the change in his names noted above. His two operas, *Leila* (Hamburg, 1848) and *Contarini* (Hamburg, 1872), have not retained their hold upon the German public as his music to *Faust* has done, a work which, until quite recently, was frequently associated with Goethe's drama. He was never recognized in England as he was in Germany, for the most important part of his career fell in the period of the Mendelssohn fashion, when not to imitate that master was to court disaster, and not to admire his methods and mannerisms was to ensure neglect. His most important work was the oratorio *Jerusalem*, produced at the Norwich Festival of 1852, and subsequently given in London (Sacred Harmonic Society, 1853) and Würzburg (1862). For the Norwich Festival (at one of the meetings a selection from his *Faust* music was given with success) he began an oratorio, *Hezekiah*, in 1869; it was not finished, but was given in a fragmentary condition at the festival of that year. These two large works and a number of Pierson's songs, as well as the three overtures played at the Crystal Palace, reveal undeniable originality and a wealth of melodic ideas. His critics were right in pronouncing him weak in contrapuntal skill, and his music no doubt was sadly wanting in outline and coherence; but in a more favourable atmosphere and in more fortunate conditions his great natural gifts might have been turned to better artistic account, and have made a more lasting mark upon the art of his time. He died at Leipzig, 28th January 1873, and was buried at Sonning, Berks, of which parish his brother, Canon Pearson, was rector. (J. A. F. M.)

Pietermaritzburg, capital of Natal, South Africa, situated about 40 miles north by west of Durban by rail, at an elevation of 2200 feet above the level of the sea. The town was laid out by the Boers in 1839, and takes its name from their leaders, Pieter Retief and Gert Maritz. In 1898 the population was 24,535, comprising 14,015 Europeans, 6967 natives, and 3553 Indians. The town compares favourably, as regards health and climate, with any other in South Africa. The mean temperature for the year is 64·9°, for February 71·8°, for July 55·7°. Its town hall, destroyed by fire in 1898, has been rebuilt, and there are handsome Government and Parliament buildings. The town is well lit by electricity. An extensive park, botanical gardens, and good swimming-baths are attractive features.

Pigeon Post.—Ever since the time of King Solomon, historical examples can be found of the use of pigeons to carry messages, but their extended use in modern times dates from the siege of Paris in the Franco-Prussian war of 1870–71. For a trustworthy system of communication by means of these birds, it is generally recognized that careful organization and preliminary training must first be established; but, in spite of the absence of all such arrangements, it was found possible to send a hundred and fifty thousand official messages, and a million private ones, into Paris during the siege. Soon afterwards numerous private societies were established for keeping pigeons of this class in all important European countries; and, in time, various governments recognized the importance of the subject, and established systems of communication for military purposes by pigeon post. When the possibility of using the birds between military fortresses had been thoroughly tested, attention was turned to their use for naval purposes, to send messages between coast stations and ships at sea; and at the present date most great Powers propose to employ them both for naval and military purposes. They are also found of great use by news agencies and private individuals. Governments have in several countries established lofts of their own. Laws have been passed making the destruction of such pigeons a serious offence; premiums to stimulate efficiency have been offered to private societies, and rewards given for destruction of birds of prey. It has also been found of great importance to establish registration of all birds. In order to hinder the efficiency of the systems of foreign countries, difficulties have been placed in the way of the importation of their birds for training, and in a few cases falcons have been specially trained to interrupt the service in war time.

Results of experiments differ very much, according to the conditions under which they were undertaken, and it is therefore impossible to lay down any rigid rules as to what pigeons can or cannot do, but it is possible to arrive at a general idea of what may be expected in average cases. Birds employed for such work in Great Britain are usually known as homing pigeons. The best are bred in Belgium, where private societies and owners are very numerous, much encouragement is given, and many races are organized. The Belgian homers are crossed with local breeds in various countries, with successful results. The best sort of bird to suit climatic conditions is soon arrived at, the pigeons best adapted for rough weather being somewhat heavier and slower than those employed in countries where atmospheric conditions are more favourable. A homing pigeon is trained to take a message to the loft where he was bred, or to which he was moved before he had seen the outside of any other loft. Old birds that have been brought up elsewhere are sometimes kept in lofts for breeding purposes, but these are not allowed outside, or they will probably find their way to their original home, if within a reasonable distance. Various methods have been adopted for carrying the messages. One of the most usual is to place the paper inside a quill, which is then sealed at both ends and attached to a tail feather by means of wire, one of the firmest feathers being selected if during the moulting season. Another way is to wrap the paper round the bird's leg and fix it with an elastic band, or it may be fixed to a strong wing feather. In order to reduce the weight carried, the assistance of photography may be resorted to. Messages sent to Paris in the 1870 war were photographed on films, each of which took over 2000, and in this way as many as 40,000 messages were in one case carried by a single bird. On receipt of the films in Paris they were enlarged on a magic lantern screen, copied out, and sent to their destinations. Opinions differ very widely as to the distance which birds can be relied upon to cover, and all estimates must necessarily depend upon local and temporary conditions. For lofts or land communication, perhaps 150 miles apart may be taken as a distance that should not be exceeded, although with specially picked birds messages could no doubt be sent for double this distance with but a small percentage of loss in favourable weather, and with special training even this can be considerably exceeded. For communication between ships and the coast the results of experiments differ very widely indeed. For absolutely safe work perhaps 50 miles may be taken, though successful results have been obtained up to 300. In cases where the home of the pigeon moves about, as with the headquarters of a field army or of a ship at sea, success cannot be expected excepting at ranges not exceeding a few miles—certainly not over 20. Atmospheric conditions must be studied on all occasions, as they very materially affect the results. A large proportion of the birds will be lost in foggy weather, and they fly only during the period of daylight. Should the distance to be covered be considerable, they should not be sent off in the evening, but at a time that will enable them to reach their home by daylight at their average speed. Stormy weather interferes very seriously with their flight. For these reasons, also, it is very difficult to lay down any rule about the average speed at which the messages will be carried. Whilst speeds of about 60 miles an hour are sometimes attained, the average could not be placed at over 30 miles an hour under fairly favourable conditions.

The training of young birds is commenced during the first year by taking them out in closed receptacles and releasing them at gradually increasing distances from their loft, allowing intervals of rest for several days between each flight. About 100 miles may be expected of them during the first season, and this distance increased in subsequent years. The best results are obtained by training a bird always to fly in the same general direction for the season. If intended to be kept away from their loft for a long time, they should be placed in a dark room with no look-out, and the cocks and hens should be separated. When the young are being brought up, only one of the parent birds is taken out at a time. Each brood consists of two eggs, on which both parents sit in turn, the cock only for a few hours in the middle of the day. A loft for homing pigeons should be on a commanding site. It is best made in the shape of a large room, which should be protected from vermin, suitably subdivided, and provided with drinking troughs, rock salt, and crushed mortar for the bird's use. It should also be fitted with a sufficient number of nests about 2 feet long, 20 inches in breadth and height. Arrangements should be made for allowing the pigeons to fly out daily for exercise; and they should be trained to re-enter the loft through bolting wires which open inwards only into a small chamber, to which an electric arrangement may be fitted so as to sound a bell and warn the owner of the arrival of a bird. This chamber can be shut off from the loft, if required, to facilitate the capture of birds returning with messages. Marks showing to what club and to what loft each bird belongs are usually stamped on wing feathers, and when quite young a metal ring showing the date of hatching is usually placed on the leg by passing it over the foot. The food of birds in training consists of vetch, beans, maize, peas, broken rice, and millet, in various proportions, according to the country, climate, and season of the year, the daily allowance for each bird being about 40 grammes weight. Young birds may be fed on rice in the husk and bread.

The question of the homing instinct, which enables pigeons of certain classes to find their way home over such great distances, is a study of much interest, and their method of determining the true direction is still a matter of surmise. At all times their culture provides an interesting recreation, and numerous societies exist for the organization of races, and for encouraging their further development.

(G. G. A.)

Pigments.—It is convenient to distinguish between pigments and paints, the latter being prepared from the former by the addition of a vehicle or medium. Nor are pigments and dyes identical, although there are cases in which the same colouring matter which yields a dye or stain may give rise to a pigment. A pigment is, in fact, a substance which is insoluble in the vehicle with which it is mixed to make a paint, while a dye is soluble. Pigments exhibit various degrees of transparency and opacity, and ought to possess such qualities as these: ease in working, chemical indifference to each other and, generally, to the vehicles employed, also stability under exposure to light and air. As a rule, it is desirable that pigments should not be seriously affected in hue by the vehicle; at all events, whatever change does occur ought to admit of calculation. In the case of oil colours it should be remembered that a thorough drying of the paint is preferable to the formation of a surface-skin, and that a few pigments, notably white lead, possess properties conducing to this desirable result. It is scarcely necessary to add to these general observations concerning pigments that their artistic value depends primarily upon the nature and amount of the optical sensation which they are competent to produce.

Sources. Although the number of available pigments is great, the number of chemical elements which enter into their composition is not large. Very many richly-coloured compounds cannot be employed because they lack the properties of insolubility, inertness, and stability. Pigments are drawn from various sources. Some are natural, some artificial; some are inorganic, some organic; some are elements, some mixtures, some compounds. It is not unusual to arrange them into two groups, *substantive* and *adjective*. Amongst the members of the former group such a pigment as vermilion, where each particle is homogeneous, may be cited as an example. Amongst the adjective pigments rose-madder may be named, for each particle consists of a colourless base on which a colouring matter (alizarin) has been thrown. Most of the inorganic pigments, whether natural or artificial, belong to the substantive group; while there are many organic pigments, notably those of artificial origin, which are of adjective character. The following table presents a summary classification of pigments according to their source or origin:—

Mineral pigments .	Natural; as terre verte.
	Artificial; as aureolin.
Organic pigments .	Animal; as carmine.
	Vegetable; as madder-lake.
	Artificial; as alizarin-orange.

Preparation. A variety of processes are in use in order to fit natural coloured substances for employment as pigments. The first step is, in many cases, to select or "pick over" the raw material, rejecting whatever impurities may weaken or injure the characteristic hue of the product. It is occasionally necessary to treat the finely-ground substance with water by the method of elutriation or washing-over; the wash-waters will then deposit, on standing, various grades of the coloured body required. With rare exceptions native pigments need careful grinding, either by means of a muller on a slab or by edge rollers, or horizontal mill-stones, or special machines. The substance is usually ground in spirits of turpentine, or alcohol, or water; oil-paints are of course finally ground in a drying-oil, such as linseed oil or poppy oil; water-colours require gum-water, or gum-water and glycerin if they are to be "moist" paints. In the case of all pigments, whether mineral or organic, whether natural or artificial, it is of the highest importance to make sure that they are free from saline matters soluble in water. Such salts are removed by thorough washing with distilled water. A treatment of this kind is essential in the case of a large number of pigments formed by chemical reactions in the "wet way." Characteristic examples are furnished by Prussian blue, viridian, and lakes. Sometimes it is necessary to remove dangerous impurities by solvents other than water, such as carbon bisulphide, which is used to extract free sulphur from cadmium yellow. Mention may here be made of another kind of preparative treatment which is adopted with some pigments: they are subjected to the action of heat—moderate in some cases, strong in others. Thus a few substances, such as ivory black and yellow ochre, which in ordinary circumstances contain much non-essential moisture, before they are ground in oil may with advantage be gently dried at a temperature not above that of boiling water. Again, there are pigments, such as Prussian brown, light red, and burnt sienna, which owe their hues to a process of actual calcination, the first of these being thus made from Prussian blue, the second from yellow ochre, and the third from raw sienna. The pigments known as burnt carmine and burnt madder are prepared at a much lower temperature, and ought to be described as roasted rather than as burnt.

Adulteration. The substitution of one pigment for another is rarely practised, but it is not so unusual to find that a costly substance has received an admixture of something cheaper, and that an inferior grade of a genuine pigment has had its hue exalted or enhanced by some unlawful or dangerous addition. In fact, these two kinds of sophistication are often associated. Thus vermilion is adulterated with red lead, with red antimony sulphide, or with baryta white and lead sulphate, and then the hue of the mixture is restored to the proper pitch by the introduction of one of the powerful but fugitive colouring matters from coal-tar known as eosin. Amongst other adulterations which may be named here are the addition of chrome-yellow (lead chromate) to yellow ochre, of green ultramarine to terre verte, and of indigo to ivory black; this last mixture being a substitute for vine-black, the natural blue-black. The detection of the above-named sophistications is by no means difficult even in the hands of persons unacquainted with chemical manipulation, but it needs a trained analyst when quantitative results are required. If we are dealing with an oil-colour, the first step is to remove the oil by means of a solvent, such, for example, as ether. The residual pigment is then allowed to dry, and the dry powder submitted to the appropriate physical and chemical tests. Thus a suspected vermilion, having been freed from oil, is heated in a small hard glass bulb-tube: it should prove practically volatile, leaving a mere trace of residue. In this particular case the presence of a red hue in the ether-extract affords evidence of adulteration with an organic colouring matter, such as eosin. Then, again, we may detect the presence in yellow ochre of lead chromate by pouring a little sulphuretted hydrogen water and dilute hydrochloric acid upon one portion of the dry pigment, and boiling another portion with dilute sulphuric acid and some alcohol: in the former experiment blackening will occur, in the latter the liquid part of the mixture will acquire a greenish tint. So also green ultramarine may be recognized in adulterated terre verte by the addition of dilute hydrochloric acid, which destroys the colour of the adulterant and causes an abundant evolution of the evil-smelling hydrosulphuric acid gas. Moreover, nothing is easier than the recognition of indigo in vine or charcoal-black, for the dry powder, heated in a glass tube, gives off purple vapours of indigo, which condense in the cooler part of the tube into a blackish sublimate.

A word must be said here as to the adulteration of white lead, and the examination of this most important pigment. The best variety of white lead or flake white contains two molecules of lead carbonate to one of lead hydrate, and is wholly soluble in dilute nitric acid, while barium sulphate, its most frequent adulterant, is wholly insoluble. China-clay and lead sulphate will also remain undissolved; but whitening or chalk cannot be detected in this way—indeed, the thorough examination of white lead, not only for sophistications but also for correspondence with the best type in composition, cannot be carried out save by a skilled analyst.

Classification.

One of the most instructive ways of arranging pigments is based on their chemical composition. With the ordinary pigments nine groups may be constituted, seven of these being fairly well defined, but the eighth and ninth having a somewhat miscellaneous character. The groups of Elements, Oxides, Sulphides, Hydrates, Carbonates, and Silicates present this characteristic, namely, that each member of any one group is without action upon the other members of the group; any two or more may therefore be mixed together without fear of mutual injury. The same statement may be made with reference to the various inorganic salts of Group VIII. and to the organic compounds of Group IX., although in this large final group there are two pigments containing copper (verdigris and emerald green) which must be regarded with suspicion. The inertness of the members of the same group towards each other may be explained in the majority of cases by the following consideration. An oxide does not act upon an oxide, nor does a sulphide affect a sulphide, because all the pigment oxides have taken up their full complement of oxygen, and can neither give nor lose this element to similar oxides; so also with sulphur in the sulphides. A few details regarding the several members of the nine groups are now offered:—

Group I.—*Elements.*—All the black pigments in ordinary use—ivory black, lamp black, charcoal black, Indian ink, and graphite—consist of or contain carbon, an element not liable to change; the last-named pigment, which is less correctly termed black lead and plumbago, is a special form of carbon of peculiarly unalterable character. The metallic pigments, gold, silver, aluminium, and platinum, belong here; of these, silver alone is easily susceptible of change, tarnishing by absorption of sulphur.

Group II.—*Oxides.*—The oxides have generally been formed at a high temperature and are not easily amenable to physical or chemical change; they are, moreover, not liable to affect other pigments, being practically inert, red lead only being an exception. The oxides include zinc white, green oxide of chromium, burnt umber (oxides of Fe and Mn), cobalt green ($CoO,nZnO$), cobalt blue (CoO,nAl_2O_3), cœruleum ($CoO,nSnO_2$), Venetian red, light red, Indian red, and burnt sienna (all chiefly composed of Fe_2O_3), and red lead (Pb_3O_4).

Group III.—*Sulphides.*—Some of the members of this group are liable to contain free sulphur, and some may give up this element to the metallic bases of other pigments. Thus cadmium yellow blackens emerald green, producing copper sulphide. Another pigment of this group, vermilion, is prone to a molecular change whereby the red form passes, without chemical alteration, into the black variety. This change, frequent in water-colour drawings, is scarcely observable in works painted in oil. The sulphides comprise cadmium yellow (CdS), king's yellow (As_2S_2), realgar (As_2S_3), antimony red (Sb_2S_3), and vermilion (HgS). It is convenient to give places in the same group to the various kinds of ultramarine, blue, green, red, violet, and native, for in all of them a part of the sulphur present occurs in the form of a sulphide. It may be stated that the sulphides of arsenic and antimony just named are dangerous and changeable pigments not suited for artistic painting.

Group IV.—*Hydrates or Hydroxides.*—Several native earths belong here, notably yellow ochre, raw umber, raw sienna, and Cappagh brown. These substances owe their colours mainly to hydrates and oxides of iron and of manganese, but the presence of a colourless body such as white clay or barium sulphate is usual with the paler pigments. A false yellow ochre from Cyprus is really a basic ferric sulphate, and does not properly belong to this group. Besides the yellow and brown pigments, there is a magnificent deep green pigment in this group, known as emerald oxide of chromium or viridian. The blue copper preparation which goes under the name of *bleu lumière* and mountain blue, a very unstable pigment, is also essentially a hydrate, though by no means pure. It should be stated that all the earthy or native hydrates belonging to this group contain water in two states, namely, hygroscopic or loosely-attached, and constitutional. Before grinding them in oil, the reduction in the amount of the hygroscopic moisture by means of a current of dry air or a gentle warmth often improves the hue and working quality of these pigments.

Group V.—*Carbonates.*—There is but one really important member of this group, namely, the old and typical variety of white lead ($2PbCO_3$, PbH_2O_2). Like green verditer ($2CuCO_3$, CuH_2O_2), and blue verditer ($CuCO_3$, CuH_2O_2), it is not a simple carbonate, but contains a hydrate or hydroxide as well. Purified chalk or whitening ($CaCO_3$) belongs here also.

Group VI.—*Silicates.*—Terre verte, which is a natural green ochre containing a silicate of iron, potassium, and magnesium, and one other silicate, smalt, an artificial glass containing a silicate of cobalt and potassium, constitute this small group. However, some of the ochreous earths contain silicates of iron, manganese, and aluminium, as well as hydrates of the two former metals, and so have some claim to be ranked with the silicates.

Group VII.—*Chromates.*—These salts are rich in oxygen. When in contact with some of the more alterable organic pigments belonging to Group IX., the chromates may lose oxygen, acquiring a somewhat greenish or greyish hue, owing to the formation of the lower or green oxide of chromium. The chromates cannot be trusted as pigments. The yellow chromates, those of barium, strontium, zinc, and lead, are represented by the general formula $M''CrO_4$; chrome red is basic, and is Pb_2CrO_5.

Group VIII.—*Various Inorganic Salts.*—This group is intended to receive a number of pigments which are solitary, or almost solitary, examples of various classes of salts. There is one cobalti-nitrite, aureolin ($K_6Co_212NO_2$, associated with one or more molecules of water), called sometimes cobalt yellow; one antimonate, that of lead, the true Naples yellow; one tungstate, that of chromium, known as tungsten green; a metaphosphate of manganese, which goes under the name of Nürnberg or manganese violet; and several mixed cobalt compounds containing arsenates and phosphates of that metal, and represented by cobalt violet and Thénard's blue. Two sulphates also belong here, namely, baryta white ($BaSO_4$) and lead sulphate ($PbSO_4$); also Schweinfurt green, a basic copper arsenite. It is obvious that of the members of so miscellaneous a group of pigments no general characteristics can be predicated. But it may be stated that the two sulphates, the tungstate, and the cobalt compounds are practically inert and unalterable, while the copper arsenite and the lead antimonate are sensitive to the action of sulphur and of sulphides. The cobaltinitrite, aureolin, cannot be safely mixed with some of the organic pigments belonging to the next and last group.

Group IX.—*Organic Compounds.*—Most of the members of this large and unwieldy group of pigments possess this character in common, proneness to oxidation and consequent deterioration in the presence of light, moisture, and air. Such oxidation is accelerated by the action of some of the highly oxidized pigments belonging to other groups, such as the chromates of Group VII. and aureolin of Group VIII., this action being particularly marked in the case of the yellow lakes, the cochineal lakes, and indigo. There are two pigments consisting of copper salts in this group. They are verdigris—both the blue-green and the green varieties being basic copper acetates—and the pigment known in England as emerald-green, which is a basic cupric aceto-arsenite. These copper pigments present the usual sensitiveness to the attack of sulphur which distinguishes compounds of this metal, and cannot therefore be safely mixed with the members of Group III., and more particularly with the cadmium colours. About nine members of Group IX. may be regarded as substantive pigments. These include Indian yellow (mainly magnesium and calcium euxanthates), gamboge, sap green, indigo, Prussian blue, bitumen or asphalt, bistre, sepia, and the bituminous variety of Vandyck brown. The adjective pigments include a great variety of lakes where different kinds of colouring matters of more or less acid character have been thrown upon a base, generally of colourless aluminium hydrate, aluminium phosphate, stannous hydrate, stannic oxide, baryta, or lime; sometimes coloured bases containing such metals as copper, chromium, manganese, or iron are introduced in small quantities. The colouring matters used are both natural and artificial. Amongst the former may be named Indian lake, from the resinous exudation produced in certain trees by the attacks of *Coccus lacca;* carmine, crimson, and purple lake, from the colouring matter obtained from the cochineal insect, *Coccus cacti;* rose-madder and the madder-lakes, from the alizarin and allied bodies derived from the root of the ordinary madder plant *Rubia tinctorum;* and yellow lakes, from quercitron bark (*Quercus tinctoria*), and from Persian and Avignon berries (species of *Rhamnus* or Buckthorn). The lakes derived from alkanet root, archil, Brazil wood, and red sanders wood are of very small interest and value. The same judgment may be pronounced upon the large number of artificial lakes which owe their colours to coal-tar derivatives, with the single exception of the important class of pigments obtained from artificial alizarin and from its congeners and derivatives. Of these, alizarin itself ($C_{14}H_6O_2(OH)_2$), in its purest state and associated with alumina and a little lime, yields those pigments which possess a pink or rosy hue. When purpurin ($C_{14}H_5O_2(OH)_3$) and its isomers, anthrapurpurin and flavopurpurin, are present, the red hue is more pronounced, and may even tend towards a golden colour, or, when some copper or iron or manganese is introduced, may become decidedly brown. Many of the alizarin crimsons sold as paints are not made from alizarin itself, but from the sulphonic acids of alizarin. These lakes present a wide range of hues. Another derivative of alizarin, known as β-nitro-alizarin, yields a rich orange lake, to which such names as pure orange, orange madder, and marigold have been applied.

Stability.—Some notion of the relative stability of pigments will have been derived from the remarks already made under "Classification." But as permanence is of no less importance than chromatic quality in the case of pigments used in the fine art of painting, to which the present article is mainly devoted, further particulars concerning certain selected pigments may profitably be given here. The judgments formed have been derived from direct experiments and from the study of old paintings and drawings. It will be convenient, for the practical purpose in view, to revert to the familiar arrangement according to hue. Beginning, then, with white pigments, these three may be named as useful: white lead, Freeman's white, zinc white. As an oil-colour, white lead of the old type is generally the best to use, but among water-colours its place must be taken by zinc white in the condensed form known as Chinese white. Zinc white, in spite of the qualities which recommend its use in oil, namely, the fact of its being not only unaffected by sulphur, but odourless and non-poisonous, lacks toughness as an oil-paint, and has a tendency to scale. Freeman's white, which consists essentially of lead sulphate, is the best substitute for white lead yet devised. The small percentages of zinc white and baryta white which it contains are not to be regarded as adulterations, for they greatly increase its *body*, and though of less specific gravity than lead sulphate, actually raise the weight per cubic foot of the dry pigment. Out of a dozen or more familiar yellow paints, a selection may be made of these six: yellow ochre, raw sienna, mars orange, cadmium yellow, aureolin, and baryta yellow. Concerning two of these, cadmium yellow and aureolin, the following recent observations may be set down. There is but one sulphide of cadmium, CdS, but this compound exists in two forms, which in some measure correspond to the two modifications of mercuric and antimonious sulphides. One of these forms is yellow and the other reddish orange. When sulphuretted hydrogen is sent into a weak, cold, and neutral solution of a cadmium salt, the sulphide which separates is pale and yellow—the orange variety is obtained from a strong, hot, and acid solution. The pale variety is more prone to change than the darker one; but as oil-colours both forms are sufficiently stable for use, provided they are pure. The value of aureolin as a pigment depends much upon its mode of preparation. A new variety of bright yellow hue was described by Adie and Wood in 1900, and is represented by the formula $K_2NaCo(NO_2)_6,H_2O$; it seems likely to prove an excellent and permanent pigment. Of red pigments, six claim special mention. These are vermilion, light red, Venetian red, Indian red, red ochre, and the red lakes derived from madder or alizarin. Vermilion is stable in oils, but as a water-colour paint is prone to change, under exposure to strong light, into the black modification of mercuric sulphide. The iron-reds named above, whether natural or artificial, are quite permanent, but so much cannot be said of the various madder-paints. They are of far greater stability under exposure to light than any other red organic pigments, and are absolutely necessary to the artist. It must be noted that those madder and alizarin lakes which contain an element of yellow and brown are less stable than those of a crimson hue. Five green pigments may be recommended, namely, viridian, or the emerald oxide of chromium, the ordinary green oxide, cobalt green, green ultramarine, and terre verte. Except for minor decorative work, where permanence is of secondary moment, one is obliged to exclude from the palette emerald green, green verditer, verdigris, sap-green, and the numerous preparations which owe their colour to mixtures of Prussian blue and chrome yellow, and are sold under the names of green vermilion, chrome green, Brunswick green, and so on. All these pigments usually contain much barium sulphate. Similarly, amongst blue pigments, ultramarine, cobalt blue, and cœruleum may be retained, while smalt, indigo, and all the copper blues should be rejected. Prussian blue, or the mixture of this pigment with a white base which is usually called Antwerp blue, can scarcely be spared, but care should be taken to choose a sample containing no potassium compounds. Cœruleum, which may be described as cobalt stannate, presents the peculiarity of appearing a greenish blue in artificial light, not a purplish blue like that of ordinary cobalt blue. Cobalt violet is a sound pigment, while manganese metaphosphate or Nürnberg violet is said not to be safe in oil. Mars violet, an artificially prepared ferric oxide, is dull in hue but permanent. Passing on to brown pigments, it is matter for regret that there are no permanent colours possessing the artistic capacities of asphalt, madder brown, and the old bituminous Vandyke brown. Cappagh brown, burnt sienna, and raw and burnt umber may be employed safely. Little need be said as to the selection of black pigments, for all are permanent. The soot from burning acetylene, which has recently been introduced, forms a black pigment of remarkable intensity.

Uses.—Hitherto pigments have been considered chiefly in relation to the requirements of the painter of pictures, whose aim it is to translate ideas of colour and of light and shade into a concrete and permanent form. In many merely decorative arts, such as the manufacture of wall-papers and the painting of woodwork and of iron, the pigments available are in one direction, that of cost, more restricted, but, on the other hand, many alterable or weak pigments are commonly employed. In paints intended for the protection of ironwork, the nature of the pigment introduced is a matter of great moment, for red lead, zinc white, and white lead are found to exert a strong protective influence, which is not observed in the case of the vast majority of pigments. There are a number of other uses besides those just named for which special pigments, or, more precisely, special paints, are employed. Amongst such preparations may be named luminous paints, anti-fouling paints, metallic paints, damp-proof paints, and asbestos and other fire-proof paints.

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Pilibhit, a town and district of British India, in the Rohilkhand division of the North-West Provinces. The town is situated on the left bank of the Deoha river; railway station, 34 miles north-east of Bareilly. Population (1881), 29,721; (1891), 33,799. The municipal income in 1897–98 was Rs.42,535, more than half derived from octroi; incidence of taxation, 11 annas per head; registered death-rate (1897), 89·7 per thousand. It was made the headquarters of a district in 1879, and has considerable trade in country produce, manufactures of sugar, a high school, and a printing-press. The district of Pilibhit has an area of 1372 square miles; population (1881), 451,601; (1891), 485,366; (1901), 470,689, showing an increase of 7 per cent. between 1881 and 1891, as compared with a decrease of 8 per cent. in the previous nine years, and a decrease of 3 per cent. between 1891 and 1901; average density, 342 persons per square mile. The land revenue and rates were Rs.8,12,749, the incidence of assessment being Rs.2 per acre; cultivated area (1896–97), 375,640 acres, of which 73,805 were irrigated from wells, &c., including 15,595 from Government canals; number of police, 1419; vernacular schools, 78, with 3170 pupils; registered death-rate (1897), 45·3 per thousand. The principal crops are rice, pulses, wheat, and sugar-cane. The Lucknow–Bareilly section of the Oudh and Rohilkhand Railway runs through the district, a portion of which is watered by the Rohilkhand canals.

Pillau, a seaport town of Prussia, province of East Prussia, on the spit of sand (*nehrung*) which separates the Frisches Haff from the Baltic, on the north side of the entrance channel, and 29 miles by rail west by south of Königsberg. It is fortified and has a harbour, which serves as the outer port of Königsberg, and to some extent also of Elbing and Braunsberg. A new navigable channel was in 1900–01 constructed across the Frisches Haff from Pillau to Königsberg. Shipbuilding, sail-making, fishing, and the working of amber are carried on. Population (1895), 3192; (1900), 2993.

Pilots.—The name of pilot is applied either to a particular officer serving on board a ship during the course of a voyage and having the charge of the helm and the ship's route, or to a person taken on board at a particular place for the purpose of conducting a ship through a river, road, or channel, or from or into a port. The latter kind is the only one to which the term is now applied either in British or foreign countries. In England, formerly, pilots were subject to the jurisdiction of the Lord High Admiral; and in the 16th century there are many instances of the Admiralty Court dealing with pilots disciplinarily as well as civilly holding them liable in damages to owners of ships lost or damaged by their negligence.

For some considerable time throughout the United Kingdom the appointment and control of pilots have been in the hands of numerous societies or corporations established at the various ports by charter or Act of Parliament, such as the Trinity Houses of Deptford Strond (London), Kingston-upon-Hull, Newcastle-on-Tyne, and Leith, and the Society of Cinque Ports Pilots and Court of Lodemanage (now extinct). These societies had jurisdiction over the pilots exercising their employment within the limits of such ports, and in many cases made it compulsory for ships resorting thither to employ them. By degrees the London Trinity House acquired a leading position, which was confirmed and extended by the general Pilotage Acts passed in the 18th and 19th centuries, with the object of introducing a uniform system throughout the realm. At the present day the United Kingdom is divided into districts for the purpose of pilotage jurisdiction. The (London) Trinity House has jurisdiction over the London district, which extends from Orfordness to Dungeness, and comprises the Thames and Medway up to London and Rochester bridges; the English Channel district, comprising the sea between Dungeness and the Isle of Wight; and the Trinity outport districts, which include any pilotage districts for the appointment of pilots within which no particular provision is made by Act of Parliament or charter, and the number of which, according to a parliamentary return of 1899, is 40, all English and Welsh. There are 66 other districts, within which other pilotage authorities have jurisdiction.

Authorities.

The present general pilotage law is contained in the Merchant Shipping Act of 1894. Pilotage authorities are defined as bodies or persons authorized to appoint or license pilots, or to fix and alter rates of pilotage, or to exercise any jurisdiction in respect of pilotage. They are subject to the control of the Board of Trade as the supreme mercantile marine authority. Those bodies, however, which existed at the time of the passing of the Act retain their powers and jurisdiction, so far as is consistent with it. The Board has power to appoint a new pilotage authority in any area where there is none, and to include a new area where there is none within an already existing one (but in either case pilotage cannot be made compulsory), or to transfer pilotage jurisdiction over a port other than that where the pilotage authority for that port resides, from that pilotage authority to the harbour or other local authority for that port, or to the Trinity House, or to a new authority; and the Board has all powers necessary to effectuate such transfer and constitute the new authority. The Board may also, by provisional order (which requires parliamentary confirmation), provide for the representation of pilots or shipowners on the pilotage authority of any district, and the exemption of ships from compulsory pilotage in any district. Where pilotage is not compulsory, and the power of obtaining pilotage licences unrestricted, the Board can in the same way give the pilotage authority powers with respect to licences, amount of pilotage rates, and the like. Pilotage authorities may, by by-laws under the Act (which require confirmation by Order in Council), exempt wholly or partly any ships or classes of ships from compulsory pilotage, and regulate the means of obtaining licences, and the amount of pilotage rates, subject to a maximum limit. They must make yearly returns to the Board of Trade of their by-laws, the names, ages, and services of their licensed pilots, the rates of pilotage, the amounts received for pilotage and their receipts and expenditure; and if they fail to do so, the Board may suspend their authority, which is then exercised by the Trinity House.

Law.

The statute also provides generally for the qualifications of pilots. A "qualified" pilot is one duly licensed by a pilotage authority to conduct ships to which he does not belong. On his appointment he receives a licence, which is registered with the chief officer of customs at the nearest place to the pilot's residence, and must be delivered up by the pilot whenever required by the licensing pilotage authority. On his death this licence must be returned to that authority. Pilotage dues are recoverable summarily from the owner, master, or consignees of the ship, after a written demand for them has been made. A pilot may not be taken beyond the limits of his district without his consent, and if so taken he is entitled to a fixed daily sum in addition to the dues; if he cannot board the ship, and leads her from his boat, he is entitled to the same dues as if he were on board; and he must be truly informed of the ship's draught of water. An unqualified pilot may in any pilotage district take charge of a ship without subjecting himself or his employer to any penalty, where no qualified pilot has offered himself, or where a ship is in distress, or in circumstances where the master must take the best assistance he can, or for the purpose of changing the moorings of any ship in port on docking or undocking her; but after a qualified pilot has offered himself any unqualified pilot continuing in charge, or any master continuing him in charge of the ship, is liable to a penalty. A qualified pilot may not be directly or indirectly interested in licensed premises or in the selling of dutiable goods, or in the unnecessary supply of gear or stores to a ship for his personal gain or for the gain of any other person. He can be punished for quitting a ship before the completion of his duty without the consent of the master, refusing or delaying to perform his duty without reasonable cause when required by lawful authority, lending his licence, acting as pilot when suspended or when intoxicated, and any pilot who through wilful breach of or neglect of duty, or by reason of his drunkenness, endangers ship, life, or limb, is guilty of a misdemeanour and liable to suspension or dismissal; but the pilot has an appeal in cases of fines over £2, of suspension or dismissal, suspension or revocation of his licence, or the application of a pilotage fund to which he has contributed. This appeal lies in England to a county court judge having jurisdiction over the port where he is licensed, or a metropolitan police magistrate or stipendiary magistrate with the like power; in Scotland to a sheriff; in Ireland to a county court judge, chairman of quarter sessions, recorder, or magistrate. Pilotage certificates may also be granted by pilotage authorities, available within their districts, to masters and mates of ships; and the holder of such a certificate may pilot any ship in respect of which it is available without incurring any penalty for not employing a qualified pilot.

Qualifications.

The statute further makes special regulation for Trinity House pilots. Every such pilot, on his appointment, must execute a bond for £100 conditioned for due observance of the Trinity House regulations and by-laws, and thereupon he is not liable for neglect or want of skill to anybody beyond the penalty of the bond and the amount payable to him for pilotage on the voyage on which he was engaged at the time of his so becoming liable. The licence may be revoked or suspended by the Trinity House when it thinks fit; it only continues in force for a year, and the Trinity House has absolute discretion whether it shall be renewed or not.

Pilot boats and signals.

A pilot boat is approved and licensed by the district pilotage authority who appoints or removes the master thereof. In order to be easily recognized, she has printed on her stern in legible white letters the name of her owner and her port, and on her bows the number of her licence; the remainder of the boat is usually black. The pilot flag is a red and white horizontal flag of a comparatively large size, and is flown from a conspicuous position. When the flag is flown from a merchant vessel, it indicates that a licensed pilot is on board, or that the master or mate holds a certificate entitling him to pilot the ship. By Order in Council of 1900, on and after the 1st day of January 1901 the signals for a pilot displayed together or separately are to be:—In daytime, there is (1) hoisted at the fore the Union Jack having round it a white border, one-fifth of the breadth of the flag; (2) the international code pilotage signal indicated by P.T.; (3) the international code flag S., with or without the code pennant; (4) the distant signal consisting of a cone pointing upwards, having above it two balls or shapes resembling balls. By night, (1) the pyrotechnic light commonly known as a blue light, every fifteen seconds; (2) a bright white light, flashed or shown at short or frequent intervals just above the bulwarks for about a minute or two.

Compulsory pilotage.

Pilotage in British waters may be either compulsory or free for all or certain classes of ships. From the parliamentary pilotage return of 1899, it appears that it is compulsory in 64 districts of the United Kingdom (of which two-thirds are the Trinity House districts), free in 32, free and compulsory in 8, while in 3 cases (Berwick, Dingwall, and Coleraine) no particulars are given. British warships in British waters are not compelled to employ a pilot, the navigating officer becoming the pilot under the direction of the captain. If a pilot be employed, the captain and navigating officer are not relieved from responsibility. They supervise the pilot, and should, if necessary, remove him from the ship. In the majority of foreign ports British warships are exempted from employing pilots, but the Suez Canal and the ports of France are exceptions. The Merchant Shipping Act continues the compulsory employment of pilots in all districts where it was already compulsory, and also the already existing exemptions; and there is no power in any pilotage authority or the Board of Trade to increase the area of compulsory pilotage, though there is to diminish it. Compulsion is enforced by a provision in the Act, that within a district where compulsory pilotage exists, the master of an unexempted ship who pilots her himself without holding the necessary certificate, after a qualified pilot has offered or signalled to take charge of the ship, shall be liable for each offence to a fine of double the amount of the pilotage dues demandable for the conduct of the ship. The exemptions from compulsory pilotage still existing in British territorial waters are as follows:—Ships or vessels with British registers trading to Norway or the Cattegat or the Baltic (except vessels on voyages between any port in Sweden or Norway and the port of London), or round the North Cape, or into the White Sea on their inward or outward voyages whether coming up by North or South Channels; any constant British traders inwards from ports between Boulogne inclusive and the Baltic coming up by North Channel, and any British ships or vessels trading to ports between the same limits on their outward passages and when coming up by the South Channels; Irish traders using the navigation of the Thames and Medway; ships engaged in the regular coasting trade of the kingdom; ships or vessels wholly laden with stone produced in the Channel Islands and Isle of Man and brought thence; ships or vessels not exceeding 60 tons, whether British or belonging to a foreign country specified by Order in Council; ships within the limits of the port or place to which they belong, if this is not a place particularly provided for by Act of Parliament or charter as regards the appointment of pilots; ships passing through the limits of any pilotage district in their voyages from one port to another port, and not being bound to any port or place within such limits or anchoring therein, but not including ships loading or discharging at any place situate within the district, or at any place situate above the district on the same river or its tributaries. Ships whose masters or mates are owners or part-owners of them, and living at Dover, Deal, or the Isle of Thanet, may be piloted by them from any of these places up and down the Thames or Medway, or into or out of any place or port within the jurisdiction of the Cinque Ports. The following ships in the London district and Trinity outport districts are also exempt when not carrying passengers, namely: ships employed in the coasting trade of the United Kingdom; ships of not more than 60 tons burden; ships trading to or from any port in Great Britain within the above districts to or from the port of Brest in France, and any port in Europe (which does not include the United Kingdom) north and east of Brest, or to the Channel Islands or Isle of Man; and ships navigating within the limits of the port to which they belong. The port to or from which the ship must be "trading" in this provision has been interpreted by the decisions to mean the port where the cargo is substantially discharged or loaded respectively; and the word "coaster" similarly has been held to apply only to a vessel carrying to one port of the United Kingdom a cargo which has been taken in at another. Every ship carrying passengers between any place in the British Islands and any other place so situate must carry a compulsory pilot, unless her master or mate have a pilotage certificate. The effect in law of the ship (British or foreign) being in charge of a compulsory pilot under the Act is that her owner and master are not answerable to any person whatever for any loss or damage occasioned by the fault or incapacity of any qualified pilot acting in charge of such ship within any district where the employment of such pilot is compulsory by law. In order to take advantage of this privilege, the shipowner must show (1) that a properly qualified pilot was acting in charge of the ship; there are, however, various kinds of qualified pilots—the qualified pilot who is always capable of acting, and the qualified pilot who is liable to be superseded if a better can be obtained; (2) that that charge was compulsory; the pilot, however, need not be compulsorily employed at the place where the accident happened, so long as he is compulsorily employed within the district where it happens; (3) that it was solely the pilot's fault or incapacity which caused the damage. Similarly, under the Harbours, Piers, and Docks Clauses Act, the owner of a vessel is not liable for damage done thereby to docks or piers when she is in charge of a duly licensed pilot.

This statutory exemption of a ship in charge of a compulsory pilot from any liability for her negligent navigation by that pilot, is only declaratory of the common law of England, and is based on the principle that the pilot is a State official put in charge of a ship, and is not the servant of the shipowner so as to make him liable for his negligence; and a British court gives the same effect to any foreign or colonial law which makes it compulsory on shipowners to put a pilot in charge of their ship when within their jurisdiction. Most foreign codes, however, while agreeing with English law in making the presence of a pilot on board compulsory, differ from it in not putting him in charge of the ship; and in this case the defence of compulsory pilotage cannot be pleaded successfully in British courts. Judicial decisions have established that French, Suez Canal, Danube, and Dutch pilots are not compulsory pilots in the British sense of the word, being only advisers of the master, or "living charts." But if the pilot is put in charge by the foreign or colonial law, although that law expressly provides that in spite of the owner surrendering the charge of the ship to him the owner shall still remain liable, a British court will hold the owner free from liability, on the ground that to make any person liable for a tort committed abroad, the act complained of must be wrongful not only according to the foreign law but also by English law. This consequence which English law attaches to the employment of a compulsory pilot has been much criticized in recent times, and it would seem that the foreign view is much more satisfactory, in regarding the pilot merely as the adviser and not the superior of the master. Moreover, the adoption of the foreign law on this point would restore the old general maritime law. The policy of the law was at one time inclined to extend this principle of compulsory pilotage, on the ground that it was for the benefit of commerce and the safety of seamen's lives, but it now restricts it within as narrow limits as possible, *e.g.*, the presence of a compulsory pilot on board a tow who is directing the navigation of a tug does not protect the tug-owner from liability for negligent navigation. As already pointed out, pilotage authorities have no power to extend its scope.

A pilot who is compulsorily in charge of a ship under English law has supreme control over her navigation, superseding the master for the time being; and if she is a tow he has also control of the navigation of her tug. The judicial decisions establish that it is within his province to decide whether the ship shall get under way, the proper time and place for her to anchor, the way of carrying her anchor, the proper orders for the helm, her rate of speed, and whether the statutory rules of navigation shall be complied with; and the master and crew must not interfere with his control, and only remain liable for the proper execution of the pilot's orders and the trim and general efficiency as to lookout, &c., of the ship. The master, however, is bound to supersede the pilot in case of his intoxication or manifest incapacity, and to interfere if there is a clear and plain prospect of danger to the ship in following the pilot's directions, *e.g.*, getting under way in a thick fog. A pilot taken voluntarily, and not by compulsion of law, is considered as the servant of the shipowner, and as such renders him liable for his acts of negligence towards third parties. He does not, it seems, supersede the master in the control of the ship, but only advises him. The Admiralty and the Board of Trade and the Trinity House all take the view that the captain or master is bound to keep a vigilant eye on the navigation of the vessel by the pilot, and insist on all proper precautions being taken. For the purposes of a policy of marine insurance a ship is not seaworthy without a pilot in compulsory pilotage waters; and where there is no legal compulsion to have one, but the locality requires navigation by a person having local knowledge, it has been said that a ship must take a pilot, certainly when leaving a port, and probably on entering a port if a pilot is available.

A pilot can sue for his pilotage fee at common law or in Admiralty (*q.v.*), in the latter case provided that the contract was made and the work done not within the body of a county; but he has a summary remedy by statute which is of easier application. He cannot be sued in Admiralty for damage done by a collision caused by his negligence (*e.g.*, on the Admiralty side of a county court having Admiralty jurisdiction); but he can be made liable at common law or in the Admiralty Division of the High Court, although in the case of a Trinity House pilot his liability is limited to the amount of his bond and pilotage fee then being earned (see above); but the court has refused to join him as a defendant to an action *in rem* brought against the ship of which he had the charge. A pilotage authority cannot be made liable for the negligent navigation of a ship by a pilot which it has licensed, for he is not its servant, though it has been held liable for the negligence of a person not licensed by it as a pilot, but employed by it for wages to pilot ships into a harbour under its jurisdiction, itself taking the pilotage dues and applying them for harbour purposes. A pilot is not in common employment with the master and crew of a ship, and can recover for any injury done him by their negligence. He may be entitled to claim salvage from a ship of which he has charge, if the services he renders are beyond the scope of his pilotage contract, either from the outset or owing to supervening circumstances, but not otherwise, whether he is on board her or leading her from his boat. (See SALVAGE.)

United States pilotage laws are regulated by the respective states according to Congress. If the waters are the boundary between two states, a duly licensed pilot of either state may be employed, but no discrimination can be made in the rates of pilotage between vessels of different states. In the *German Empire* the pilotage laws are very complicated. In the majority of the maritime states each one has its own regulations and laws. In *Prussia* there are Government pilots who enter the service as apprentices, and are placed under a department of state. In *France* the general organization of pilots is regulated by the Statute on Pilots of the 12th December 1806, and the pilotage regulations for each port are made by the Minister of Marine at the request of his local representative and the Chamber of Commerce. French pilots are exempt from military service.

See ABBOTT. *Shipping.* London, 1892.—MAUDE and POLLOCK. *Shipping.* London, 1881.—MARSDEN. *Collisions at Sea.* London, 1896.—*Select Pleas of the Admiralty.* Selden Society, London, 1892 and 1897.—TWISS. *Black Book of Admiralty.* London, 1871.

(G. G. P*.; J. W. D.)

Piloty, Karl von (1826–1886), German painter, was born at Munich, 1st October 1826. Under the guidance of his father, Ferdinand Piloty (*d.* 1844), who enjoyed a great reputation as a lithographer in that city, young Piloty acquired in early life an insight into the principles of art. In 1840 he was admitted as a student of the Munich Academy, where he became a zealous pupil of the artists Schorn and Schnorr. After a journey to Belgium, France, and England, undertaken for the purpose of visiting the galleries in those countries, he commenced work as a painter of *genre* pictures, and in 1853 produced a work, "Die Amme" (The Wet Nurse), which, on account of its originality of style, caused a considerable sensation in Germany at the time. But he soon forsook this branch of painting in favour of historical subjects, and produced in 1854 for King Maximilian II. an historical painting representing "The Adhesion of Maximilian I. to the Catholic League in 1609." This picture has been variously criticized, but on the whole opinion inclines to regard it as being somewhat superficial and theatrical in tone, whilst it strongly betrayed the influence of the Belgian school of colourists. It was succeeded by "Seni at the Dead Body of Wallenstein" (1855), which gained for the young painter the membership of the Munich Academy, where he succeeded Schorn (his brother-in-law) as professor. Among other well-known works by Piloty are the "Battle of the White Mountain near Prague," "Nero Dancing upon the Ruins of Rome" (1861), "Godfrey of Bouillon on a Pilgrimage to the Holy Land" (1861), "Galileo in Prison" (1864), and "The Death of Alexander the Great" (unfinished), his last great work. He also executed a number of mural paintings for the royal palace in Munich. For Baron von Schach he painted the justly celebrated "Discovery of America." In 1874 he was appointed keeper of the Munich Academy, being afterwards ennobled by the king of Bavaria. Piloty was the foremost representative of the realistic school in Germany: he strove to represent nature to the minutest details. He was a most successful teacher, and among his more famous pupils may be mentioned Makart, Lenbach, Defregger, Max, and Grützner. He died at Munich on the 21st of July 1886.

Pilsen (Czech, *Plzeň*), the second town of Bohemia, Austria, at the confluence of the Mies and Radbusa, 52 miles west-south-west of Prague. Population (1890), of the town proper, 9778, including suburbs 50,221; (1900), 68,292, including the garrison of 2259 men. In 1880 the Czech and German elements were nearly equal, but it is now estimated that about 84 per cent. are Czech, 16 per cent. German; 94 per cent. Catholic, 5 per cent. Jewish, and 1 per cent. Protestant. Of all Bohemian towns, with the exception of the four suburbs of Prague, Pilsen shows the largest increase of population since 1857, when it had 14,269 inhabitants. As in Prague, there are separate educational establishments for the two nationalities, including gymnasia, *real* schools, commercial and trade academies, training colleges, &c. A joint-stock company was formed in 1893 for the manufacture of the staple product of the town, the celebrated Pilsen beer. In that year the two largest breweries produced 808,600 hectolitres of beer, over four times the entire quantity produced in the 'eighties. Other branches of industry comprise manufactures of malt, of iron and metal wares (including bell-founding and wire-drawing), of carts and waggons, and explosives, and the preparation of marble, granite, mill-stones, &c., together with steam corn and saw mills.

Pinar del Rio, capital of Pinar del Rio, the easternmost province of Cuba, 97 miles south-west by west of Havana. The town has rail connexion with Havana, and is the centre of the tobacco industry of the Vuelta Abajo region. Population (1899), 8880.

Pind Dadan Khan, a town of British India, in the Jhelum district of the Punjab, situated in 32° 35′ N. and 73° 5′ E., near the right bank of the river Jhelum, and a station on the salt mine branch of the North-Western Railway. Population (1881), 16,724; (1891), 15,055; municipal income (1897–98), Rs.30,381. It is an important centre of trade, and its manufactures include boats, brass-ware, pottery, embroidered scarves, and riding-whips. There is a municipal school.

Pine Bluff, a city of Arkansas, U.S.A., capital of Jefferson county, on the Arkansas, at an altitude of 216 feet. It is in one of the richest cotton regions of the country, and is on the St Louis, Iron Mountain, and Southern, the St Louis South-Western, and the Pine Bluff and Arkansas River railways. It has a large trade in cotton, and has cotton compresses, cotton-seed oil mills, planing mills, flour mills, and car works. Population (1880), 3203; (1890), 9952; (1900), 11,496, of whom 359 were foreign-born and 5771 negroes.

Piotrków, a province in the west of Russian Poland, with an area of 4729 square miles. Geologically it represents a continuation of Upper Silesia, and is built up of Upper Carboniferous deposits, containing near Bendzin a layer of coal, 265 square miles in extent, of which only one-fifth is worked. Permian and Jurassic deposits, containing zinc ores, as also lignite and limonite iron ores, overlie the Carboniferous. The surface forms a series of heights, from 1000 to 1580 above sea-level, intersected by ravines, and stretching from south-west to north-east. The province is watered by the Warta and the Pilica, and was formerly covered by thick forests. It was colonized by Mazurs and Poles (Veliko- and Malo-Polyans). The domiciled population numbered 1,409,044 in 1897, of whom 707,272 were women, and 509,699 lived in towns. Most of the inhabitants are Poles, the rest being Jews (189,000) and Germans (162,500). The province is divided into eight districts, of which the chief towns are Piotrków (see below), Bendzin (21,190), Brzeziny (7669), Czenstochowo (45,130), Łask (4238), Łódź (315,209), Nowo

Radom (12,407), and Rawa (6471). Pabianice has 26,900 inhabitants, Zgerż 19,124, and Tomaszew 21,041. Educational institutions are comparatively numerous and efficient. Although the soil is not fertile, agriculture is the main occupation of the people, and nearly 1,440,000 quarters of various cereals and 2,165,000 quarters of potatoes are grown annually, the latter chiefly for the distilleries. The average crops of 1895–99 were: wheat, 568,000 cwt.; rye, 3,154,000; oats, 1,254,000; all cereals, 5,941,000; and potatoes, 11,724,000 cwt. Cattle-breeding is extensively carried on, and in 1897 there were 123,130 horses, 251,050 horned cattle, and 220,000 sheep. Weaving as a domestic industry gave employment in 1897 to 8920 workers, and yielded a return of £460,000. Small furniture works and forges are widely scattered amongst the villages. Coal-mining gives occupation to 13,500 workers, and 3,230,000 tons are extracted annually. Iron ore was extracted in 1898 from 44 mines (1630 workers), and there were 9 iron works (6250 workers), employing 79 steam engines, and showing a return of 125,000 tons of pig iron and 100,000 tons of iron rails and iron-ware. Textile industries have rapidly developed, the towns of Łódź Pabianice, Zgreż, and Bendzin all being important manufacturing centres. The chief industries are cotton-spinning, cotton-printing, dyeing, and the manufacture of woollen cloth, silks, and jute. They employ 150,000 workers, and the value of their yearly output reaches £15,000,000. Granica and Sosnowice are two of the chief custom-houses in Russia, and the annual trade of the province is estimated at £12,000,000. (P. A. K.)

Piotrków, capital of the above government, situated 90 miles by rail south-west of Warsaw, on the railway to Vienna. It is a well-kept town, with numerous gardens. Its factories (agricultural machinery works, flour-mills, saw-mills, tanneries) are unimportant. Population (1882), 23,050; (1897), 30,372.

Piqua, a city of Miami county, Ohio, U.S.A., on the Miami river, the Miami and Erie Canal, and the Cincinnati, Hamilton and Dayton, and the Pittsburg, Cincinnati, Chicago, and St Louis railways, at an altitude of 865 feet. It contains varied manufactures, especially of agricultural implements, furniture, waggons, tin-plate, and woollen goods. Population (1890), 9090; (1900), 12,172, of whom 901 were foreign-born and 487 negroes.

Pirano, a seaport town in the crownland of Istria, Austria, situated at the point of a small peninsula, a few miles south of Trieste. In addition to viticulture and the cultivation of the olive, its principal resources are shipbuilding, fishing, the manufacture of chemicals, and the evaporation of sea-salt, of which some 50,000 tons are annually produced. Its port is entered and cleared by an aggregate of about 7500 vessels of 442,000 tons annually, mostly coasting vessels. Pirano is celebrated for the victory of the Venetians over the fleet of the Emperor Frederick I. in 1177. Population (1900), 13,339.

Pirna, a town of Germany, on the Elbe, 11 miles by rail south-east of the town, and in the circle of Dresden, kingdom of Saxony. It has several educational institutions, amongst them a girls' higher-grade school, a girls' industrial school, a commercial school, and a seminary for teachers. Population (1890), 13,852; (1900), 18,295.

Pirot, during the Turkish rule known as *Shehr-Koey*, a Servian town, 12½ miles from the Bulgarian frontier at Tsaribrod, on the railway line between Nish and Sofia. It has a mediæval fortress, believed to have been built on the site of the Roman fortress *Quimedava*, on the military road leading from Old Naissus to Philippopolis. The town is of great strategical importance, for which reason the Russian plenipotentiaries at the Berlin Congress (1878) stubbornly tried to include it within the Bulgarian frontier, while Austria and some other Powers insisted that it should be given to Servia. In the war between Servia and Bulgaria in 1885 the Bulgarians occupied and held it until the conclusion of peace. It is the seat of the prefecture for the whole district, with a tribunal, several schools, and a custom-house. A regiment of infantry, with several batteries, is stationed permanently in Pirot, the neighbourhood of which has since 1886 been strengthened by modern fortifications. It is the only really industrial town in Servia, having numerous small factories for the manufacture of thin cloth (*shayak*), woollen braid (*gaytan*), and especially carpets. Its carpets have a great reputation in the Balkan Peninsula for their quaint designs, durability, and freshness of colour. Population (1900), 10,421.

Pisa, a town, archiepiscopal see, and capital of the province of Pisa, Tuscany, Italy, on the Arno, 7 miles from the sea and 49 miles west of Florence by rail. It still retains its ancient walls, 6¼ miles in circuit, and is defended by a citadel on the south-west. The principal streets run alongside the river, and are lined with fine buildings. Besides the cathedral, the baptistery, and the leaning tower, the city possesses several notable churches, as the Renaissance church of the Tuscan order of St Stephen, built in 1562 from plans by Vasari; San Niccolo, with a four-storeyed tower (1230), built by Niccola Pisano, and the tomb of John of Swabia, the parricide; Santa Caterina (1262); Santa Maria della Spina, in the Italo-Gothic style, built in 1230 and restored in 1872; San Sepolchro, erected in 1150 by Diotisalvi; San Francesco, with frescoes by Taddeo Gaddi; and the basilica of San Michele (1018). Amongst the secular buildings may be mentioned the royal palace; the archiepiscopal palace; the palace of the order of St Stephen, built by Niccola Pisano and reconstructed by Vasari; the Upezzinghi (formerly Lanfreducci) palace, built of Carrara marble in 1590; the Lanfranchi, Agostini, and other palaces; the university (1472); a large hospital (1258); and fine market halls. There are statues to Cosimo I. (by Francavilla), Archduke Leopold, and Ferdinand I. The city possesses also an academy of the fine arts, with a gallery of paintings; and the university a library of 120,000 volumes, a natural history museum, botanical garden, and agricultural schools. The university, founded in 1338, has faculties of law, medicine, mathematics, and philosophy and literature. In 1898 it was attended by 1087 students and had 56 professors. There are also numerous other educational institutions, including the school of the Chamber of Commerce and a technical school. The most important industry is the manufacture of cottons. In the vicinity of the city are the royal stud-farm (horses and dromedaries) of Cascine di San Rossore, and the mineral baths of San Giuliano, alkaline-ferruginous, with temperature 91·4° to 105·8° Fahr. Population (1881), 42,779; (1900), 61,279.

Pisciculture (Marine).—The extent and efficiency of sea-fishing operations in British waters greatly increased during the last decade of the 19th century, but the quantity of fish landed by no means increased in equal proportion, and in the case of certain kinds actually decreased. The average price of fish, especially of soles and turbot, advanced considerably, and it can be proved that the supply at any rate of ground fish on the more accessible grounds, which have been exploited for the longest time, has materially diminished. In the drift-net fisheries the development of the industry and the diminution in the supply have not hitherto been so conspicuous. The fecundity of fish being so great, it is often supposed that adequate protection of the young would be sufficient to maintain the supply of adults. But in cases where the capture of the commercially valuable adult fish is very extensive and persistent, the number of mature individuals surviving to breed may diminish every season, in spite of the protection of the young, and thus in every season there may be fewer young to be protected.

We may specially consider, in reference to this point, the trawl fishery in the North Sea, where the steam trawler, with the large otter trawl, extending 90 or 100 feet at the mouth, is so enormously more efficient than the old sailing trawler with the beam trawl of 40 or 50 feet. The most definite evidence on this question is supplied by Dr Fulton's account of the results of experiments made by the Scottish Fishery Board (*Fourteenth Annual Report*, p. 128). That authority prohibited trawling for ten years in the Firth of Forth and St Andrews Bay, and throughout that time took careful observations of the abundance of fish both in the closed areas and the open areas adjacent to them. Dr Fulton, after careful discussion of the results, shows that in spite of the closure a decrease took place, both in the closed and the open areas, in some of the most important flat-fishes, namely, plaice and lemon soles. Dr Fulton points out that the plaice and lemon sole spawn in the open off-shore areas and not in the closed, and concludes that the diminution was due to the capture of so many adult mature fish in the open areas by the trawlers. Exception was taken to Dr Fulton's evidence by Professor M'Intosh; but Mr Garstang, after re-examining it, finds that, though Dr Fulton's discussion of the statistics was open to certain objections, his conclusions are nevertheless correct. Dr Fulton thinks that protection of the off-shore spawning-grounds is the method most likely to increase the supply of fish. But the question arises whether it is practicable to close off-shore areas to trawling or other kinds of fishing. The Scottish Fishery Board has now for some years closed the whole of the Moray Firth, which includes spawning-grounds as well as inshore grounds; but this closure applies only to British subjects, and is not therefore complete, as foreign vessels can and do trawl there, a state of things which it is difficult to justify.

Artificial Propagation.—The conclusion that the chief cause of the diminution in the supply of fish is the excessive destruction of the mature adults, is a strong argument in favour of the necessity of artificial propagation. But in spite of the efforts which have been made since 1890, it is by no means certain that a practically successful system of artificial propagation has yet been devised. The practice hitherto followed is to obtain a large number of fertilized eggs, to keep them in appropriate apparatus until they are hatched, and then to liberate the fry in the sea. The number of eggs produced by a single female fish is very large, as will be seen from the following list of average numbers:—

Plaice	300,000	Haddock	500,000
Lemon dab	500,000	Whiting	100,000
Sole	500,000	Cod	3,000,000
Turbot	8,000,000	Ling	20,000,000

The number varies according to the size of the individual fish, as well as according to the species; but a very large number of eggs can be obtained from a small number of mature fish, and if the number of valuable fish produced bore any considerable proportion to the number of eggs which can be obtained, the results of artificial propagation would be very important. The fertilization of the spawn is very easily effected. The eggs are collected either by stripping them from the mature adult immediately after capture, or by keeping the adults alive until they are ready to spawn, and then stripping them, or by keeping them in reservoirs of sea water and allowing them to spawn of their own accord. In the two former cases a little milt is allowed to fall from a male fish into a vessel containing sea water, and the eggs are pressed from the female fish into the same vessel. With few exceptions, the eggs of commercially valuable marine fishes are buoyant in sea water and free; those of the herring and of the American winter flounder, however, are heavy and adhesive.

The United States Fish Commission possesses two marine hatcheries, one at Gloucester and one at Wood's Hole, both in Massachusetts. In the winter of 1897–98 the following results were obtained:—

Gloucester	160 million eggs yielded	96 millions of	cod fry.
,,	7 ,, ,,	4 ,,	pollack fry.
Wood's Hole	153 ,, ,,	105 ,,	cod fry.
,,	57 ,, ,,	39 ,,	winter-flounder fry.

The Government of Newfoundland possesses a hatchery at Dildo Island, in Trinity Bay. This establishment is under the direction of Mr Adolf Nielsen, Superintendent of Fisheries, and is devoted entirely to the propagation of cod. The total output of fry since the commencement of operations has been as follows:—

1890	17 millions.	1894	221 millions.
1891	39 ,,	1895	188 ,,
1892	165 ,,	1896	186 ,,
1893	201 ,,		

The annual average, therefore, has been over 145 millions. In 1896 the number of cod eggs placed in the hatching apparatus was 233 millions, so that the proportion lost in the process of development was 20 per cent. In 1890, we are informed, the loss was 49·4 per cent., and therefore a great improvement has been effected.

The first important marine hatchery established in Europe was that of Captain Dannevig at Flödevig, near Arendal, on the south coast of Norway. This also deals almost exclusively with cod eggs. The total numbers hatched annually have been as follows:—

1891	193½ millions.	1894	100 millions.
1892	208 ,,	1895	85 ,,
1893	240 ,,	1896	327 ,,

Of these fry about 15 millions have been liberated on the average every year in Christiania Fjord; the rest have been put into the sea near Arendal.

In Britain the Scottish Fishery Board has maintained a marine fish hatchery since the year 1894. Until 1899 this establishment was situated at Dunbar; it has since been removed to the Bay of Nigg, near Aberdeen. Its resources have been devoted principally to plaice, the fry of which have been hatched in numbers varying from 11 millions to 38 millions per annum. In the years 1895 and 1896 a few million fry of cod, lemon dabs (*Pl. microcephalus*), and turbot were hatched. In the earlier years the fry were all liberated in the sea near Dunbar, but in recent years all the plaice fry were put into upper Loch Fyne, in order that more definite evidence might be obtained concerning the effect of the introduction of artificially hatched fry on the subsequent supply of adult fish. The efficiency of the arrangements in the Dunbar hatchery, which has been under the management of Mr Harald Dannevig, a son of Captain Dannevig, is proved by the fact that the loss of eggs during hatching operations was only 10·7 per cent. for a whole season.

A small hatchery has been established by the Lancashire Sea Fisheries Committee at Piel, on the shore of Morecambe Bay. In the year 1899 over 3 million fry were produced and liberated. These consisted principally of cod fry; of plaice there were 364,000, of haddock 340,000, and of flounder a few thousands.

Hatching Apparatus.—In the United States and in Newfoundland the apparatus generally used for hatching buoyant ova is the M'Donald automatic tidal box. This apparatus is made of wood, and consists of water-tight compartments each 2½ feet by 1½ foot in area, and 18 inches deep. In each compartment fits an egg-box, the bottom of which consists of linen scrim. The outflow pipe is in the form of a siphon, so that the outflow is intermittent, and the level of the water in the box rises and falls alternately. Water is admitted through the side of the egg-box. These arrangements are supposed to keep the eggs in constant motion. In the Dannevig apparatus, which is used in England and Norway, the egg-boxes are only 1 foot square, and are hinged by one side to the sides of the water-tight compartments. The apparatus is fixed in a slanting position and water flows from one compartment into the egg-box below, the overflow being continuous, not intermittent. Usually the egg-boxes are moved at intervals by a mechanical arrangement, to keep the eggs in motion. This apparatus has proved very successful.

Results of Artificial Propagation.—Very little satisfactory evidence, of a statistical kind, of the results of artificial propagation has been published. The following figures, given by Captain Dannevig for Christiania Fjord, are probably the most important yet produced:—

Year.	Number of Cod caught.	Millions of Fry planted.
1892	44,013	10
1893	50,322	20
1894	65,212	—
1895	65,753	12
1896	70,414	18
1897	70,898	15
1898	81,367	15
1899	78,760	15

During the period covered by the above figures the great cod fisheries of the north of Norway showed considerable fluctuations, but no general increase.

As there seems no reason at all to suppose that artificially-hatched fry are in any way inferior to those produced naturally, a certain proportion of the millions of fry planted must develop into fish of marketable size. The only questions, therefore, to be considered are: (1) What is the magnitude of the results produced by operations of the method and extent indicated above? (2) Does the value of possible result exceed the cost of the operations? (3) What improvements can be suggested in the mode of operation?

If the fry placed in a certain area, such as Christiania Fjord, were the only fry of the species in that area, there would be no doubt that the fish caught were the result of artificial propagation. But in order to be convinced that an increase in the fish caught is due to artificial operations, we ought to be able to compare the number of fry introduced with the number naturally produced. We may do this either by comparing parent fish in the two cases, or the eggs and fry in the two cases. Supposing every egg hatched into living fry, the fifteen millions of fry placed by Dannevig in Christiania Fjord would be the produce of only about five mature female cod. Supposing that only one-tenth of the eggs are hatched in the sea, the same number of fry would be the produce of fifty female cod. The question therefore arises whether the addition of fifty mature female cod, with a suitable number of males, each year would double the cod supply in Christiania Fjord. It is at any rate evident that artificial propagation on the scale on which it has hitherto been carried on cannot possibly check to any considerable extent the diminution of great sea fisheries. For example, it has been calculated that four million mature female plaice were landed in a year at Grimsby alone. The greatest number of plaice fry produced by the Scottish hatchery was thirty-eight millions. Taking the number of eggs produced by one plaice at only 200,000, and supposing only one-tenth to hatch in the sea, the produce of the hatchery represents 1900 female plaice in the sea; so that the work of the hatchery is equivalent to returning to the sea one female plaice out of every 2000 killed at Grimsby, leaving the plaice landed at other ports out of consideration.

As an instance of the comparison of artificially and naturally produced fry, the following may be given. Mr Williamson (*Report* of Scottish Fishery Board for 1898) estimated, from a number of tow-net collections made at definite intervals, that 483 millions of plaice eggs were naturally produced in Loch Fyne in one spawning season. The number of artificially-hatched fry added was 19 millions. As the plaice eggs in the loch were in all stages of development, the loss before hatching could not be very high. Supposing only 100 million fry were naturally hatched in the loch, the increase in the supply of plaice due to artificial hatching would be only 19 per cent. However, even a small percentage added to the produce of a valuable fishery may be worth a good deal of money, and it is interesting to consider whether it is possible to compare the cost of hatcheries with the value of results.

The working of the hatchery at Dildo, Newfoundland, in 1896, is stated to have cost £200 a year. Captain Dannevig states that his hatchery has produced 2163 millions of fry in ten years, at a cost of £485 a year, but he does not say whether the value of the fishery has been increased by that amount. With regard to shad-hatching in the United States, it is stated (U.S. Fish Commission *Report* for 1898, published 1899) that the value to the fishermen of the shad caught in 1880 was $995,790, in 1896 $1,656,711, an increase of $660,921, while the total expenditure in the year 1896–97, for shad-hatching alone, was only $15,726. The total appropriation for the Commission from the U.S. Treasury in 1898 was $462,076 = £92,415; for propagation alone, $132,500, or £26,500.

Rearing of Fry.—The development of the fish in the egg up to the moment of hatching takes but a short time, namely, from three or four days up to about three weeks, according to temperature and the kind of fish. The development of the hatched fry up to the perfect condition in which it resembles its parents takes from six weeks to three months. There can be no doubt that most destruction occurs during this stage, both because it is longer than the egg stage and because the young fish have to seek their own food. The fry also have more enemies than the eggs or older fish. It would therefore be advantageous to rear the fry through the larval stage before putting them into the sea. Such rearing has generally been found very difficult, but experience indicates that the two chief conditions of success are: (1) to feed the larvæ *before* the yolk has all been absorbed; (2) to move the larvæ artificially in the water. Fish larvæ and other pelagic creatures seem to require the stimulus of considerable agitation in the water to keep them in vigour. In 1886 Dannevig turned out 500,000 cod larvæ into a closed reservoir 43 yards long by 20 yards in breadth and 5 yards in greatest depth. Some of these lived for two years; but his object was merely to prove that they would develop into perfect cod, not to rear them before they were put into the sea. In 1896 Harald Dannevig reared plaice larvæ at Dunbar in a large glass carboy, changing the water twice a day: when six weeks old they had nearly completed their transformation and had taken to lying on the bottom. If the fry are not reared to the fully-developed condition, it is open to question whether it would not be equally beneficial to put the fertilized eggs directly into the sea, instead of hatching them. The process of hatching absorbs a large proportion of the cost of artificial propagation, and it is not certain that the protection of the eggs alone is worth the expense.

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Pisek, the chief town of a government district in Bohemia, Austria, on the Woltawa, 24 miles west by south of Tabor. Population (1890), including suburbs, 10,950; (1900), 13,574, including garrison of 935; mostly Czech and Catholic. Feldspar, quartz, and granite are quarried in the environs.

Pistoja, a town and episcopal see of the province of Florence, Tuscany, Italy, 21 miles north-west of Florence on the railway to Bologna. It is surrounded by a wall pierced by five gates and further defended by a citadel. Its institutions embrace a medical institute, a natural history museum, an academy of sciences, and two small libraries. Its varied industries include iron and steel works, manufactures of glass, silk, macaroni, woollens, olive oil, ropes, paper, and vehicles. Population (1881), 30,951; (1899), 32,000.

Pitcairn Island, the most southerly island of the Low Archipelago, in the eastern Pacific Ocean, in 25° 3′ S. and 130° 6′ W. It became known as the home of the mutineers of the *Bounty*, of whom the present inhabitants are for the most part descendants by Tahitian wives. Described in past travels as the denizens of an earthly Paradise, they seem to have fallen sadly from their high estate. There has been a gradual disappearance of trees, which has affected the climate and caused droughts, and though there is still much fertile soil left in the valleys and on the hills in the interior, the energy to make use of it is lacking. Recent accounts describe the people as "lax in morals" and "weak in intellect"; as "degenerating"; "unless something is speedily done to alter their condition they will probably drift into hopeless imbecility." Intermarrying has brought about its natural results, and the want of intellect among the young is reported to be appalling. There would appear, however, to be some reason to believe that these accounts have been unduly pessimistic, for later report is of a much more favourable character. Nevertheless the population is diminishing. In 1901 it was 126. Meat, except goat's flesh and chicken, is unknown. The island is overrun by chickens, which unfortunately the islanders do not appreciate. Tea, coffee, tobacco, and spirituous liquors are never tasted. There is an annual election of a governing body of seven, who elect their chairman. The island has now been placed under the jurisdiction of the High Commissioner of the Western Pacfic. It has been proposed to remove the people *en masse* to Fiji, Tahiti, or Norfolk Island, but the mischief may be remedied by the opening up of a frequent communication with Tahiti.

The Parliamentary Papers C. 9148, *Correspondence relating to the Condition of the Pitcairn Islanders*, 1899, and Cd. 754, *Further Correspondence, &c.*, 1901, should be consulted. (H. E. EG.)

Pitch, Musical.—The pitch of a musical sound is aurally defined by its absolute position in the scale and by its relative position with regard to other musical sounds. It is precisely defined by a vibration number recording the frequency of the pulsations of a tense string, a column of air, or other vibrator, in a second of time. In Great Britain and America the complete vibration to and fro (swing both ways of a pendulum) is taken as the unit; elsewhere the vibration in one direction only (swing one way of the pendulum). The only official standard is the French, dating from 1859, preserved by a tuning-fork vibrating 870·9 (double vib. 435·45) at a temperature of 15° Centigrade (59° Fahr.) in a second. The vibration number stated in the edict establishing the Diapason Normal is 870 (435), which for comparison will be here adhered to. The natural basis for a standard musical pitch is the voice, particularly the male voice, which has been of greater importance historically. There is no reason to suppose the human voice has varied, during the period of which we have evidence, more than other physical attributes. The only difference to be reckoned with may be in recent tendencies of solo vocalists to sing for effect, and so to extend the compass of the voice upwards. Otherwise we may assume no disturbing alteration has taken place for more than 2000 years in its position and extent. Vibrations increase in rapidity as a note rises, and decrease as it falls. Any note may be a pitch note; for orchestras custom has settled upon a^1 in the treble clef, for organs and pianos in Great Britain c^2, and for modern brass instruments b flat^1.

We are not without a clue to the pitch usual in the classic Greek and Alexandrian ages: the vocal octave to which the lyre was adapted was noted as from e to e^1. As in choruses baritone and low tenor singers always prevail, d–d^1, at French or at medium pitch, would really be the Greek singing octave; we may therefore regard it as a tone lower than that to which we are accustomed. But to sing the lower Greek modes in or near the vocal octave it was necessary to transpose (μεταβολή) a fourth upwards, which is effected in modern notation by a flat placed upon the b line of the staff; thus modulating from our major key of C to that of F. This transposition has had, as we shall see, much to do with the history of our subject, ultimately influencing the ecclesiastical chant and lasting until the 17th century of our era. It does not appear from any evidence that the keyboards—when there were more than one—of the early organs were arranged for transposition, but it is certain that the Flemish harpsichords to 1650 were made with double keyboards to accommodate it, as the writer has proved elsewhere (*History of the Pianoforte*, Novello, London, 1897). But a positive identity of pitch cannot be claimed for any period of time, and certainly not for the early organs; the foot-rule of the organ-builder, which had to do with the lengths of the pipes, and which varied in every country and province, could easily cause a difference of a semitone. Scale and wind-pressure are also important factors. But with all these often opposed conditions, we find less variation than might be expected, the main and really important divergence being due to the necessity of transposition, which added a very high pitch to the primarily convenient low one.

The first to attempt to define pitch would seem to have been Arnold Schlick (*Musica ausgeteutscht und ausgezogen*, Heidelberg, 1511), who gives a measure, a line of $4\frac{7}{8}$ Rhenish inches, which, he says, multiplied sixteen times, should be the lowest F of a small organ. He gives no diameter or wind-pressure. The late Dr A. J. Ellis used this indication to have an organ pipe made which, with one-sixteenth diameter and a wind-pressure of $3\frac{1}{4}$ inches, at one-fourth Schlick's length, gave f^1 301·6, from which he derived a just major third of a^1 377, which would compare very well with an old Greek a^1. Schlick goes on to say the organ is to be suited to the choir and properly tuned for singing, that the singer may not be forced to sing too high or too low and the organist have to play chromatics, which is not handy for every one. Further, he says pitch cannot be exactly defined, because voices vary; he nevertheless gives the measure above mentioned for the low F, but if a larger organ is built to include the still lower C, then this C must be *of the same measurement*, the reason being that a greater part of Church music ends in "grambus," a word understood by Schlick's editor to mean the transposition of a fourth. The larger high-pitch organ will therefore be at a^1 502·6. The Halberstadt organ, about which so much has been written, was, according to Praetorius (*Syntagma Musicum*, Wölffenbüttel, 1618), built in 1361, and repaired or rebuilt 1495. He gives the longest pipe of this organ, B natural, as 31 Brunswick feet, and the circumference $3\frac{1}{2}$ feet. He further tells us this pitch was a tone, nearly a tone and a half, higher than a suitable church pitch (*Chorton*), for which he gives a diagram. Dr Ellis had pipes (now preserved in the Royal Institution, London) made to reproduce both these pitches at $3\frac{1}{4}$ inches wind-pressure. The Halberstadt pitch was found to be a^1 505·8; the *Chorton*, 424·2. Ellis used mean-tone temperament in calculating this lower pitch; but as he used just intonation for the Halberstadt, it seems preferable to substitute it for the *Chorton*, thus reducing it to a^1 422·8. Praetorius's *Cammerton*, or chamber pitch, formulated in his diagrams for voices and instruments, is, he says, a whole tone higher; equivalent, therefore, to a^1 475·65. Nearly all the German organs in his time were tuned to this higher pitch. Ellis offered the suggestion of a much higher pitch for this *Cammerton* in his lecture "On the History of Musical Pitch," read before the Society of Arts, London (*Journ. Soc. Arts*, 5th March 1880), but the writer is unable to accept it. The lower vibration number is justified by due consideration of the three divisions of the male voice, bass, tenor, and alto, as given by Praetorius, whose *Cammerton* very closely corresponds with Bernardt Schmidt's Durham organ, 1663–68, the original pitch of which has been proved by Professor Armes to have been a^1 474·1. The Halberstadt pitch is nearly a semitone higher, which again agrees with the statement of

Praetorius, and also Schlick's high C organ. Yet it would seem there had been a still higher pitch used in the old ecclesiastical music. Upon this interesting question Praetorius is confused and difficult to understand, but he never wavers about the transposition of a fourth. In one passage he distinctly says the old organ high pitch had been a whole tone above his *Cammerton*, with which we shall find his *Tertia minore* combines to make the required interval. The term "*Tertia minore*," or "*inferiore*," is used by Praetorius to describe a low pitch, often preferred in England and the Netherlands, in Italy, and in some parts of Germany. An organist, instead of transposing a whole tone down from the *Cammerton*, would for the *Tertia minore* have to transpose a minor third. A corroboration of this pitch is found in A. Silbermann's great organ in Strasburg minster (1713–16), the pitch of which, taken in 1880 and reduced to 59° Fahr. (as are all pitches in this article), is a^1 393·2. An old organ at Versailles (1789) was very near this example, a^1 395·8. Sir Frederick Gore Ouseley (*vide* Ellis's lecture) regarded the French *ton de chapelle* as being about a minor third below the Diapason Normal, a^1 435, and said that most of the untouched organs in the French cathedrals were at this low pitch. Strasburg was French territory in 1713, but Silbermann's organ is not quite a whole tone below. Ellis quotes an organ at Lille, a^1 374·2, but no other instance of the very low Schlick pitch is recorded, although trial of the French cathedral organs might perhaps result in the finding of examples. Ellis gives Dom Bédos (*L'Art du Facture d'orgues*, Paris, 1766) as authority for a mean tone a^1 376·6. To return to the *Tertia minore*. Dr R. Smith, of Cambridge, in 1759, had the organ of Trinity College, built by Bernhardt Schmidt, lowered a whole tone, to reduce it to certain Roman pitch pipes made about 1720. His determinations of pitch by a weighted wire are not trustworthy; Ellis thinks they are not safe within four or five vibrations per second, but gives a mean pitch for this organ, when altered, of a^1 395·2. St Michael's Church at Hamburg, built as late as 1762 and unaltered in 1880, had a 17th-century pitch, a^1 407·9. This is about a semitone below the Diapason Normal, and a just minor third lower than the St Jacobi organ in the same city (1688), measured by Herr Schmahl, a^1 489·2. What was remarkable in this organ was that it had one stop which was an equal minor third lower, a^1 411·4[1]. The difference of a minor third, or, as we shall see later, a whole tone, had replaced the earlier fourth. Sir Frederick Gore Ouseley's comparison of the church and chamber pitches of Orlando Gibbons (*vide* Ellis's lecture) clearly shows the minor third in Great Britain in the first half of the 17th century. But the narrowing continued. Bernhardt Schmidt, better known in England as Father Smith, was invited about 1660 to build the organ for the Chapel Royal, Whitehall. Two years later he built the organ in Durham Cathedral, a^1 474·1, difference a whole tone, and practically agreeing with the *Cammerton* of Praetorius. The Hampton Court organ of 1690 shows that Schmidt had further lowered his pitch a semitone, to a^1 441·7. What happened at Durham was that at some subsequent date the pipes were shifted up a semitone to bring the organ into conformity with this lower pitch, with which it is probable Schmidt's organs in St Paul's and the Temple, and also Trinity College, Cambridge, agreed. This lowering tendency towards the low church pitch, and the final adoption of the latter as a general mean pitch throughout the 18th century, was no doubt influenced by the introduction of the violin, which would not bear the high tension to which the lutes and viols had been strained. Harpsichords had long been preferred at the *Tertia minore*. The *Chorton* of Praetorius, a^1 422·8, is practically the same pitch as that of the fork the possession of which has been attributed to Handel, a^1 422·5. It is a very fair mean between G. Silbermann's 18th-century Dresden pitch, a^1 415, and the organs of Renatus Harris, a^1 428·7. Stein tuned Mozart's piano to a fork a^1 421·6, and the Broadwood pianos used at the London Philharmonic Society in its first concerts (1813) were tuned to a fork c^2 506·8, which gives a mean tone a^1 423·7.

According to Schindler (*Niederrheinische Musik-Zeitung*, 1855, Nos. 8 and 9) and the report of the French Commission, 1859, the rise in pitch began at the Congress of Vienna in 1816, the military bands being the cause. With the improvements in wind instruments this continued, as a more brilliant effect was gained. In 1823 Weber's *Euryanthe* is recorded as having been played in Vienna at a^1 437·5, and in 1834 Kreutzer's *Nachtlager* at a^1 440. The measurements are doubtful, but the upward tendency is clear. Scheibler, who was nothing less than trustworthy, owing to his simple and accurate Tonometer, has recorded pitches in Vienna about 1834 from a^1 433·9 to 440·2. About that time, or it may be a few years earlier, Sir George Smart established a fork for the Philharmonic Society, a^1 433·2. Forks intended for this vibration number, stamped "Philharmonic," were sold as late as 1846. But about that year the performing pitch of the Society had reached 452·5. Sir Michael Costa was the conductor 1846–54, and from his acceptance of that high pitch the fork became known as Costa's, and its inception was attributed to him, though on insufficient grounds. In 1874 a further rise in the fork to a^1 454 was instigated by Sir Charles Hallé. The British army is bound by His Majesty's Rules and Regulations to play at the Philharmonic pitch, and a fork tuned to a^1 452·5 in 1890 is preserved as the standard for the Military Training School at Kneller Hall. But the Philharmonic Society adopted the Diapason Normal in 1896, and the military bands have not gone with it. In point of fact, they are gradually going higher, and the brass bands, which are so important in the North of England and in Wales, are not behind them.

It was the irrepressible upward tendency that caused the French Government in 1859, acting with the advice of Halévy, Meyerbeer, Auber, Ambroise Thomas, and Rossini, to establish by law the *Diapason Normal*. Other countries have gradually followed, and, with few exceptions, the low pitch derived from the Diapason Normal may be said to prevail throughout the musical world. Great Britain has been the last to fall in, but the predominance of the low pitch, introduced at Covent Garden Opera since 1880, is assured. The proprietors of Queen's Hall, London, did much for it when they undertook the alteration, at great expense, of their large concert organ, which had only just been erected. In 1896 the Philharmonic Society decided upon a performing pitch, ostensibly at 68° F., of a^1 439; and in 1899 Messrs Broadwood made a successful effort to get this vibration number accepted by their competitors in Great Britain. The high pitch remains only where there are large concert organs not yet lowered, and with the military and brass bands.

The consideration of temperature as affecting the use of a standard pitch was not attended to when the French Government issued its ordonnance. The 15° Centigrade attached to the description of the standard fork in Paris was intended for the definition and verification of the fork only. The alteration of the fork due to heat is scarcely perceptible, but wind instruments, and particularly the organ, rise almost proportionately to the increase in temperature of the surrounding air, because sound travels at an enhanced rate as the temperature rises. The coefficient of this rise is equivalent to half a vibration (0·5) per degree Fahr. per second. Mr D. J. Blaikley (*Essay on Musical Pitch*, Catalogue of the Royal Military Exhibition, Chelsea, 1890) and Mr Victor Mahillon (*Catalogue descriptif et analytique du Musée*, Bruxelles, troisième volume, appendice, 1900) have recorded their experience of wind instruments under changes of temperature. The French Commission, in establishing the Diapason Normal, should have chosen a temperature of 20° C. There would then have been less disturbance owing to the breath of the players and heat of the theatres or concert rooms. It would be a great advantage to get this higher grade generally adopted. It was proposed in the Stimm-Conferenz at Vienna in 1885, but not carried. Table III., showing orchestral pitches obtained in 1899, for the measurements of which the writer is responsible, prove how chimerical it is to hope for greater accuracy than is found between 435 and 440 vibrations a second for a^1, inasmuch as temperature must always be reckoned with.

Table I.

1495 to 1690. Pitch descending.	Authority.	V. at 59° F.
Halberstadt organ . . . 1495	Ellis	a^1 505·8
Arnold Schlick, Heidelberg 1511	Ellis	502·6
St Jacobi, Hamburg . . 1688–93	Schmahl	489·2
St Catharinen, Hamburg . 1543	Degenhardt . . .	480·8
Praetorius. *Cammerton* . 1618	Hipkins	475·65
Durham organ 1683	Armes and Ellis .	474·1
Great Franciscan organ, Vienna . . . . . *c.* 1640	Ullmann . . .	457·6
Hampton Court organ . . 1690	Ellis	441·7

Table II.

1511 to 1900. Pitch ascending.	Authority.	V. at 59° F.
Arnold Schlick, Heidelberg 1511	Ellis	a^1 377·0
Strasburg Minster. A. Silbermann 1713–16	Stockhausen . .	393·2
Trinity College, Cambridge . 1759	Smith and Ellis .	395·2
Versailles organ 1789	M'Leod and Ellis .	395·8
Praetorius "Tertia minore" 1618	Hipkins	396·4
St Michael's, Hamburg . . 1762	Schmahl	407·9
Pascal Taskin's tuning-fork, Paris 1783	Lissajous . . .	409·0
St Jacobi, Hamburg, "Tertia minore" stop . . . 1688–93	Schmahl	411·4
Hofcapelle, Dresden . . . 1754	Näke	415·0
St Sophie, Dresden. G. Silbermann 1722	Näke	415·5
Freiberg. G. Silbermann . 1714	Näke	419·5
Seville Cathedral . . . 1785–90	Ellis	419·6
Old English tuning-fork *c.* 1715	Ellis	419·9
Imperial Russian Court Church Band 1860	Näke and Ellis . .	421·2
Stein's tuning-fork, Vienna 1780	Näke and Ellis . .	421·6
Handel's tuning fork . . 1751	Ellis	422·5
Praetorius. *Chorton* . . . 1618	Ellis and Hipkins .	422·8
Peppercorn's tuning-fork (Broadwood) 1813	Ellis	423·5
Renatus Harris, St Andrew's Undershaft 1696	Ellis	427·7
Renatus Harris, Newcastle-on-Tyne 1670	Ions and Ellis . .	428·7
C. Meerens, proposed standard derived from c^2 512, and favoured by Boïto and other Italian musicians . 1876	Meerens	432·0
Sir George Smart, Philharmonic 1826–34	Ellis	433·2
Scheibler No. I., Vienna orchestra 1834	Scheibler . . .	433·9
Montal's tuning-fork, Paris opera 1829	Cagnard de la Tour	434·0
Scheibler No. II., Paris opera 1834	Scheibler . . .	434·0
Reissiger's tuning-fork, Dresden 1826	Näke	435·0

Table II—continued.

1511 to 1900. Pitch ascending.	Authority.	V. at 59° F.
Paris Diapason Normal. Ordonnance 1859	Fr. Comm. . .	435·0
Scheibler No. III., Paris Conservatoire 1834	Scheibler . . .	435·2
Paris Diapason Normal. Standard fork 1859	Koenig	435·45
Paris opera 1836	Cagnard de la Tour	437·0
Scheibler, Stuttgart, proposed standard (440 at 69° F.) 1834	Scheibler . . .	440·2
Scheibler No. IV., Vienna opera 1834	Scheibler . . .	440·3
Hullah's tuning-fork . . . 1842	Ellis	441·3
Naples opera. San Carlo . 1857	Lissajous . . .	444·9
Society of Arts intended for 444. (Since 1886 the Society of Arts has advocated the Diapason Normal) 1860	Ellis	445·7
Broadwood's medium . . 1850	Ellis	445·9
Paris grand opera 1858	Lissajous . . .	448·0
Lazarus's clarinet 1843	Ellis and Hipkins .	448·0
Gewandhaus, Leipzig . . 1869	Ellis	448·2
Berlin opera 1857	Lissajous . . .	448·4
Milan opera, La Scala . . 1856	Lissajous . . .	450·3
Philharmonic, London . 1846–54	Ellis and Hipkins .	452·5
Kneller Hall 1890	Hipkins	452·5
Philharmonic, London . . 1874	Hipkins	454·0
Streicher's tuning-fork, Vienna 1859	Ellis	456·1
Strauss's Band, Imperial Institute, London, open air 1897	Hipkins	457·5

Table III.

Orchestral Pitch. 1899.	Authority.	V. at 68° F.
Leipzig	Blüthner . . .	a^1 435·0
Berlin	Bechstein . . .	438·0
New York	Steinway . . .	438·6
Boston	Chickering . . .	438·8
London	Broadwood . .	439·0
St Petersburg	Becker	439·4
Meiningen (and Bayreuth) . . .	Mühlfeld's clarinet	439·5
Stuttgart	A. Schiedmayer .	440·0
Vienna	Bösendorfer . . .	440·0
London. Covent Garden opera .	Hipkins	440·0
Paris	Erard	442·4

Verified by A. J. Hipkins. But for Leipzig a comparison with the Gewandhaus Band may be sought. (A. J. H.)

Pitesci, or PITESTI, a small town in Rumania (Wallachia), situated on the right bank of the river Arges, and capital of the district of the same name. The branch railway to Curtea d'Arges leaves the main line at this point. Population (1900), 15,570.

Pithiviers, chief town of arrondissement, department of Loiret, 26 miles north-east of Orleans, on the railway to Malesherbes. The church of St Solomon is partly of the 12th century, and there are some remains of the ancient ramparts. Statues have been erected of the mathematician Poisson (*d.* 1840), and of the physician and agriculturist Duhamel de Monceau (1700–82), who introduced into his park at Monceau several hundred species of trees and shrubs previously unknown in France. The town is an important centre for saffron, the cultivation of which, originally introduced by the Jews of Avignon, was fostered by Louis XIV. Lark pies and almond cakes are noted comestibles. The shrine of St Solomon in the 9th, and that of St Gregory, an Armenian bishop, in the 10th century formed the nuclei of the town; and the donjon built at the end of the 10th century for Héloïse, lady of Pithiviers, from the design of Lanfroy, was one of the finest of the period. Population (1881), 4745; (1891), 5115; (1901), 6225.

Pitlochry, a village of Perthshire, Scotland, in the midst of charming Highland scenery, at the south end of the Pass of Killiecrankie and on the banks of the Tummel, 7½ miles south of Blair Athole and 28½ north-north-west by rail from Perth. It is a favourite summer resort and excursion centre for the Scottish Highlands. Amongst its immediate attractions may be mentioned the Loch and Falls of Tummel, Killiecrankie Pass, and a couple of hydropathics. The village is well sheltered, although standing 300 feet above sea-level. Population (1901), 1541.

Pitman, Sir Isaac (1813–1897), English phonographer, was born at Trowbridge, Wiltshire, 4th January 1813, and educated at the local grammar school. He started in life as a clerk in a cloth factory, a business with which his father also was connected; but in 1831 it was decided that he should become a schoolmaster, and for this purpose he was sent for training to the Normal College of the British and Foreign School Society in London. Between 1832 and 1839 he held masterships at Barton-on-Humber and Wotton-under-Edge, and from 1839 to 1843 he conducted a private school of his own at Bath. In 1829 he took up Taylor's system of shorthand, and from that time he became an enthusiast in developing the art of phonography. A detailed account of his own system (which he first expounded in 1837) is given under the article SHORTHAND (*Ency. Brit.* xxi. 838 *et seq.*). Pitman devoted himself to perfecting phonography and propagating its use, and established at Bath a Phonetic Institute and a *Phonetic Journal* for his purpose; he printed in shorthand a number of standard works, and his new book on phonography (1st ed., 1840) went through many editions. He was also an enthusiastic spelling reformer, and adopted a phonetic system which he tried to bring into general use. He was twice married, his first wife dying in 1857, and his second, whom he married in 1861, surviving him. In 1894 he was knighted, and on 22nd January 1897 he died at Bath. Sir Isaac Pitman's memory will live as the popularizer of shorthand at a time when the advance of the newspaper press and modern business methods were making it a matter of great commercial importance. His system adapted itself readily to the needs of journalism, and its use revolutionized the work of reporting. He was a non-smoker, a vegetarian, and a great advocate of temperance principles.

Pitt-Rivers, Augustus Henry Lane-Fox (1827–1900), English soldier and archæologist, son of W. A. Lane-Fox, was born 14th April 1827. It was not till 1880 that he assumed the name of Pitt-Rivers, on inheriting the Dorsetshire and Wiltshire estates of his great-uncle, the second Lord Rivers. Educated at Sandhurst, he received a commission in the Grenadier Guards in 1845, being captain 1850, lieut.-colonel 1857, colonel 1867, major-general 1877, and lieut.-general 1882. He served in the Crimean War, and was at the Alma and the siege of Sebastopol. His talent for experimental research was utilized in investigation into improvements of the army rifle, and he was largely responsible for starting the Hythe School of Musketry. It is not, however, for his military career, but for his work as an anthropologist and archæologist, that General Pitt-Rivers will be remembered. His interest in the evolution of the rifle early extended itself to other weapons and instruments in the history of man, and he became a collector of articles illustrating the development of human invention. His collection became famous, and, after being exhibited in 1874–75 at the Bethnal Green Museum, was presented in 1883 to the University of Oxford. When, in 1880, General Pitt-Rivers obtained possession of his great-uncle's estates—practically untouched by the excavator since they had been the battleground of the West Saxons, the Romans, the Britons—he devoted himself to exploring the rich field of research which they offered. His excavations round Rushmore discovered a mine of materials of the utmost interest and value; he founded a local museum to exhibit the results, and published several illustrated volumes recording them. As a scientific archæologist he was recognized as taking rank among the first. Oxford gave him the degree of D.C.L. in 1886; he was president of the Anthropological Institute, and F.R.S. He married, in 1853, Alice Margaret, daughter of the second Lord Stanley of Alderley, and had a numerous family; his second daughter became, in 1884, the wife of Sir John Lubbock (Lord Avebury). General Pitt-Rivers died at Rushmore, 4th May 1900.

Pittsburg, a city of Crawford county, Kansas, U.S.A., at the intersection of five trunk lines of railway, at an altitude of 934 feet. It has a level site and a regular plan, and is divided into four wards. It is in the lead and zinc region of south-eastern Kansas and south-western Missouri, and contains zinc smelting works. Population (1880), 624; (1890), 6697; (1900), 10,112, of whom 860 were foreign-born and 365 negroes.

Pittsburg.—Pittsburg, the second city in Pennsylvania and chief iron and steel manufacturing centre in the United States, situated at the junction of the Allegheny and Monongahela rivers, where they unite to form the Ohio river. The closing decades of the 19th century brought exceptional municipal and industrial growth. In 1880 the population within the city limits was 156,389, in 1890 it was 238,617, and in 1900 it was 321,616. The largest growth during the last decade of the century was in the manufacturing and residential suburbs outside the city limits. The total population for the entire industrial community of city and suburbs, estimated in 1885 at 325,000, was 450,000 in 1890, and in 1900 was estimated at 650,000. For several years the city enjoyed in natural gas a smokeless and extraordinarily cheap fuel. About 1890 the supply began to be inadequate to the demand, and the price rose to a level which confined its main use to household purposes, and manufacturers returned to the coal of western Pennsylvania. The cheques passing through the clearing-house in 1883 aggregated $497,653,962. In 1901 they aggregated $2,047,605,967, or more than four times as much. In the same period the production of iron and steel in the city and its neighbourhood increased sixfold. In 1901 there were 34 blast furnaces, producing 3,690,011 tons of pig iron, and (1899) 63 rolling mills and steel works, producing 4,134,917 tons of finished iron and steel. Of the entire production of the United States, the Pittsburg district in 1899 produced 24 per cent. of the pig iron, 34 per cent. of the Bessemer steel, 50 per cent. of the open-hearth steel, and 64 per cent. of the structural iron. Not only have existing works, such as the Carnegie Steel Company, the Westinghouse works, expanded until they are the largest in their respective lines in the world, but districts previously rural, such as Ford City, East Pittsburg, Glassport, Charleroi, and Davis Island City, have become manufacturing towns, so that the manufacturing district of Pittsburg has been extended 25 to 30 miles up the Allegheny and Monongahela, and 10 miles down the Ohio. Within this manufacturing district in 1900 there were 3300 manufacturing establishments of all kinds, employing 250,000 men, and having aggregate assets of $2,000,000,000. The total freight tonnage of the district for 1899 was 58,656,697, of which

5,683,120 tons were shipped by river. In 1901 Pittsburg received a new charter under the state law for the government of second-class cities. The government consists of two branches of councils, and a Recorder as executive, directing departments of public works, public safety, and public charities. Under it about $30,000,000 have been expended for city improvements of all kinds. Prior to 1890 Pittsburg had no parks, but it now contains Schenley Park, of 422 acres, the greater part of which was the gift of Mrs Mary E. Schenley; Highland Park, of 366 acres; and seven smaller parks aggregating 132 acres; and over a million dollars has been authorized for further park acquisitions. The County Court House of Allegheny county, which was completed in 1888, and cost about $2,500,000, is a splendid structure in the Romanesque style, designed by H. H. Richardson. Another very prominent municipal building is the Carnegie Institute, at the Schenley Park entrance, founded by Andrew Carnegie in 1894, and combining within one building a free library —which has branches throughout the city—an art gallery, a music hall, and a museum. On this foundation Andrew Carnegie has expended nearly $8,000,000, while his similar gifts to the suburban municipalities amount to $2,000,000 more. Schenley Park also contains a fine conservatory, the gift of Henry Phipps; and Highland Park contains zoological buildings, the gift of C. L. Magee. The total assessed valuation of real and personal property in the city in 1900 was $352,582,792; the net debt was $19,600,569. The income for the fiscal year, not including loans of $7,137,410, was $9,251,065; and the total expenditures, not including loans repaid, were $10,838,360. The amount of cash on hand at the end of the fiscal year was $7,449,751. Of the total population in 1900, 84,878 were foreign-born and 17,040 were negroes. Out of 96,563 adult males, 7933 were illiterate (unable to write), of whom 6419 were foreign-born and 1116 were negroes. The death-rate in 1890 was 20·1; in 1900 it was 20. (See Allegheny.)

Pittsfield, a city of Massachusetts, U.S.A., capital of Berkshire county, on the Housatonic river, at an altitude of 1013 feet. It has a large area, 43 square miles, situated mainly in the broad, level valley between the Hoosac and Taconic mountains. The densely-built portion is regularly laid out, has a water supply derived from Lake Ashley by gravity, and is divided into seven wards. It is on the main line of the Boston and Albany Railway, and on a branch of the New York, New Haven, and Hartford Railroad. The city has extensive manufactures of cotton and woollen goods, boots and shoes, and paper. Population (1890), 17,281; (1895), 20,461; (1900), 21,766, of whom 4344 were foreign-born and 277 negroes.

Pittston, a city of Luzerne county, Pennsylvania, U.S.A., on the north branch of the Susquehanna river, near the mouth of the Lackawanna, at an altitude of 571 feet. Its site is uneven, the street plan is irregular, and it is divided into eleven wards. It is on five railways, the Central of New Jersey, the Delaware and Hudson, the Delaware, Lackawanna, and Western, the Erie and Wyoming Valley, and the Lehigh Valley. It is in the anthracite coal region, and has a large coal traffic. Its manufactures are varied. Formerly a borough, it received a city charter in 1894. Population (1890), 10,302; (1900), 12,556, of whom 3394 were foreign-born.

Piura, the most northerly department of Peru; area, 13,931 square miles. Population (1896), 213,000. The principal towns of the department are Tumbez (3000), the most northerly port of Peru; Paita (5000), the port of Piura; and Piura, capital of the department (12,000)—all in provinces of the same names; Catacaos, in the province of Ayabaca; Sechura (8500); and Sullana (7000), in Huancabamba. In the eastern mountain district are the towns of Morropon (5000), Tambo Grande (8000), and Chulucanas (6000).

Pizzo, a seaport town of the province of Catanzaro, Calabria, Italy, 72 miles north-east of Reggio on the west coast railway from Naples, and 27 miles south-west of Catanzaro, on a steep cliff overlooking the Gulf of Santa Eufemia. It has an old castle, in which Joachim Murat, ex-king of Naples, was shot on 13th October 1815. The people engage in tunny- and coral-fishing, and carry on an active coasting trade. In 1897 the port was cleared by 350 vessels of 65,542 tons. In 1783 the town was almost destroyed by an earthquake. Population (1899), about 8500.

Plague.—The exhaustive article by Dr J. F. Payne in the ninth edition of this work brings the history of plague down to about 1880. Since then much has happened to enlarge our knowledge of the disease from every point of view. The most striking feature of the previous history, summarized by Dr Payne, is the gradual retrocession of plague from the West, after a series of exceedingly destructive outbreaks extending over several centuries, and its eventual disappearance from Europe. It appears to have come to a sudden end in one country after another, and to have been seen there no more. Those lying most to the west were the first to be freed from its presence, namely, England, Portugal, and Spain. From all these it finally disappeared about 1680, at the close of a period of pandemic prevalence. Northern and central Europe became free about 1714, and the south of France in 1722. The last outbreak in northern Russia occurred in 1770. After this, plague only appeared in the south-east of Europe, where in turn it gradually died away during the first half of the 19th century. In 1841 its long reign on this continent came to an end with an isolated outbreak in Turkey. From that time until quite recently it has been extinct, except in the East. The province of Astrakhan, where a very small and limited outbreak occurred in 1878, is politically in Europe, but geographically it belongs rather to Asia. And even in the East plague was confined to more or less clearly localized epidemics; it showed no power of pandemic diffusion. In short, if we regard the history of this disease as a whole, it appears to have lost such power from the time of the Great Plague of London in 1665, which was part of a pandemic wave, until the present day. There was not merely a gradual withdrawal Eastwards lasting nearly two hundred years, but the outbreaks which occurred during that period, violent as some of them were, showed a constantly diminishing power of diffusion and an increasing tendency to localization. The sudden reversal of that long process is therefore a very remarkable occurrence. Emerging from the remote endemic centres to which it had retreated, plague has once more taken its place among the zymotic diseases with which Western communities have to reckon, and that which has for more than a century been little more than a name and a tradition has become the familiar object of investigation, carried on with all the ardour and all the resources of modern science. In what follows an attempt will be made to summarize the facts and indicate the conclusions to be drawn from recent experience.

Diffusion.—At the outset it is characteristic of this subtle disorder that the present pandemic diffusion cannot be traced with certainty to a definite time or place of origin. Herein it differs notably from other exotic diseases liable to similar diffusion. For instance, the last visitation of cholera could be traced clearly and definitely to a point of origin in northern India in the spring of 1892, and could be followed thence step by step in its march Westwards. (See CHOLERA.) Similarly, though not with equal precision, the last wave of influenza was shown to have started from central Asia in the spring of 1889, to have travelled through Europe from east to west, to have been carried thence across the sea to America and the Antipodes, until it eventually invaded every inhabited part of the globe. (See INFLUENZA.) In both cases no doubt remains that the all-important means of dissemination is human intercourse. The movements of plague cannot be followed in the same way. With regard to origin, several endemic centres are now recognized in Asia and Africa, namely, (1) the district of Assyr in Arabia, on the eastern shore of the Red Sea; (2) parts of Mesopotamia and Persia; (3) the district of Garwhal and Kumaon in the North-West Provinces of India; (4) Yunnan in China; (5) East and Central Africa. All these are mentioned by Dr Payne, with the exception of the last, which was recently discovered by Dr Koch. It includes the district of Kisiba in German East Africa, and extends into Uganda. In applying the term "endemic centres" to these localities, no very precise meaning can be attached to the word. They are for the most part so remote, and the information about them so scanty, that our knowledge is largely guesswork. What we mean is that there is evidence to show that under various names a disease identical with plague has been more or less continuously prevalent for a number of years, but how long and how continuously is not known. Whether any of them are permanent homes of plague the evidence does not enable us to say. They seem, at any rate, to have harboured it since its disappearance from Europe, and probably further investigation would disclose a still wider prevalence. For instance, there are good reasons for believing that the island of Réunion has been subject, since 1840 or thereabouts, to outbreaks under the name of "lymphangite infectieuse," an elegant euphemism characteristically French. In all the countries named, plague appears to behave very much as it used to do in Europe from the time of the Black Death onwards. That is to say, there are periods of quiescence, with epidemic outbreaks which attract notice at irregular intervals. Taking up the story at the point where Dr Payne leaves off, we get the following list of countries in which plague is known to have been present in each year (Local Government Board's Reports, 1898–99–1900):—1880, Mesopotamia; 1881, Mesopotamia, Persia, and China; 1882, Persia and China; 1883, China; 1884, China and India (as *mahamari*); 1885, Persia; 1886, 1887, 1888, India (as *mahamari*); 1889, Arabia, Persia, and China; 1890, Arabia, Persia, and China; 1891, Arabia, China, and India (as *mahamari*); 1892, Mesopotamia, Persia, China, Russia (in central Asia); 1893, Arabia, China, Russia, and India (as *mahamari*); 1894, Arabia, China, and India (as *mahamari*); 1895, Arabia and China; 1896, Arabia, Asia Minor, China, Japan, Russia, and India (Bombay); 1897, Arabia, China, Japan, India, Russia, and East Africa; 1898, Arabia, Persia, China, Japan, Russia, East Africa, Madagascar, and Vienna; 1899, Arabia, Persia, China, Japan, Mesopotamia, East Africa, West Africa, Philippine Islands, Straits Settlements, Madagascar, Mauritius, Réunion, Egypt, European Russia, Portugal, Sandwich Islands, New Caledonia, Paraguay, Argentine, Brazil: 1900, to the foregoing should be added Turkey, Australia, California, Mexico, and Glasgow; and in 1901, South Africa.

This list is probably by no means exhaustive, but it sufficiently indicates in a summary fashion the extent of that wave of diffusion which set in during the closing years of the 19th century and is still in progress. It did not fully gather way till 1896, when plague appeared in Bombay, but our modern knowledge of the disease dates from 1894, when it attacked Hong Kong and first presented itself to accurate observation. From this point a more detailed account may be given. Plague was recognized at Hong Kong in May 1894, and there can be little doubt that it was imported from Canton, where a violent outbreak—said to have caused 100,000 deaths—was in progress a few months earlier, being part of an extensive wave of infection which is believed to have come originally out of the province of Yunnan, one of the recognized endemic centres, and to have invaded a large number of places in that part of China, including Pakhoi and other seaports. Hong Kong was severely affected, and has never since been entirely free from plague. In two intermediate years—1895 and 1897—very few cases were recorded, but more recently the epidemic has gathered force again. The following table gives the cases and deaths in each of the six years 1894–99:—

Year.	Cases.	Deaths.	Case Mortality.
1894	2833	2550	90 per cent.
1895	45	36	80 ,,
1896	1204	1078	89 ,,
1897	21	18	85 ,,
1898	1320	1175	89 ,,
1899	1486	1415	95 ,,
Total . .	6909	6272	90·7 per cent.

The excessively high rate of mortality is probably due in part to under-statement of the number of cases. Concealment is practised by the Chinese, who are chiefly attacked, and it is easier to conceal sickness than death. Plague appears to have been equally persistent and destructive on the mainland in southern China during the period indicated, but no accurate details are available. In 1897 the Portuguese settlements of Lappa and Macao were invaded. In addition to the provinces of Yunnan, Kwang-si, and Kwang-tung in southern China, plague is reported to have been present for several years in a district in Mongolia to the north of Peking, and distant about "twelve days' ride." More recently several localities in Mongolia and Manchuria have been affected. Formosa was attacked in 1896, and has suffered considerably in subsequent years; in 1899 the Japanese Government officially reported 2633 cases, with 1974 deaths. Japan itself has had a certain amount of imported plague, but not on a large scale. Speaking generally, the disease has persisted and spread in the Far East since 1894, but precise information is lacking, except with regard to Hong Kong.

In 1896 plague appeared in the city of Bombay. It was certainly present in August, but was not recognized until 23rd September, and the diagnosis was not bacteriologically confirmed until 13th October. This fact should be remembered when failure to recognize the disease on its first appearance occurs elsewhere. The origin of the Bombay invasion is shrouded in obscurity. It is not even known when or in what part of the city it began (Condon, *The Bombay Plague*). Several theories have been put forward, but it seems useless to discuss conjectures as to matters of fact in the absence of evidence. Importation by sea from China is the theory which has met with most acceptance. The native form of plague, known as *mahamari*, is confined to the southern slopes of the Himalaya. It is described by Dr Payne, whose account of plague in India begins with the epidemic of

1812–21, and may here be supplemented by some earlier references unearthed by the *Bombay Gazetteer* (vol. iv.). Ibn Batesta notices two destructive pestilences in the 14th century, and Ferishta one in 1443, which he calls *ta'un*, and describes as very unusual in India. At the end of the 16th century there was a pestilence following a prolonged famine, and in the 17th century two violent epidemics are recorded under the names *ta'un* and *wába*. In the second of these, which occurred in the Ahmedabad district of the Bombay Presidency in 1683–89, buboes are distinctly described. In the 18th century several pestilences are recorded without description. It is at least probable from these notes that even before the undoubted outbreak, which began in Cutch in 1812, India was no stranger to epidemic plague. To return to Bombay and 1896: the infection spread gradually and slowly at first, but during the first three months of 1897 not only was the town of Bombay severely affected, but district after district in the presidency was attacked, notably Poona, Karachi, Cutch Mandvi, Bhiwandi, and Daman. The number of cases and deaths reported in the presidency, exclusive of the city, in each year down to the end of 1899, was as follows:—

Year.	Cases.	Deaths.	Case Mortality.
1896	367	273	74·3 per cent.
1897	49,125	36,797	74·7 ,,
1898	90,506	68,061	75·2 ,,
1899	131,794	101,485	77·0 ,,
Total . .	271,792	206,616	75·8 per cent.

The corresponding figures for Bombay city are:—

Year.	Cases.	Deaths.	Case Mortality.
1896	2,530	1,801	71·1 per cent.
1897	11,963	10,232	85·7 ,,
1898	19,863	18,160	91·2 ,,
1899	19,484	15,830	81·3 ,,
Total . .	53,840	46,023	85·4 per cent.

The total for the presidency, including the city, in four years was 325,632 cases with 252,549 deaths in a population of 26,960,421 (census of 1891). The population of the city is 821,764, but during the earlier plague period large numbers fled, so that the foregoing figures do not give the true plague incidence according to population. Moreover, concealment was extensively practised, and there can be little doubt that the number of victims was really much greater than the official returns indicate. The most striking fact brought out by the tables given above is the large and steady increase year by year in the presidency, in spite of all efforts to arrest the spread of infection. It has gone on since 1899, and it has not been confined to Bombay, but has extended over the whole of India. In 1897 it had already penetrated to Rajputana, the Punjab, the North West Provinces, and the Central Provinces. In the following year Bengal, Madras, Haidarabad, and Mysore were invaded. Not all these provinces suffered alike, but on the whole plague steadily strengthened its hold on India generally, and hardly relaxed it in any part. The most noteworthy details available are as follow:—Calcutta, mortality, 192 in 1898, 2745 in 1899, 7449 in first half of 1900; Patna district, mortality in first half of 1900, 17,674; Punjab, mortality in 1898, 2049; Madras Presidency, mortality August 1898 to June 1900, 2892; Haidarabad, mortality in 1899, 4242; Mysore, mortality 1898–99, 15,597.

Out of China and India plague has caused no great mortality in any of the countries, enumerated above, in which it has appeared, with the exception perhaps of Arabia, about which very little is known. But some of the outbreaks are interesting for other reasons, and require notice. The first case is the singular occurrence of three deaths at Vienna in October 1898, undoubtedly occasioned by a laboratory accident. The earliest victim was an attendant named Barisch, employed in the pathological laboratory of the Vienna General Hospital, and told off to look after the animals and bacteriological apparatus devoted to the investigation of plague, cultures of which had been brought from India by the medical commissioners sent by the Royal Academy of Science in 1897. Barisch was drunk and out all night on 8th October; on 14th October he fell ill. Plague was suspected, but Dr Müller, who attended the man and had studied the disease in India, would not admit the diagnosis on clinical grounds, nor was it bacteriologically established until 19th October. Barisch died on 18th October. On the 20th one of the nurses, and on the 21st Dr Müller, fell ill. Both died of pneumonic plague, from which also Barisch had undoubtedly suffered. A second nurse and a sister of mercy had feverish attacks, but no further case occurred. Barisch was shown to have been careless in the performance of his duties, and to have disregarded instructions; and the inference is that he conveyed the infection to his mouth, and so to the lungs, from the bacteriological specimens or inoculated animals. The melancholy incident illustrates several points of interest: (1) the correctness of the bacterial theory of causation, and the identity of the *bacillus pestis* as the cause; (2) the infectious character of the pneumonic type of disease; (3) its high fatality; (4) the difficulty of diagnosis. The next occurrence of special interest is the appearance of plague in Portugal in 1899, after an absence of more than 200 years. Its origin is shrouded in obscurity. Oporto, the seat of the outbreak, had no connexion by sea with any place known to be infected, and all attempts to trace introduction ended in speculation or assumption. The most probable theory was that soldiers returning home from infected Portuguese possessions in the East brought it with them, but this does not explain the selection of Oporto and the escape of other places. The earliest cases, according to retrospective inquiry, occurred in June 1899; suspicions were aroused in July, but the diagnosis was not established until August. It was contended by some medical men that the disease had really been present long before; but this view was supported by no better evidence than the opinion held in the same quarters, but quite untenable, that it was not plague at all. The conclusion reached, after careful investigation by Dr Jorge, the medical officer of health, that the commencement really dated from June, is confirmed by the fact that about that time the riverside labourers, who were first affected, began to notice an illness among themselves sufficiently novel to attract their attention and that of an English shipowner, who from their description suspected plague. Through him the suspicion was conveyed to the *Medical Times and Gazette*, in which the suggestion of plague at Oporto was made before any public mention of it in the town itself. The outbreak never assumed large proportions. It gained ground by degrees until October, after which it declined, and eventually ceased in February 1900. No recrudescence has been officially announced. The number of cases recorded in a population of 150,000 was 310, with 114 deaths, representing a case mortality of 36·7 per cent. They were widely scattered about the town and outlying suburbs; but no further extension occurred, except some isolated cases at Braga, a town 35 miles distant, and one at Lisbon, in the person of the distinguished bacteriologist, Professor Camara Pestana, who contracted the disease in making a *post-mortem* at Oporto, and died in Lisbon. The only other appearance of plague in Europe in 1899 was on the Volga. Three places were affected, namely, Kolobovka and Krasnoyarsk, in the province of Astrakhan, and Samara, higher up the river. All three outbreaks were small and limited, and no further extension took place. A commission appointed by the Russian Government pronounced the disease to be undoubtedly plague, and it appears to have been very fatal. The origin was not ascertained.

The most interesting extensions of plague in 1900 were those in Australia and Glasgow. The following towns were affected in Australia:—Sydney, in New South Wales; Adelaide, in South Australia; Melbourne, in Victoria; Brisbane, Rockhampton, Townsville, Cairns, and Ipswich, in Queensland; Fremantle, Perth, and Coolgardie, in West Australia. In none of these, with the exception of Sydney, did plague obtain a serious hold. The total number of cases reported in Queensland was only 123, with 53 deaths. In Sydney there were 303 cases, with 103 deaths, a case mortality of 34 per cent. The infection is supposed to have been brought from Noumea, in New Caledonia, where it was present at the end of 1899; and the medical authorities believe that the first case, which occurred on 19th January, was recognized. The outbreak, which hardly reached epidemic proportions, lasted about six months. That in Glasgow was on a still smaller scale. It began, so far as could be ascertained, in August 1900, and during the two months it lasted there were 34 cases and 15 deaths. Once more the disease was not at first recognized, and its origin could not be traced. In 1901 plague invaded South Africa, and obtained a distinct footing both at Cape Town and Port Elizabeth. The total number of cases down to July was 760, with 362 deaths; the number of Europeans attacked was 196, with 68 deaths, the rest being natives, Malays, Indians, Chinese, and negroes. With regard to Great Britain, a few ship-borne cases have been dealt with at different ports from time to time since 1896, but except at Glasgow the disease has nowhere obtained a footing on land.

Causation.—Plague is a specific infectious fever, caused by the *bacillus pestis*, which was identified in 1894 by Kitasato, and subsequently, but independently, by Yersin. An account of the organism will be found under the heading of PATHOLOGY (*Parasitic Diseases*). It is found in the buboes in ordinary cases, in the blood in the so-called "septicæmic" cases, and in the sputum of pneumonic cases. It may also be present in the urine. *Post mortem* it is found in great abundance in the spleen and liver. Nothing is known of its natural history outside the body, but on cultivation it is apt to undergo numerous involution forms. Its presence in a patient is regarded as positive diagnostic proof of plague; but failure to find or to identify it does not possess an equal negative value, and should not be too readily accepted, for many instances are recorded in which expert observers have only succeeded in demonstrating its presence after repeated attempts. It is clear, from the extreme variations in the severity of the illness, that the resisting power of individuals varies greatly. According to the Plague Research Committee of Bombay, the predisposing causes are "those leading to a lower state of vitality," of which insufficient food is probably the most important. There is no evidence that age, sex, or race exercises a distinct predisposing influence. The largest incidence in Bombay was on young adults; but then they are more numerous and more exposed to infection, because they go about more, than the younger and the older. Similarly, the comparative immunity of Europeans in the East may be explained by their different conditions of life. It is doubtful whether the distinction drawn between *pestis minor* and *pestis major* (see Dr Payne's article) has a real ætiological basis. Very mild cases occurring in the course of an outbreak of typical plague may be explained by greater power of resistance in individuals, but the epidemic prevalence of a mild illness preceding the appearance of undoubted plague suggests some difference or modification of the exciting cause. "It is impossible," writes Sir Richard Thorne (Local Government Board Report, 1898–99), "to read the medical history of this disease in almost every part of the world without being impressed with the frequency with which recognized plague has been preceded by ailments of such slight severity, involving some bubonic enlargement of glands and some rise in body-temperature, as to mask the real nature of the malady." Considering the great importance of arresting the spread of infection at the outset, and the implicit reliance placed upon bacteriological criteria, the ætiology of such antecedent ailments deserves more attention than has hitherto been paid to it. Of course plague does not stand alone in this respect. Epidemic outbreaks of other diseases—for instance, cholera, diphtheria, and typhoid fever—are often preceded and followed by the prevalence of mild illness of an allied type; and the true significance of this fact is one of the most important problems in epidemiology. In plague, however, it is of special importance, on account of the peculiarly insidious manner in which this disease fastens itself upon a locality.

The path by which the bacillus enters the body has not been satisfactorily determined. In pneumonic cases it is presumed to enter by the air-passages, and in bubonic cases by the skin, through some abrasion or crack. The Bombay Plague Research Committee, whose experience is unequalled, say: "In a number of instances points of inoculation were found on the extremities of patients, from which plague cultures were obtained, and in these cases buboes were found above the point of inoculation. In the majority of instances, however, no local indication could be found marking the point at which the microbe was implanted." From the fact that bacilli are hardly ever found in the blood of bubonic cases, it may be inferred that they are arrested by the lymphatic glands next above the seat of inoculation, and that the fight—which is the illness—takes place largely in the bubo; in non-bubonic cases they are not so arrested, and the fight takes place in the general circulatory system, or in the lungs. As might be expected from these considerations, the bubonic type is very little infectious, while pneumonic cases are highly so, the patients no doubt charging the surrounding atmosphere by coughing. Whether infection can be introduced through the digestive tract by infected food is doubtful. The bacillus is non-resistant and easily killed by heat and germicide substances, particularly acids. Little is known of its toxic action; only a weak toxin has been obtained from cultures. Of the lower animals, mice, rats, guinea-pigs, rabbits, squirrels, and monkeys are susceptible to the bacillus; horses, cattle, sheep, goats, pigs, dogs, and cats are more or less resistant, but cats and dogs have been known to die of plague (Oporto, Daman, Cutch, and Poona). In the Great Plague of London they were believed to carry the infection, and were killed in vast numbers. The bacillus has been demonstrated in the bodies of fleas, flies, bugs, and ants.

Clinical Characters.—One of the results of recent observation is the classification of plague cases under three heads, which have already been mentioned several times: (1) bubonic, (2) pneumonic, (3) septicæmic. (The word "pesti-cæmic" is also used instead of "septicæmic," and though etymologically objectionable, it is otherwise better, as "septicæmic" already has a specific and quite different meaning.) It should be understood that this classification is a clinical one, and that the second and third varieties are just as much plague as the first. It is necessary to say this, because a misleading use of the word "bubonic" has given rise to the erroneous idea that true plague is necessarily bubonic, and that non-bubonic types are a different disease altogether. The word "plague"—or "pest," which is the name used in other languages—had originally a general meaning, and may have required qualifications when applied to this particular fever; but it has now become a specific label, and the prefix "bubonic" should be dropped. The illness varies within the widest limits, and exhibits all gradations of severity, from a mere indisposition, which may pass almost unnoticed, to an extreme violence, only equalled by the most violent forms of cholera. The mild cases are always bubonic; the other varieties are invariably severe, and almost always fatal. Incubation is generally from four to six days, but it has been observed as short as thirty-six hours and as long as ten days (Bombay Research Committee). Incubation, however, is so difficult a thing to determine that it is unwise to lay down any positive limit. As a rule the onset is sudden and well marked. The symptoms may be described under the headings given above. (1) Bubonic cases constitute fully three-fourths of the whole, and the symptoms may therefore be called typical. In a well-marked case there is usually an initial rigor—in children convulsions—followed by a rise of temperature, with vomiting, headache, giddiness, intolerance to light; pain in epigastrium, back, and limbs; sleeplessness, apathy, or delirium. The headache is described as splitting; delirium is of the busy type, like delirium tremens. The temperature varies greatly; it is not usually high on the first day—from 101° to 103°—and may even be normal, but sometimes it rises rapidly to 104° or 105° or even 107° F.; a fall of two or three degrees on the second or third day has frequently been observed. The eyes are red and injected; the tongue is somewhat swollen, and at first covered with a thin white fur, except at the tip and edges, but later it is dry, and the fur yellow or brownish. Prostration is marked. Constipation is the rule at first, but diarrhœa may be present, and is a bad sign. A characteristic symptom in severe cases is that the patient appears dazed and stupid, is thick in speech, and staggers. The condition has often been mistaken for intoxication. There is nothing, however, in all these symptoms positively distinctive of plague, unless it is already prevalent. The really pathognomonic sign is the appearance of buboes or inflamed glands, which happens early in the illness, usually on the second day; sometimes they are present from the outset, sometimes they cannot be detected before the third day, or even later. The commonest seat is the groin, and next to that the axilla; the cervical, submaxillary, and femoral glands are less frequently affected. Sometimes the buboes are multiple and on both sides, but more commonly they are unilateral. The pain is described as lancinating. If left, they usually suppurate and open outwards by sloughing of the skin, but they may subside spontaneously, or remain hard and indurated. Petechiæ occur over buboes or on the abdomen, but they are not very common, except in fatal cases, when they appear shortly before death. Boils and carbuncles are rare. (2) Pneumonic plague was observed and described in many of the old epidemics, and particularly by two medical men, Dr Gilder and Dr Whyte, in the outbreak in Kathiawar in 1816; but its precise significance was first recognized by Childe in Bombay. He demonstrated the presence of the bacilli in the sputa, and showed that the inflammation in the lungs was set up by primary plague infection. The pneumonia is usually lobular, the onset marked by rigors, with difficult and hurried breathing, cough, and expectoration. The prostration is great and the course of the illness rapid. The breathing becomes very hurried—forty to sixty respirations in the minute—and the face dusky. The expectoration soon becomes watery and profuse, with little whitish specks, which contain great quantities of bacilli. The temperature is high and irregular. The physical signs are those of broncho-pneumonia; œdema of the lungs soon supervenes, and death occurs in three or four days. (3) In septicæmic cases the symptoms are those of the bubonic type, but more severe and without buboes. Prostration and cerebral symptoms are particularly marked; the temperature rises rapidly and very high. The patient may die comatose within twenty-four hours, but more commonly death occurs on the second or third day. Recovery is very rare.

There is no reason for doubting that the disease described above is identical with the European plagues of the 14th and subsequent centuries. It does not differ from them in its clinical features more than epidemics of other diseases are apt to vary at different times, or more than can be accounted for by difference of handling. The swellings and discolorations of the skin which play so large a part in old descriptions would probably be equally striking now but for the surgical treatment of buboes. Similarly, the comparatively small destructiveness of modern plague, even in India, may be explained by the improved sanitary conditions and energetic measures dictated by modern knowledge. The case mortality still remains exceedingly high. The lowest recorded is 34 per cent. in Sydney, and the highest 95 per cent. at Hong Kong in 1899. During the first few weeks in Bombay it was calculated by Dr Viegas to be as high as 99 per cent. It is very much higher among Orientals than among Europeans. In the Bombay hospitals it was about 70 per cent. among the former, and between 30 and 40 per cent. among the latter, which was much the same as in Oporto, Sydney, and Cape Town. It appears, therefore, that plague is less fatal to Europeans than cholera. The average duration of fatal cases is five or six days; in the House of Correction at Byculla, where the exact period could be well observed, it was five and a half days. Patients who survive the tenth or twelfth day have a good chance of recovery. Convalescence is usually prolonged. Second attacks are rare, but have been known to occur.

Diagnosis.—When plague is prevalent in a locality, the diagnosis is easy in fairly well-marked cases of the bubonic type, but less so in the other varieties. When it is not prevalent the diagnosis is never easy, and in pneumonic and septicæmic cases it is impossible without bacteriological assistance. The earliest cases have hardly ever been even suspected at the time in any outbreak in a fresh locality. As the doctor who was called to the first cases in Glasgow said afterwards, "It never occurred to me that I was dealing with plague." It very seldom does occur to medical men in similar circumstances, and not infrequently they continue to believe the disease is something else after full proof of its nature has been furnished. This will show the difficulty of diagnosis when plague is a novelty. In these circumstances it may be taken at first for almost any fever, particularly typhoid, or for venereal disease or lymphangitis. In plague countries the diseases with which it is most liable to be confounded are malaria, relapsing fever, and typhus, or broncho-pneumonia in pneumonic cases.

Treatment.—The treatment of plague is still symptomatic. The points requiring most attention are the cerebral symptoms—headache, sleeplessness, delirium, &c.—and the state of the heart. Alcohol and cardiac stimulants may be required to prevent heart failure. Speaking generally, it is important to preserve strength and guard against collapse. Buboes should be treated on ordinary surgical principles. An antitoxic serum has been prepared from horses by the Institut Pasteur in France, but has not met with success. The results in India obtained by British and various foreign observers were uniformly unfavourable, and the verdict of the Research Committee (1900) was that the serum had "failed to influence favourably the mortality among those attacked." Success was somewhat noisily claimed for an improved method tried in Oporto, but the evidence is of little or no value. Of 142 cases treated, 21 died; while of 72 cases not treated, 46 died; but the former were all hospital patients, and included several convalescents and many cases of extreme mildness, whereas the non-serum cases were treated at home or not at all, some being only discovered when death had made further concealment impossible. Moreover, it is not known how many non-serum cases there really were to furnish the 46 deaths; 72 was the number notified, but an unknown number was concealed, which might entirely alter the proportions. Some light is thrown upon these curious statistics by the singular fact that the mortality was nearly twice as great among those serum cases which had the advantage of the treatment from the beginning, as it was among those treated at a later stage of their illness and therefore under less favourable conditions. There were 7 deaths in 31 full-serum cases, and only 14 deaths in 111 part-serum cases. The only possible conclusion is either that the serum had an injurious effect, or that the statistics are valueless. Another serum, prepared by Lustig and Galeotti, has not been successful.

Morbid Anatomy.—(1) Bubonic cases. A bubo is found to consist of a chain of enlarged glands, surrounded by a mass of engorged connective tissue, coagulated blood, and serum. Nearly all the lymphatic glands in the body are a little swollen, but the lymphatic vessels show little or no change. The spleen and liver are always enlarged, the former sometimes to twice or thrice its natural size. The lungs are engorged and œdematous, and often show hæmorrhages. The kidneys are enlarged and congested. The serous membranes show petechiæ and hæmorrhages. The right side of the heart is frequently dilated, with clots in the cavities. The heart muscle is normal, or soft and friable. The substance of the brain, spinal cord, and nerve trunks is normal, but the membranes are engorged. (2) Pneumonic cases. The lymphatic glands are hardly affected. There is general engorgement and œdema of the lungs, with pneumonic patches varying in size and irregularly distributed. (3) Septicæmic cases. Nearly all the lymphatic glands in the body are involved, and have a characteristic appearance. They are enlarged to the size of an almond, rounded, firm, and pink; there is some engorgement and œdema on section; the substance is rather soft, and can be scraped off with a knife. The surrounding tissue is not engorged or œdematous. The description of the other organs given under (1) applies also to (2) and (3).

Dissemination.—Given the bacillus, the questions arise, How is it disseminated? and What are the conditions that favour its propagation? Only a very imperfect answer can be given. The perpetual failure to trace introduction, even with approximate precision, shows how obscure and secret the movements of this poison are. Perhaps it is unscientific to assume introduction as a matter of course in all cases, but its appearance in places where it has been unknown for centuries, and in others where it has never been known at all, combined with the fact that seaports are the points of attack, is sufficient evidence to justify the assumption in general. That it is conveyed from person to person is an undoubted fact, proved by innumerable cases, and tacitly implied by the word "infectious," which is universally allowed. The sick are a source of danger and one means of dissemination, and, since the illness may be so slight as to pass unrecognized, an obviously insidious one. The ambulatory plague patient goes far to explain the spread of the disease without leaving any track. But there is evidence that persons may carry the infection and give it to others without being ill at all themselves. One such case occurred at Glasgow, and another at Oporto. In the Glasgow case the wife of a laundryman employed in handling plague linen contracted the disease. She was brought into connexion with it in no other way, and there can be no doubt that she took it from her husband, though he was not ill at all himself. The Oporto instance is still more conclusive. Two little girls had plague at Argoncilhe, a suburb some miles from Oporto, and were the only cases which occurred in that place. Their father was a riverside labourer, who lodged during the week in Oporto, but went home for Sunday. He was not ill, but several cases of plague occurred in the house in which he lodged. How the poison passes from one person to another is less clear. In pneumonic cases patients no doubt spread it around them by coughing, and others may take it up through the air-passages or the skin; but even then the range of infection is small, and such cases are comparatively rare. In the vast majority of cases the bacilli are in the lymphatic or the circulatory system, and aërial convection, even for a short distance, seems highly improbable. This view is borne out by the experience in hospitals and with "contacts," which goes to show that with reasonable care and under fair conditions the risk of infection from ordinary plague patients is very small. When persons live crowded together in close contact, and when they are careless with regard to discharges of all kinds from patients, the risk is obviously much increased. Discharges—vomited matters, sputa, urine, and fæces—are probably the media by which plague is chiefly spread from person to person. They also contaminate clothing, which thus becomes another means of dissemination capable of acting at a distance. This is the most probable explanation of the two cases of indirect infection related above. Failure to catch or induce plague from clothing that has been worn by plague patients proves nothing. Such clothing is not necessarily infectious; indeed, the probability is that it is not, unless contaminated by discharges. There is no evidence that merchandise and foodstuffs are means of dissemination, and a great deal of evidence against such a theory, but suspicion has sometimes fallen on bakers' shops. Then we come to the lower animals. Attention has been concentrated on rats, and some observers seem disposed to lay upon them the whole blame for the propagation and spread of plague, which is held to be essentially a rat-borne disease. This hypothesis is in advance of the evidence, and not consistent with some of the facts. The susceptibility of rats has been noted from remote times and in many countries, particularly in China, but it has never attracted so much attention as during the recent prevalence of plague. From one place after another a great mortality among rats was reported, and the broad fact that they do die of plague is incontestable. It is therefore easily intelligible that they may play an important part in multiplying and fixing the poison on a locality. How they convey it to man is less clear, for they seldom come in contact with human beings. They may conceivably infect articles of food, but the weight of the evidence is all against the conveyance of plague by ingestion. Fleas have been suggested; and that again is possible, for it has been shown that rat fleas will bite man, but it can hardly happen often enough to account for the incidence of plague. Equally doubtful is the part played by them in disseminating the disease to a distance. Mortality among rats is said to precede the appearance of human plague, but the evidence of this is always retrospective and of a very loose character. The proof that rats migrate in large numbers to great distances is still more unsatisfactory. We are told that "armies of rats" were seen migrating on sundry occasions; but we are not told who saw them, or what an "army of rats" is. Such rhetorical language condemns itself. The strongest evidence in favour of rat-borne plague yet produced is the experience at Sydney, where a careful investigation was made. The conclusion reached by Dr Tidswell is that "there was no ground for even a suspicion that our epidemic was being maintained by any process of direct contagion between man and man," but that rats were the carriers. This seems to prove too much. The inference is that infected rats are more dangerous to human beings than infected persons, although the latter manufacture the poison on a much larger scale and come into far closer contact. In Glasgow the experience was just the contrary. Personal connexion was traced in every case, and rats excluded; there was no mortality among them, and of 300 caught and examined none had plague (Chalmers). Similarly, at Oporto personal connexion was traced in all the earlier cases; there was no mortality among rats, and no evidence to connect them with the outbreak (Jorge). Again, a comparison between rat-infested and rat-free districts in Bombay showed a much higher incidence of plague in the latter. A campaign against rats in Bombay, by which 50,000 or 60,000 were killed in a short time, had no effect in checking the disease. Plague-rats have rarely been found in ships sailing from infected ports; and though millions of these animals must have been carried backwards and forwards from quay to quay between Hong Kong, Bombay, and the great European ports, they have not brought the disease ashore. The evidence, therefore, is conflicting on the subject. Perhaps a fair conclusion is that rats are one of the means of disseminating plague; but it can exist without them, and be spread by other agencies. According to the official history of plague in India (Nathan), rats are "certainly not so common a cause of infection as the sick person and his surroundings." Very little light has been thrown on the conditions which favour the prevalence of plague. We do not know why it has developed a diffusive activity of late years, nor why it has attacked some places and consistently passed by others, such as Singapore. The words "dirt" and "insanitary conditions" are much used, but such general terms explain nothing. Singapore, where plague has several times been introduced, but never taken hold, is probably quite as dirty and insanitary as Hong Kong, and it is pertinently remarked by the Bombay Research Committee that filth *per se* has but little influence, inasmuch as "there occurred in the House of Correction at Byculla, where cleanliness is brought as near to perfection as is attainable, an outbreak which exceeded in severity that in any of the filthy *chawls* and tenements around." Again, in Oporto there is an area which combines every possible sanitary defect—dense overcrowding, great poverty, no light, no air, no drainage, no scavenging, water brought in buckets. Plague got into this quarter, but did not spread there; on the other hand, it appeared in other and vastly superior parts of the town. Yet in at least one case neither the patient nor the "contacts" were removed, but were all shut up in one room with a sentry at the door and another in the street. The seasonal variations have been well marked and extremely regular in Bombay. The disease begins to be active in late autumn or the commencement of winter, and reaches its height in February or March, dying down in the summer. Mr Baldwin Latham has made an elaborate examination of the meteorological conditions, and more particularly of the vapour tension, from which he draws the conclusion that the seasonal variations are due to exhalation from the ground. His observations are original and worth attention. A simpler explanation is that the people live more indoors, and are so more exposed to infection during the plague season. The curve shows two rises, one at the beginning of winter, and the other at the commencement of the monsoon, and at both these times the people are driven indoors. A broad survey of the epidemiological facts suggests some general conclusions. The outbreaks fall into two well-defined groups: (1) those in which the disease is destructive and persistent, (2) those in which its effects are slight and transient. In the former the poison clearly fastens on the locality, and gradually increases its hold. The place is infected, not merely the people in it; for if they evacuate it, the disease soon ceases among them, and if they return in a short time, they are again attacked. Now the poison is contained, as we have already seen, in the discharges from patients, and in such infected localities the standing conditions and the habits of the people combine to retain the discharges on the premises. The floors, mostly of mud covered with dung, are fouled with spittle, vomit, and urine, and, being seldom or never cleaned out, foster a gradual accumulation of poison, to which infected rats and the concealment of illness contribute. These are just the conditions which prevailed in Europe in the old plague days. They do not prevail now in those "white countries" which have been invaded but have repelled the attack with comparative ease and little loss. It may be concluded, with some confidence, from experience and theory alike, that localities where they do not prevail may fail to keep plague out, but have very little to fear from it, except the disturbance of trade caused by the traditional terrors that still cling to the name.

Prevention.—The principles are the same as those which govern the prevention of other infectious diseases. "Sanitary cordons" and the like are obsolete. International procedure is supposed to be regulated by the Venice Convention of 1897, but that instrument has never been ratified, and it contains an optional clause, which allows countries to do as they please with their own frontiers. Except Great Britain and Germany, they all retain quarantine in a more or less stringent form at seaports. It is generally used as a system of local extortion imposed upon travellers and shipping. According to the Venice Convention, ships are divided into (1) healthy, (2) suspected, (3) infected. (1) Healthy are those free from plague throughout the voyage; (2) suspected, those in which plague has occurred, but no fresh case within twelve days; (3) infected, those in which plague has occurred within twelve days. Great Britain relies on medical inspection, removal of sick or suspected cases, and supervision of the healthy arriving on an infected ship; infected clothing is burnt and infected ships disinfected. The procedure is the same as for cholera, and it has been equally successful. Ships passing through the Suez Canal are subject to similar inspection; sick persons are landed at Moses Wells, and suspected ones detained. The risk of importing plague from India has been materially lessened by medical inspection of outward-bound ships at the principal ports. This has been very thoroughly carried out at Bombay with good results. In 1897 pilgrimages from India to the Hedjaz were prohibited. By the Venice Convention a number of articles of merchandise are classed as susceptible and liable to be refused admission, but the only ones which there is any reason to consider dangerous are used clothing and rags. A watch should be kept on rats at ports of arrival and on board ships from infected countries.

When plague is present in a place, the measures to be taken are the usual ones for dealing with infectious disease, with some additions. The sick and suspected should be removed in special ambulances to an isolation hospital, their soiled linen, &c., should be burnt, and the premises disinfected. Corrosive sublimate in an acid solution is the best disinfectant, but sulphuric acid, 1 in 250, is efficient and cheaper. Suspected cases should be bestowed in a special isolated building until the diagnosis is fully determined. "Contacts" should be kept under observation. Rats should be exterminated as far as possible. The greatest care should be taken in dealing with the hospital linen and discharges from patients. Hospital staffs should be kept apart. Inoculation with Haffkine's prophylactic fluid should be offered to all persons willing to avail themselves of it. It is especially desirable for hospital and ambulance staffs to be inoculated. This drug is prepared from sterilized cultures of plague bacillus. Inoculation is harmless, and the results obtained in India justify a favourable opinion of its protective efficacy. At Hubli, where nearly the whole population was inoculated between 11th May and 27th September 1898, the mean mortality among the inoculated was 1·3 per cent.; among the uninoculated 13·2 per cent. At Daman the mortality was—inoculated 1·6 per cent., uninoculated 24·6 per cent.; at Dharwar—inoculated 1·2 per cent., uninoculated 5·2 per cent. In all these cases the numbers dealt with were large and the test fair. For further statistics and details the reader is referred to *The Bombay Plague*, by Captain Condon (official, 1900). Inoculation protects against attack, and greatly modifies the illness when it fails to protect. How long the protection lasts has not been determined, but it appears to be several months at least. Evacuation of streets and whole villages has been adopted in India with marked success, but in Western countries so drastic a measure is hardly feasible and not likely to be required.

Recent experience goes to show that plague is an exceedingly difficult disease to keep out altogether, but a very easy one to control under fairly good local conditions, and even under bad ones provided that it is not allowed to implant itself firmly in a locality. When that happens, it is most difficult to eradicate or confine. Vigilance, therefore, on the part of medical men, and promptness on the part of the administrative authorities, are of the utmost importance. Backed by them, the foregoing measures may be relied upon with perfect confidence to dispose of plague quickly and effectually. Without them it is likely, in a favourable soil, to defy all measures.

AUTHORITIES.—CANTLIE. *Practitioner*, Oct. 1900.—CHALMERS. "Plague at Glasgow," *Epidem. Soc. Trans.* vol. xx.—CONDON. *The Bombay Plague* (official, Bombay).—JORGE. *Peste no Porto.* LATHAM. *Clinical Conditions Necessary for Propagation and Spread of Plague.*—BRUCE LOW. 28th and 29th Annual Reports to Local Government Board, Medical Supplement.—MONTENEGRO. *Bubonic Plague.*—NATHAN. *The Plague in India* (official, Simla). —RENNIE. *Plague at Canton.*—ROBINSON. Plague at Hong Kong (Official Reports).—SHADWELL. "Plague at Oporto," *Epidem. Soc. Trans.* vol. xix.; *Nineteenth Century*, Nov. 1899.—SIMPSON. "Plague," *Quain's Dictionary of Medicine* (3rd ed.).—TIDSWELL. "Plague at Sydney," *Journal Sanitary Inst.* vol. xxi.—WILSON. *Plague at Hong Kong.*—YERSIN. *Annales de l'Institut Pasteur*, 1894–97.—PATRICK MANSON. *Tropical Diseases.* (A. SL.)

Plainfield, a city of Union county, New Jersey, U.S.A., 24 miles from New York, of which it is in great measure a residential suburb, and with which it is connected by the Central of New Jersey Railroad. It is regularly and beautifully laid out on a level site commanded by hills on the north-west and south-east, is divided into four wards, and has all municipal improvements. Population (1890), 11,267; (1895), 13,629; (1900), 15,369, of whom 2733 were foreign-born and 1450 negroes.

Planarians.—In reviewing the work done by naturalists on this group of animals since the publication in 1885 of the article on them in the earlier volumes (ninth) edition of this Encyclopædia, it will be necessary not only to notice the discovery of new forms and the progress towards a fuller anatomical knowledge of the different phases of life, but also to inquire how far later investigation of this class (Turbellaria) has contributed to a solution of the pressing modern problems of comparative physiology. Lastly, the views which are held as to the affinities of the group will be discussed.

Anatomical Discovery.—Although there has been a steady stream of publications dealing with the descriptions of new forms of Polyclads, Triclads, and Rhabdocœls, the advance in taxonomic and morphological knowledge has been most marked in the case of two groups, the "Turbellaria Acœla" and the "Land Planarians." In the former the advance is a morphological one. Comparatively little is known of the specific variety of the Acœla, and no doubt there still exists a wealth of undescribed forms, as is shown by the discovery of such peculiar genera as *Polychœrus* (Mark, *Festschrift f. Leuckart*, p. 298), and the pelagic *Haplodiscus.* At present about a dozen species of Acœla are adequately known, and they have furnished the material for a monograph by von Graff (*Turbellaria Acœla*, Leipzig, 1891) which has shed a new light on many vexed questions, such as the nature of the "digestive parenchyma," the nervous system, and the relations of the Acœla to other Turbellaria.

Von Graff has shown that the parenchyma assumes a simple, an intermediate, and a complex grade of structure. The simple parenchyma is seen in *Monoporus.* It consists of a nucleated vacuolated syncytium, and contains active amœbocytes, which are probably the chief agents in digesting the food and in supplying it to the surrounding tissues. In *Amphicœrus* the walls of the vacuoles assume a firmer consistency and give more stability to the parenchyma, while in *Convoluta paradoxa* the syncytium is divisible into a central finely granular protoplasm and a peripheral cellular parenchyma. The former is presumably the digestive tract, while the latter is skeleto-trophic in nature, and, in addition to many unspecialized cells, contains the symbiotic brown structures, which are apparently unicellular algæ. In fact, the absence of a gut is more apparent than real, and the anatomical study of known Acœla leads to the conclusion that from a common central syncytial mass those tracts have been developed to which in higher Turbellaria we give the names endodermal gut and mesodermal parenchyma. The embryological study of the Acœla has thrown no clear light on this subject (see Georgovitch, *Arch. Zool. Exp.* ser. iii. vol. vii. p. 343).

Another great advance in the morphology of this interesting group has been the discovery of the nervous system. This was first made in a convincing manner by Delage (*Arch. Zool. Exp.* ser. ii. vol. iv. p. 199) in 1886, and the details of the system are pretty fully described by von Graff in his monograph. The "brain" is always placed anteriorly, and is composed of two pairs of ganglia. One of these supplies the otocyst and other sensory structures, and gives off the outer pair of longitudinal nerve tracts which course down the margin of the body. The other pair of cerebral ganglia gives off an ad-median and a lateral pair of tracts, and these form a small meshed plexus in the body-wall.

The appendix to von Graff's work on the Accela contains Haberlandt's account of the nature of the green cells in *Convoluta roscoffensis.* This animal when just hatched contains no green cells, and it is said to die unless it comes into contact with a green unicellular alga (Georgovitch, *loc. cit.*). These algæ form a definite assimilating tissue, and the *Convolutæ* adopt a plant-life mode of life. The nature of the brown, yellow, and purple structures in many other (holozoic) Accela is at present unknown. A peculiarity of this group which still holds good is the entire absence of any excretory system of "flame-cells," and of canaliculi in connexion with them.

It is to von Graff, again, that we owe the magnificent work (*Monographie d. Turbellaria*, 1899), dealing with the Land Planarians in a monographic and elaborately illustrated manner, the outcome of twenty-five years' unwearied devotion to the subject. The sections dealing with the nervous system, sense-organs, and reproduction are perhaps the most noteworthy. But the chapter and tables of distribution have the greatest general interest, since they form the first attempt on a sufficiently large scale seriously to consider the distribution of Land Planarians and the manner in which it has come to pass. One of the most salient facts is the division of the family Geoplanidæ into two closely related sections. Of these, one, the more primitive, inhabits South America; the other, Australia and New Zealand. Another striking conclusion is the contrast between Japan and the rest of the Palæarctic regions, and the almost complete restriction of the family Bipaliidæ to Madagascar, Ceylon, and Indo-Malaya (including Celebes).

Physiology.—The most noteworthy advance in recent zoology has been the broadening of its aims. Zoological science is no longer content merely to describe the anatomical facts of a group, to discriminate its members, and to determine its distribution and development. Such a collection of facts forms the basis for further investigation into the nature and influence of the factors which determine the development—sexual and asexual—of the individual; into the influence of the environment, organic and inorganic, intrinsic and extrinsic, in modifying metabolism and reproduction; into comparative physiology and phylogeny. At present it must be admitted that although planarians are very promising subjects for research on these questions, they have not been utilized by workers on the first two problems. We must therefore inquire what light research has thrown upon the organs of Planarians considered as structures for carrying out the functions of life. What indications have we as to the manner in which, *e.g.*, the muscles, nerves, secretory organs—as we know them in their highly differentiated character in Arthropoda, Annelida, and Mollusca—have arisen from the simple and yet multi-functional corresponding tissues of the lower Invertebrates? The evidence of Planarians on this question may be expected to be especially valuable, since there is reason for believing that they form a basal group, intermediate in a physiological sense between the Cœlenterates (including Ctenophores) and the segmented Chætopoda.

As an indication of the intermediate character of Planarians, reference may be made to the nervous system. In Cœlenterates this is composed of stellate ganglion-cells specially developed in relation to the musculature, whether ecto- or endodermic. These cells give off processes which serve partly to connect them *inter se* and with the muscles and skin. But these processes are equivalent. There are no distinct nerve-fibres. In the ganglion-cells and their processes there is no known differentiation of neurofibrillæ (Apathy, *Mitt. Zool. Stat. Neap.* vol. xii. pt. iv., 1897). Even in Ctenophores the grade of structure remains as we find it in medusæ or sea-anemones—simply a diffused plexus. In Chætopods, on the other hand, the nervous system never exhibits anastomosing ganglion-cells. There is a marked distinction between the central and the peripheral parts. The ganglion-cells are largely confined to the central nervous system, and their processes are of two kinds: nerve-fibres which form the peripheral system, and branching outgrowths (neuropile) confined to the core of the brain or cord. Neurofibrillæ are found both in the body of the cell and in its processes. A neuropile is established which seems to be the real seat of reflex action, the ganglion-cells becoming centres of trophic actions. The question now is, Does the nervous system of Planarians show how the differentiation of these elements of the nervous system in the higher invertebrate has taken place from the Cœlenterate ganglionic plexus? To some extent it may be said to do so, although we are not sufficiently acquainted with the minute structure of the ganglion-cells of Planarians to be able to state the origin of neuropile and neurofibrillæ. The planarian nervous system possesses scattered ganglion-cells along the course of the chief paired tracts—dorsal, lateral, and ventral—and large multi- and bi-polar cells occur peripherally in relation to the muscles and sensory organs (Monti, *Boll. Sci. Ann. Pavia*, vol. xviii. No. 24, 1897). In Triclads and Polyclads the brain is little more than a thickening due to the fusion of these tracts at the anterior end and on the ventral surface. There is no clear separation between central and peripheral portions. The gradual formation of neuropilar centres is seen in its inception. What is perhaps still more significant of the undifferentiated condition of the nervous system is its mode of reparation. A freshwater Planaria can be divided into a few or a great number of small pieces, and each of these will regenerate the organs of the entire animal, apparently so long as a small group of ganglion-cells is included in the severed part (Morgan, *Arch. f. Entwicklung*, vol. vii. p. 364, 1898). But the growth of the new ganglion-cells, as of some of the other tissues, is not due to a multiplication of pre-existing differentiated cells, but to certain elements of the "parenchyma" which have remained at an embryonic phase, and which in the severed portion give rise to new ganglion-cells. In some forms of Planarians asexual reproduction in this way is a normal physiological process.

This marked absence of "division of labour" in the planarian economy, as contrasted with the more complex and efficient mechanism of higher Invertebrates, is manifested by the other tissues, and in none more clearly than in the endoderm. In the Accela the first indication of a separation and transference of the many functions of this tissue becomes apparent. But even in Triclads the gut still plays many parts. It digests, absorbs, and circulates the food. It is partially a respiratory organ. It contains excretory products either in the form of granules or in "flame-cells" embedded in its walls (Gunda). There is some evidence (which requires confirmation) that the endoderm furnishes the ovaries and testes. Viewed from such a physiological standpoint, the Planarians exhibit little advance on the Cœlenterates, except in the presence of ducts (often of great complexity) belonging to the reproductive organs.

Affinities.—There remains for discussion the chief problem with reference to this group that morphology sets itself to solve: What are the affinities of Planarians? To this question there are at present two separate and irreconcilable answers. It is universally conceded that Planarians form a natural and homogeneous subdivision of the phylum Platyelmia. This being allowed, attempts have been made to solve the problem of the origin of this phylum in different ways, which may for convenience be distinguished as (1) the Trochophore hypothesis, (2) the Gastræa hypothesis. The view that this phylum is a degenerate outcome of more highly organized, segmented Annelids is not here discussed.

The Trochophore hypothesis is the oldest and most widely supported of these, but in its latest and most detailed form it is due to Hatschek (*Lehrbuch d. Zoologie*, 1891). Hatschek emphasizes the occurrence of the trochophore larva in many Invertebrate phyla (for example, Mollusca, Chætopoda, Polyzoa, and Rotifera), and believes it to represent, not the larva of a common ancestor, but the common ancestor itself of all invertebrates above the Planarians, the Echinoderms alone excepted; and a modification of this—the pro-trochula—is, Hatschek holds, to be considered as the point of meeting of flat-worms and all higher invertebrates. If we go farther, and inquire what this pro-trochula may be and how it arose, Hatschek's reply would be that it is a hypothetical organism represented by the stage in the development of the trochophore before the formation of the anus. How it arose is not clear. Kleinenberg (*Zeitsch. f. wiss. Zool.* vol. xliv. p. 1, 1887) held that the Trochophore was a modified form of Medusa, while Hatschek compared it to a hypothetical Ctenophore in which the gonads and excretory vessels had become separated from the stomach. And he considered that the apical sensory plate, the mesenchymatous musculature and ectodermic stomodæum were comparable structures in both Trochophore and Ctenophore. Hatschek concludes that Ctenophores, Platyelmia, and other Invertebrates (except Echinoderms) have a common ancestor which resembled a Trochophore larva. The ingenuity of zoologists has devised several variants of the Trochophore hypothesis. The Ctenophore hypothesis of Lang (1884), which has been extended by Willey (1896), reaches much the same conclusion, though with differences of detail (see Bourne in Lankester's *Treatise on Zoology*, vol. ii., 1900). In both cases the Polyclad Turbellaria are assumed to be ancestral to the remaining Planarians; but from von Graff's work on the Acœla there appears to be strong grounds for doubting the validity of such an assumption. Both hypotheses are suggestive speculations, and will remain so until we have some principles of embryology by which their real value may be gauged.

The Gastræa hypothesis has been propounded by von Graff on the basis of his study of the Turbellaria Acœla. "I find," he says (*Turbellaria Acœla*, p. 51), "that the remarkable creature discovered by F. E. Schultze, and described by him as *Trichoplax adhærens*, represents a precursor of the Acœla leading straight to the Gastræadæ." *Trichoplax* has hitherto only been found in the marine aquarium at Graz. It is a flattened amœbiform animal from 1·5 to 3 mm. in greatest length. Dorsally it is covered with a squamous epithelium, ventrally with ciliated columnar cells. Beneath this epidermis is a thin layer of circular muscle fibre. The central part of the body is composed of a jelly, secreted by mesenchymatous cells, and contains both dorso-ventral muscle elements and peculiar refringent corpuscles. Fission is the only mode of reproduction as yet known. No nervous system nor otolith has been found. The Gastræadæ from which von Graff derives this *Trichoplax*, and through it the Acœla, is an obscure group of heterogeneous and problematical members, and there is much doubt as to its validity. The parasitic Dicyemids and Orthonectids form the greater part of it; some writers add *Haliphysema* and *Physemaria*, which others consider to be aberrant sponges. The only character which these Gastræadæ have in common is a central core of nucleated tissue covered with an outer ciliated one. They may, in fact, be compared to planulæ.

A more intelligible conclusion on the view that the Acœla are the basal group of Planarians would be to consider them, as Sedgwick has done (*Text-Book of Zoology*, p. 212, 1898), as "connecting forms between large Infusoria and the higher animals, in which the endodermal protoplasm, though without a continuous cavity, is partly differentiated into a number of important organs." It seems to the present writer that this conception of the intimate relation of the endoderm to the parenchyma, and especially to the reproductive and nephridial organs, is a very promising one, and capable of considerable extension. The separation of the parenchyma from the endoderm may take place early in development, in the form of mesoblast-cells capable of secreting vast masses of a gelatinous or semi-fluid matrix forming the soft parenchyma analogous to the mesoglœa of Cœlenterates; and just as in Anthozoa and Ctenophora the reproductive function and the function of excretion are largely the work of the endoderm cells, so in Turbellaria the endoderm appears to give rise to the gonads (in Polyclads, Triclads, and Rhabdocœls), and to excrete in the form of granules the greater part of the solid waste products, while the fluid ones are swept out by the nephridial canals. Yet even these canals are often closely related to the endoderm cells, and Lang has shown in *Gunda* that the flame-cells may lie in, and form part of, the endoderm. If we further consider the gradual differentiation of the parenchyma in the Acœla, the conclusion seems probable that the endoderm in Turbellaria has by no means lost, or lost connexion with, the functions of reproduction and excretion; and that while it performs its characteristic work of digestion, it is still closely associated with the sexual and uropoietic properties which we connect with it in Cœlenterates. From the fact that the parenchyma (and its contained organs) may remain in connexion with the endoderm throughout life (Acœla), or separate at a late period (larva of *Stylochus pilidium*) or early in development (many Polyclads), we should expect to find, on a more extended basis of observation, that this cell-layer exhibits in the Turbellaria that gradual differentiation into a number of different organs to which Mr Sedgwick has alluded. If that proves to be the case, the attempt by Hatschek (*loc. cit.*), followed by Lankester (*Treatise on Zoology*, vol. ii., 1900), to claim the so-called "generative sacs" of Planarians as "cœlomic" in nature, and to include the Platyelmia among the Cœlomata (Cœlomocœla), must be given up. There are at present no facts to support it; and what facts there are as to the origin of reproductive and nephridial tissues seem to show that there is actually no cœlom at all, but that if it be desired to force the Platyelmia into the "Cœlomata," the branches of the gut itself will have to be considered as a virtual cœlom. For this there is no more justification than in the case of many Cœlenterates.

Authorities.—The literature on Planarians is conveniently summarized in the article "Flat-Worms" (*Cambridge Natural History*. Macmillan. 1896); and in *A Treatise on Zoology* (edited by E. Ray Lankester, F.R.S. Black. 1901). Part iv., "Platyhelmia and Mesogoa."—To these lists the following important papers should be added:—Hesse (*Zeit. Wiss. Zool.* vol. lxii. 1897. "On the Eyes of Planarians").—Dorler (*Ibid.* vol. lxviii. 1900. "On Certain Parasitic Rhabdocœls").—And Loeb (*Comparative Physiology of the Brain*. Murray. 1901. "On the Nervous System and Response to Stimulation").

(F. W. Ga.)

Planquette, Robert (1850– ——), French musical composer, was born in Paris, 31st July 1850, and was educated at the Conservatoire. While little more than a boy he wrote numerous songs and operettas for café concerts, and sprang into fame as the composer of *Les Cloches de Corneville* (Paris, 1877; London, 1878). In this popular work he showed a fertile if somewhat commonplace vein of melody, which won instant recognition. There is besides in his music a touch of romantic feeling, which, had he cared to cultivate it, would have placed him far above contemporary writers of *opéra bouffe*. Unfortunately, he did little but repeat the formula which originally brought him reputation. *Le Chevalier Gaston*, his next work, was produced in 1879 with little success. In 1880 came *Les Voltigeurs du 32me*, which had a long run in London in 1887 as *The Old Guard*, and *La Cantinière*, which was translated into English as *Nectarine*, though never produced. In 1882 Planquette's *Rip van*

Winkle was produced in London, being subsequently given in Paris as *Rip*, in both cases with remarkable success. The libretto, an adaptation by H. B. Farnie of Washington Irving's famous tale, brought out what was best in Planquette's talent. In *Rip van Winkle* there is a note of tenderness and even of pathos such as is rarely heard in works of this kind. In 1884 the phenomenon of an opera by a French composer being produced in London previously to being heard in Paris was repeated in *Nell Gwynne.* In this work Planquette reached the highest point of his achievement. His score was carefully written, and some of the concerted music was excellent. It suffered from being allied to a libretto of more than ordinary inanity and inconsequence. *Nell Gwynne* was tolerably successful in London, though it failed completely when produced in Paris as *La Princesse Colombine. Nell Gwynne* was followed by *La Crémaillère* (Paris, 1885), *Surcouf* (Paris, 1887; London, as *Paul Jones*, 1889), and *Captain Thérèse* (London, 1887). A change in popular taste banished French *opéra bouffe* from the London stage during the last decade of the 19th century, its place being taken by so-called musical comedy of home manufacture, and none of Planquette's later works found their way across the Channel. The most successful of his more recent productions have been *La Cocarde Tricolore* (Paris, 1892), *Le Talisman* (Paris, 1892), *Panurge* (Paris, 1895), and *Mam'zelle Quat'sous* (Paris, 1897). Planquette is more gifted naturally than any writer of *opéra bouffe* of his time. His melodies are always fluent, and often original, but the workmanship of many of his operas suffers from the fact that he appears to aim at nothing but popularity of the most transient description.

Plasencia, a town of Spain, province of Caceres, on the right bank of the river Jerte. It has some trade in agricultural products and live stock, and the local industries are unimportant. It is still interesting on account of its churches and convents, and as the highroad to the monastery of Yuste (St Just), where Charles V. retired and died. Population (1877), 7090; (1897), 8351.

Plate River, or Rio de la Plata, a funnel-shaped estuary, on the east side of South America, extending west-north-west from the sea about 170 miles. Its extreme breadth at its mouth is 138 miles. It narrows quickly to 57 miles at Montevideo, and at its head, where it receives the united Paraná and Uruguay rivers, its width is about 25 miles. Its northern or Uruguayan shore is somewhat elevated and rocky, while the southern or Buenos Airean shore is very low, and much of it has a *tosca* rock cap which gently dips under the river-bed. The whole estuary is very shallow, and in no place above Montevideo exceeds 36 feet in depth when the river is low. The bottom generally consists of enormous banks of sand covered with from 10 to 20 feet of water, and there is a continuous and intricate channel, of about 22 feet depth only, to within 14 miles of the port of Buenos Aires. The remaining distance has a depth of 18 feet in the uncertain channel. At times, however, the river is so low that for three or four days together carts can drive out a distance of three miles or more from the shore. Azara says that "in 1795 the water fell so much in a calm day, that for three leagues out the shore was exposed, remaining so a whole day." The Plata is simply the estuarine receptacle of two mighty streams, the *Uruguay* and *Paraná*, which drain the Plata basin. This has an area of 1,198,000 square miles, or over two and one-half times that of the Pacific slope of the Andes, and comprises the most fertile, healthiest, and best part of Brazil, a large portion of the Argentine Republic, the whole of Paraguay and south-eastern Bolivia, and most of Uruguay.

The Uruguay and affluents.

The Uruguay river has a length of about 1000 miles. Many small streams from the western slope of the Brazilian Serra do Mar unite, in about 27° 45′ S., to form this river, which then, in imposing volume, flows west-north-westwards, serving as the boundary between the states of Santa Catharina and Rio Grande do Sul, as far as 52° W., near which it receives a considerable tributary from the north, called the *Pepiri-guazú.* Throughout this section it is enriched by many minor streams, mostly from the highlands which cross the state of Rio Grande do Sul. Between 27° 58′ and 33° 34′ S. three important tributaries join it from the east—the *Ipui-guazú*, the *Ibicui*, and the *Negro*, the last being its main affluent. A few unimportant streams enter it from the Argentine provinces of Misiones, Corrientes, and Entre Rios, the *Gualeguaychú* being the largest.

The Pepiri-guazú was one of the limits between the possessions of Portugal and Spain. Its lower course is about 250 feet wide, but higher up it narrows to about 30 feet, and runs with great violence between high wooded banks. It is navigable for canoes for about 70 miles above its mouth, as far as its first fall. The Rio Negro has a delta of several large islands at its confluence with the Uruguay. Its head-waters are in the southern part of Rio Grande do Sul, but the main river belongs entirely to the state of Uruguay, which it cuts midway in its course from north-east to south-west. *En route* it receives a great number of copious affluents and waters a most inviting region. Its lower reaches are navigable for craft of moderate draught.

Course of the Uruguay.

From the time the Uruguay leaves the coast range of Brazil, it runs for a long distance through a beautiful, open, hilly country, but afterwards enters a forest belt of high lands. At the river Pepiri-guazú it turns suddenly to the south-west, and continues this course to its junction with the Paraná and Plata. Near Fray Bentos, 61 miles before reaching the Plata, it forms a great lake, about 56 miles long and from 4 to 6 miles wide. At Punta Gorda, where it debouches into the Plata, it is only 1 mile to 1½ mile wide, but is 90 feet deep. From the Pepiri-guazú junction its banks are high and covered with forest as far down as 27° 30′ S., where the river is 2300 feet wide and from 10 to 40 feet deep. Thence its course is through a smooth and generally open, but occasionally broken, country; but along the lower 100 miles of its eastern side there are picturesque hills, from 100 to 500 feet high, divided by many rivulets, which fertilize rich valleys beyond, while the Entre Rios margin is low, monotonous, and wooded. The Uruguay is much obstructed by rocky barriers. Four miles below its confluence with the Pepiri-guazú it has a cataract, about 8 miles long, with a total fall of 26 feet at low water. The river near the Pepiri-guazú is 1550 feet wide, but about 1½ mile before reaching the cataract its width is reduced to 600 feet. Along the cataract it is closed in between high precipitous walls of black rock only 70 feet apart. Above Punta Gorda, 212 miles, is the Salto Grande, which has a length of 15 miles of rapids, the greatest single fall being 12 feet, and the difference of level for the entire length of the reefs 25 feet. These cross the river diagonally, and during floods all, excepting a length of 1½ mile of them, are submerged. Nine miles below the Salto Grande is the Salto Chico, which bars navigation during six months of the year, but in flood-time may be passed in craft drawing 5 feet of water. The Uruguay can be navigated at all seasons by vessels of 4½ feet draught as far up as the Salto Chico, and of 14 feet up to Paysandú for a greater part of the year. Fray Bentos may be reached all the year round by any vessel that can ascend the Paraná. Above the navigable lower river there is launch and canoe navigation for many hundreds of miles upon the main artery and its branches, between the rapids which are met with from time to time. The Uruguay has its annual floods, due to the rains in its upper basin. They commence at the end of July and continue to November, attaining their maximum during September and October. At the narrow places the river rises as high as 30 feet, but its average rise is 16 feet. It flows almost for its entire course over a rocky bed, generally of red sandstone, at times very coarse and then again of extremely fine composition. Except in floods, it is a clear-water stream, and even at its highest level carries comparatively little silt.

The Paraná and its affluents.

The Paraná (the "Mother of the Sea" in Guarani) drains a vast area of southern Brazil. It is formed by the union of the *Rio Grande* and *Paranáhyba*, and is about 1600 miles long from its extreme source in Goyaz to its junction with the Paraguay, and thence 600 more to the Plata estuary. Its average width for the latter length is from 1 to 3 miles. Its Rio Grande branch descends from the slope of the Serra da Mantiqueira, in the region where the orographic system of Brazil culminates near the peak of Itatiaia-assú, almost in sight of Rio de Janeiro. It is about 680 miles long, but only navigable in the stretches between the many reefs, falls, and rapids which interrupt its regular flow. Among its numerous affluents, the principal one is the *Rio das Mortes*, rising in the Serra Mantiqueira. It is 180 miles long, with two sections, of a total of 120 miles, which are navigable for launches. The main branch of the Paraná, the Paranáhyba, rises in about 15° 30′ S., on the southern slopes of the Pyreneos mountains, and receives numerous tributaries before its confluence with the Rio Grande, near which it is barred by two cataracts. It drains a little-known region of Goyaz and western Minas Geraes, lying upon the immediate southern watershed of Brazil.

Besides these rivers, the Paraná has many long and powerful affluents from the Brazilian states of São Paulo and Paraná; but its western ones, limited by the Serra Cayapó and the highlands which border north-eastern Paraguay, are not of equal importance. Most of them, although obstructed by rapids, are navigable for launches and canoes. Among the eastern tributaries are the *Tiété*, the *Paraná-panema*, formerly known as the Anemby, and the *Iguazú*.

The *Tiété*, over 700 miles long, rises in the Serra Paranápicaba and flows in a north-west direction. With the river Pardo, it was the favourite route of the "Sertanistas"—explorers and raiders of Matto Grosso—although its course is broken by fifty-four rapids, and the lower river by two falls, the Avanhandava, 44 feet drop, and the Itapurá, 65 feet.

The *Paraná-panema* is about 600 miles long, and rises in a ramification of the Serra Paranápicaba which overlooks the Atlantic Ocean. Its general course is north-west. From the south it receives many important tributaries, and from the north about a score of affluents, all of small volume. It is navigable for a distance of only about 30 miles above its mouth, and for its whole course it has so many obstructions that it is useless for commercial purposes.

The *Iguazú*, also called the Rio Grande de Curutiba, has its sources on the slopes of the Serra do Mar of Brazil, and flows nearly west, through thick forests, along the line of 26° S. Its navigation is difficult even for small craft, as it is full of reefs, rapids, and cataracts. Sixteen miles above its mouth is the magnificent Salto del Iguazú, sometimes called the Victoria Fall, round which canoes have to be transported 37 miles before quiet water is reached again. Its mouth is about 800 feet wide, and the depth in mid-river 40 feet. The volume of water which the Iguazú receives from its four principal branches and numberless small streams is large; and as the great river tumbles 197 feet over the Iguazú fall into a wild gorge, the scene is of imposing grandeur. The width of the falls, measured along their crest or edge, is 2½ miles; part of the river takes two leaps of about 100 feet each, but a portion of it plunges down the whole depth in unbroken mass.

Course of the Paraná.

The Paraná, at a point 28 miles above the mouth of the Tiété, is interrupted by the falls of Urubupunga, but below these it has unobstructed navigation for about 400 miles, as far down as the falls of Guaira, in 24° 3′ S., where the river forms a lake 4½ miles long and 2½ wide, preparatory to breaching the Serra de Mbaracayú, which there disputes its right of way. It has torn a deep gorge through the mountains for a length of about 2 miles, where it is divided into several channels, filled with rapids and cataracts. It finally gathers its waters into a single volume, to plunge with frightful velocity through a long cañon only about 200 feet wide. From these so-called falls of Guaira, or "Sete Quedas," as far as its confluence with the Paraguay river, the Paraná has carved a narrow bed through an immense cap of red sandstone, along which it sometimes flows with great rapidity, occasionally being interrupted by dangerous narrows and rapids, where the banks in some places close in to a width of 450 to 600 feet, although the average is from 1200 to 1600 feet. At the south-east angle of Paraguay the Paraná is prevented from continuing its natural southern course to the river Uruguay by the highlands which cross the Argentine province of Misiones, and connect those of Rio Grande do Sul with the Caa-guazú range of Paraguay. Here, therefore, it is turned westwards; but before escaping from its great sandstone bed, it is obstructed by several reefs, notably at the rapids of Apipé, which are the last before it joins the placid Paraguay, 130 miles farther on. From the Apipé rapids there is a vast triangular space at the south-western corner of Paraguay but little above sea-level, consisting of low, sandy ground and morasses, at times flooded by the Paraguay river. This district, united to the equally enormous area occupied by the Yberá lagoon and its surrounding morasses, in the northern part of the Argentine province of Corrientes, was probably the delta of the Paraná river when it emptied into the ancient Pampean Sea. The Paraná is charged with but little silt in comparison with its much smaller affluent, the Paraguay, although in flood it carries a volume of water estimated to be ten times that of the latter stream, and its width along the northern sandstone border of the province of Corrientes is from 3 to 9 miles.

The Paraguay.

The river PARAGUAY, the main affluent of the Paraná, rises in Matto Grosso, in the vicinity of the town of Diamantino, about 14° 24′ S. It flows south-westwards, as far as Villa Maria, along the foot of the high plateau which divides it from the Cuyabá river to the east, and then, turning southwards, soon reaches the morass expansion of Xarayas, which it traverses for about 100 miles. A few miles below Villa Maria it receives an affluent from the north-west, the Jaurá, which has its source nearly in contact with the head-waters of the Guaporé branch of the river *Madeira*. The *Cuyabá*, which is known as the São Lourenço for 90 miles above its confluence with the Paraguay, has its sources in 13° 45′ S., almost in touch with those of the Tapajos branch of the Amazon. The Cuyabá flows past them at a right angle, from north-east to south-west, for a distance of 150 miles, and is only separated from them by the plateau-ridge of Trombador, which in places is not 3 miles wide. As it flows onwards it is enlarged by a great number of minor streams, especially from the north-west, until it reaches the spur of the great sandstone plateau, at the south-eastern point of which the town of Cuyabá is situated; thence it enters the upper margin of the vast, swampy, and inundated region between the rivers Paraguay and São Lourenço. Just below the point where it takes this latter name it is 700 feet wide. Above the town of Cuyabá it is from 150 to 400 feet wide, and may be navigated up stream by canoes for 150 miles; but there are many rapids. The town may be reached from the Paraguay river, at low water, by craft drawing 18 inches. According to the observations of Clauss, Cuyabá is only 660 feet above sea-level. From the junction of the São Lourenço (or Cuyabá) with the river Paraguay, the latter, now a great stream, moves sluggishly southwards, spreading its waters, in the rainy season, for hundreds of miles to the right and left, as far south as 20°, turning vast swamps into great lakes—in fact, temporarily restoring the region, for thousands of square miles, to its ancient lacustrine condition.

Lagoons of upper Paraguay

On the west side of the upper Paraguay, between about 17° 30′ and 19° S., are several large, shallow *lagunas* or lakes which receive the drainage of the southern slopes of the Chiquitos sierras, but represent mainly the south-west overflow of the vast morass of Xarayas. The principal of these lakes, naming them from north to south, are the Oberaba, the Gaiba, Mandioré, and the "Bahia" de Casares. The Oberaba is the largest; its margins are completely inundated at high water, and the surrounding lands, as far as the eye can see, are tree-covered swamps and creeks choked with aquatic plants. The Gaiba is connected with the river Paraguay by a short *caño* or canal, said to offer 7 feet depth of water in the channel. The total length of the lake, which is in two unequal divisions, is 11 miles; its greatest width is 5 miles, and its maximum depth 12 feet—all at low water. It has long shelving shores which prevent access to its margins, except with craft of extremely light draught of water. The northern division of the lake belongs entirely to Brazil, but the southern division, about two-thirds of its area is bisected from north to south by the boundary-line between Brazil and Bolivia, according to the treaty of 1867. It is in great part surrounded by high ground and hills, but its southern coast is swampy and flooded during the rainy season. The west shore is historic. Here, in 1543, the *conquistador*, Martinez de Irala, founded the "Puerto de los Reyes," with the hope that it might become the port for Peru; and from Lake Gaiba several expeditions, in Spanish colonial days, penetrated 500 miles across the Chaco to the frontier of the empire of the Incas. At the Puerto de los Reyes Bolivia laid out a town in December 1900, in the forlorn hope that the "Port" may serve as an outlet for that commercially suffocated country, there being no other equally good accessible point for Bolivia on the Paraguay river. West of, and almost in contact with, the Gaiba is the smaller *laguna* Gaiba-Merim. A little to the south of the Gaiba is the shallow and useless Mandioré lake, and it is probably connected with it by a *caño* choked with weeds. Still farther south is the lake called the "Bahia" de Casares (Puerto Suarez), 19° S. It is too shallow to navigate, except by craft drawing less than 3 feet of water. "Bahia" Negra, 20° 10′ S., is an irregular flooded region forming a group of large connected lakes on the west side of the Paraguay river. They take the drainage of the river Otuquis, through the sandy district in which it is lost in its unsuccessful effort to reach the Paraguay. As an outlet for the country to the west and north of it the Bahia Negra is valueless.

Affluents of the Paraguay.

South of the São Lourenço, the first river of importance which enters the Paraguay from the east is the *Taquary*, about 19° S. It rises in the Serra Cayapó, on the southern extension of the Matto Grosso tableland. It is a river famous in the history of the slave-raiders from São Paulo in the 16th century. South of this stream, about 50 miles, a considerable river, the *Mondego*, with many branches, draining a great area of extreme southern Matto Grosso, also flows into the Paraguay; and still farther south, near 21°, is the *Apá* tributary, which forms the boundary between Paraguay and

Brazilian Matto Grosso. From northern to southern Paraguay the western drainage slope sends numerous short streams to swell the Paraguay. From the west it has but few and very short tributaries until the river *Pilcomayo* is reached, the country being too flat and the soil too sandy and thirsty to allow any large amount of water to flow to the great river.

The Pilcomayo.

The PILCOMAYO is of more importance from its length than from its volume. It rises among the Bolivian Andes north of Potosi and north-west of Sucre, races down the mountains to their base, crosses the Chaco plains, and pours into the river Paraguay near Asuncion. Nor does it receive any branch of importance until it reaches about 21° S., where it is joined from the south-west by the river *Pelaya*, upon which Tupiza, the most southerly city of Bolivia, is situated. The Pelaya rises upon the lofty inter-Andean plateau, and, taking an easterly course, saws its way across the inland Andean range, turns northwards and then eastwards to unite with the Pilcomayo, which it is said at least to equal in volume. Just below the junction is the fall of Guarapetendi, 23 feet high. From this point to the mouth of the Pilcomayo the distance in a straight line is 480 miles, although by the curves of the river, which is extremely tortuous, it is about double that distance. According to Storm, who quotes Captain Baldrich, the river bifurcates at 21° 51′ S., but again becomes a single stream at 23° 43′, the right channel being the greater in volume. It is probable that between 23° and 24° S. it throws east-south-eastwards three great arms to the river Paraguay, the upper portions of which have yet to be explored, but the lower parts have been examined for 100 to 200 miles up from the Paraguay. Enumerating from north to south, they are called the Esperanza, the Montelindo, and the Macá. From 180 to 200 miles above its mouth the Pilcomayo filters through a vast swamp about 100 miles in diameter, through which there is no principal channel. This swamp, or perhaps shallow lagoon, is probably partly drained by the river Confuso, which reaches the Paraguay between the Pilcomayo and Macá. A northern branch of the Pilcomayo, the Fontana, the junction being at 24° 56′ S., is probably also a drainage outlet of the same great swamp.

For the first 100 miles below the fall of Guarapetendi the Pilcomayo is from 600 to 1000 feet wide, but it so distributes its waters through its many bifurcations, and loses so much from infiltration and in swamps, and by evaporation from the numerous lagoons it forms on either side of its course, that its channel is greatly contracted before it reaches the Paraguay. It is possible that its Montelindo outlet may be the main river. From Sucre to the Andean margin of the Chaco, a distance of about 350 miles by the river, the fall is at least 8000 feet—a sufficient indication that its upper course is useless for purposes of navigation. The statements made by explorers regarding the Pilcomayo are very confused. This is probably due to the wandering propensities of the river and the immense areas of country it overflows in flood-time.

The missionaries in 1556 first reported the existence of the Pilcomayo, which for a long period of time was known as the Araguay. The first definite information regarding its course was given by the expedition of Armenta y Zaráte, which descended its valley by land for a considerable distance in 1672. In 1721 Patiño and Rodriguez partially explored it, and since then numerous attempts have been made to test its navigability, all of which have been failures; and several of them have ended in disaster and loss of life, so that the Pilcomayo now has a sinister reputation.

The Bermejo.

The BERMEJO river flows parallel to the Pilcomayo, and enters the Paraguay a few miles above the junction of this with the Paraná. Its numerous sources are on the eastern frontage of the inland Andes, between the Bolivian town of Tarija and the Argentine city of Jujuy. Its most northerly tributary is the San Lorenzo, which, after being augmented by several small streams, takes the name of *Rio de Tarija*. This, running east, is in turn swollen by several affluents, and then taking a general south-easterly course, joins the Bermejo in 22° 50′ S. at a point called the Juntas de San Antonio. Thence, flowing southwards, the Bermejo is enriched by many tributaries from the Andean gorges, and finally, in 23° 50′ S., receives its main affluent, the San Francisco, from the south-west. The latter has its source in about 22° 30′ S., and, under the name of Rio Grande runs directly southwards, in a deep, mountain valley, as far as Jujuy. It then turns eastwards for 50 miles, and is then joined by the Lavayen from the south-west. These two streams form the *San Francisco*, which from their junction runs north-eastwards to the Bermejo. The average width of the San Francisco is about 400 feet; it is seldom over 2 feet deep, and has many shoals and sandbanks. From its junction with the latter stream the Bermejo flows south-eastwards to the Paraguay, with an average width in its main channel of about 650 feet, although narrowing at times to 160 and even 100. In its course, however, it bifurcates and ramifies into many channels, forming enormous islands, and frequently leaves old beds for new ones. During floods it inundates immense areas of the flat Chaco country, filling vast lagoons and swamps on both sides of the river, which at such times becomes of indefinable width.

Since the exploration of the Bermejo by Patiño in 1721, it has often been examined from its sources to its mouth, with a view to ascertain its navigability. Captain Page in 1854 and 1859 found it impracticable to ascend it over 135 miles, in the dry season, with a little steamer drawing 23 inches of water; but in flood-time, in December 1871, he succeeded, in 60 days, in reaching a point 720 miles from its mouth, in the steamer *Alpha*, 53 feet long and 30 inches draught. He afterwards penetrated another 100 miles up stream. The round voyage took a year, owing to the swift currents, shoals, quicksands, snags, and fallen trees.

The Salado.

The SALADO, about 250 miles south-west of and approximately parallel to the Bermejo, is the only great tributary which the Paraná receives from the west below its confluence with the Paraguay. Its extreme head-waters are in the Argentine province of Salta, and they drain a much broken Andean region lying between 24° and 26° 30′ S. The most westerly sources are the rivers Santa Maria and Calchaqui, which unite near the town of San Carlos and form the river Guáchipas, which flows north-eastwards until it meets the Rio Arias, which has collected in a single artery various small affluents from the north and west. Having received the Arias, the Guáchipas runs north-eastwards about 50 miles, and then it changes its name to the Juramento, which is retained until the river reaches the Chaco plains at the base of the foot-hills of the Andes. Here it becomes the Salado, a name it preserves for the remainder of its course. It joins the Paraná near Santa Fé, in 31° 39′ S. and 60° 40′ W. From the time the Salado leaves the foot-hills it lazily rambles across the plains in a south-easterly course, now in a single channel, then dividing into several branches and forming long islands, and again overflowing to the right and left into great lagoons and swamps, sometimes to a width of 60 miles. In the dry season it is a narrow, tortuous stream, full of shoals and snags. At all times it carries an immense quantity of floating vegetation and trunks of trees, which constantly fall from its crumbling banks. Explorers of the river, inclusive of Captain Page in 1855, claim that its lower half is navigable, but the many efforts which have been made to utilize it as a commercial route have all resulted in failure. The Salado occupies the south-western side of a very level depression 300 miles across from south-west to north-east, and only 240 feet above the sea. Along the north-east side of this depression runs the Rio Bermejo.

As the Pilcomayo, the Bermejo, and the Salado wander about the country, ever in search of new channels, they erode and tear away great quantities of the Pampean material, dissolve it into silt, and pour it into the Paraguay and Paraná rivers. The engineer Pelleschi estimates that "the soil annually subtracted from the territory of the Chaco by the Bermejo alone equals 6,400,000 cubic yards."

South of the Salado, the rivers *Saladillo*, *Primero* and *Segundo*, provide the water for the evaporation from the great inland lake Porongos. The *Tercero* and *Quarto* streams unite and empty into the Paraná near Rosario, with a considerable volume of water. The *Quinto*, with other small rivers, draining the southern spurs of the Cordoba range, are absorbed by the thirsty Pampean morass La Amarga.

South-easterly course of Paraná.

South of its confluence with the river Paraguay, the Paraná washes the western foot of a series of sandstone bluffs for 30 miles. Thence for 240 miles the bordering hills are about 80 feet high, but at Goya the country is almost on a level with the river. Near the boundary-line between Corrientes and Entre Rios the banks are very low on both sides of the river, and continue so for nearly 100 miles; but farther down, for 150 miles, the left bank is margined, as far as Diamante, by a range of hills from 125 to 160 feet high, at times boldly escarped. At Diamante they trend inland, south-eastwards, for about 50 miles, and probably once bordered an ancient channel of the river. From 31° 30′ S. to the head of the Plata estuary the western bank of the Paraná is a precipitous bluff of reddish clay, varying from 25 to 75 feet above mean river level. It is being gradually undermined, and tumbles into the water in great blocks, adding to the immense volume of silt which the river carries. According to Ramon Lista, "the lowest level of the Paraná is in October and November, and, save an occasional freshet, it remains stationary until the beginning of summer, when its waters commence to rise, reaching their maximum about the middle of February in the lower part of their course." The difference between low and high river is generally about 12 feet, depending upon the varying quantity of rains in Brazil and the melting of the Andean snows. Below its junction with the Paraguay the Paraná has an average current of $2\frac{1}{2}$ miles an hour, and the river varies in width from 1 to 3 miles at low water; but in floods it seems almost a continuous lake, broadening to 10 and 30 miles and burying many of its numerous islands and marginal swamps under a vast sheet of water, and obliterating its many parallel lateral channels and intricate systems of connecting canals.

In the middle Paraná, from the mouth of the Iguazú to the mouth of the Paraguay river, there are many islands, some of them large, rocky, and high above the river. From Paraguay to the city of Rosario, islands are numerous, many of them of great area; and again below Rosario they soon increase in number and size until the Plata estuary is reached. In the lower Paraná they are mostly covered with dense and beautiful vegetation, sometimes mingled with the bright crimson foliage of the Seibo tree. In flood-time the upper portion of the trees being out of water, they have the appearance of floating forests. Then the river often makes wild work with its banks, and builds up or sweeps away entire islands, leaving deep channels instead. Mouchez in 1857, searching for two islands, the position of which he had fixed in the previous year, found in their place 25 and 32 feet of water. The lower delta of the Paraná does not share in these phenomena; its islands and main channels appear more fixed. This probably is due to the less elevation attained by the waters in flood-time, and the numerous branches which distribute them into the Plata estuary. This must have extended, in a very recent geological period, inland from its present head to at least 32° S.; but the enormous quantity of silt which the Paraná receives from its Paraguay affluent, and from the tributaries which reach it from the Andes, has filled this length of about 220 miles with these muddy islands, which rest upon a sandy bed of great depth.

Islands of Paraná.

The frontage of the Paraná delta is 40 miles across, almost in a straight line from north to south. Through this the river finds its way to the Plata by eleven outlets, large and small, the two principal ones being the Paraná-guazú and the Paraná de las Palmas. The frontage is a line of marked regularity, due probably to the current of the Uruguay river, which cuts across its face and carries the silt to the south-west until it meets the outflow of the Paraná de las Palmas, which sweeps it south-east along the Buenos Aires shore.

Paraná delta.

The mean flow of the Mississippi river at New Orleans is 675,000 cubic feet per second, and its flood maximum about 1,000,000 feet. The minimum of the Plata past Buenos Aires is 534,000, the maximum 2,145,000. It may therefore be fairly assumed that the yearly discharge of the great North American river is not superior, and may be inferior, to that of the Plata.

The Paraná is navigable at all times as far up as the São Lourenço river by craft drawing 3 feet of water, and to within a few miles of Asuncion, the capital of Paraguay, by vessels drawing 9 feet. The city of Paraná may always be reached with a draught of 12, and Rosario with 15, feet of water.

The commercial development of the Plata basin may be conveniently illustrated by statistics for the year 1822, which marks the beginning of independent rule in its republics; for 1854, when the steamboat and the railway first began to play a part in this quarter of the world; and in 1898 and 1899, as indicating approximately the state of affairs at the end of the 19th century. In Buenos Aires, for example, the foreign trade (entered and cleared) in 1822 aggregated 107,170 tons; in 1854, 342,463 tons; and in 1899, 5,046,847 tons. The coasting and river trade of the same port increased from 150,741 tons in 1854 to 3,695,088 tons in 1899. But, taking into account all the Argentine ports, except those which lie to the south of the Plata, there was for the six years ending with 1899 an annual average of 14,000,000 for the overseas commerce and 11,000,000 tons for the river and coasting trade. On the other, or northern, bank of the stream the chief port is Montevideo; and its foreign commerce increased from an aggregate of 50,000 in 1822 to 150,000 tons in 1854 and to 4,069,870 tons in 1898, the river and coasting trade having increased from 50,000 tons in 1822 to 150,000 tons in 1854 and to 3,915,421 tons in 1898. The total foreign trade of the Plata valley thus increased from over 157,000 tons in 1822 to nearly 18,100,000 tons in 1898–99. (G. E. C.)

Commerce.

Plattsburg, a village of New York, U.S.A., capital of Clinton county, on the west shore of Lake Champlain, at the mouth of the Saranac river, at an altitude of 120 feet. It is on the Delaware and Hudson railroad, and is the terminus of the Chateaugay railroad. Its site is level and its plan regular. Its manufacturing establishments include saw-mills, pulp-mills, foundries, and machine shops. Population (1890), 7010; (1900), 8434, of whom 1053 were foreign-born.

Plattsmouth, a city of Nebraska, U.S.A., capital of Cass county, at the junction of the Platte and the Missouri rivers, at an altitude of 968 feet. The city has an irregular plan, with good water supply and sewer systems. It is upon the Burlington and Missouri River and the Missouri Pacific railways, has a large trade in grain and cattle, and has the works of the Burlington and Missouri River railroad. Population (1880), 4175; (1890), 8392; (1900), 4964, of whom 979 were foreign-born.

Plauen, a town of Germany, on the Weisse Elster, 21 miles south-west of the town and in the circle of Zwickau, kingdom of Saxony; stations on the Leipzig–Hof, Reichenbach–Eger, and Gera–Weischlitz railways. The seat of a commercial and industrial chamber, Plauen has 3 churches, a Methodist chapel, a gymnasium, a builders', an industrial, a commercial school, and other schools, and a seminary for teachers. Its industries include cotton, carded woollen, paper, twisting, embroidery, and other mills, many dye and bleaching works, leather, piano, iron safe, and other factories. Population (1880), 35,082; (1890), 47,007; (1900), 73,891.

Playfair, Lyon, 1st Baron (1818–1898), was born at Chunar, Bengal province, on 21st May 1818. He was sent to Europe by his father at an early age, and received his first education at St Andrews. Subsequently he studied medicine at Glasgow and Edinburgh. A short visit to India (in 1837–38) was followed by his return to Europe to study chemistry, which had always attracted him. This he did at University College, London, and afterwards under Liebig at Giessen, where he took his doctor's degree. At Liebig's request, Playfair translated into English the former's work on the *Chemistry of Agriculture*, and represented Liebig at a meeting of the British Association at Glasgow. The outcome of his studies was his engagement in 1841 as chemical manager of the Primrose print works at Clitheroe, a post which he held for rather more than a year. In 1843 he was elected hon. professor of chemistry to the Royal Institution of Manchester, and soon afterwards was appointed a member of the Royal Commission on the Health of Towns, a body whose investigations may be said to have laid the foundations of modern sanitation. In 1846 he was appointed chemist to the Geological Survey, and thenceforward was constantly employed by the public departments in matters of sanitary and chemical inspection. He had previously been offered, and had accepted, a professorship of chemistry at Toronto; but the representations of his friends, who had interested Sir Robert Peel in his favour, induced him to withdraw his acceptance and rely on the certainty of a career in England. The opportunity of his life came with the 1851 Exhibition, of which he was one of the Special Commissioners. For his services in this connexion he was made C.B., and his work had the additional advantage of bringing him into close personal connexion with the Prince Consort, who appointed him Gentleman Usher in his household. He was selected to appoint the jurors for the Exhibition of 1862, and was one of the English commissioners at the Paris Exhibition of 1855, and again in 1878. From 1856 to 1869 he was professor of chemistry at Edinburgh University, numbering among his pupils the present King and the late Duke of Edinburgh. In 1868 he was elected to represent the Universities of Edinburgh and St Andrews in Parliament, and retained his seat till 1885, from which date until 1892 he sat as member for Leeds. In 1873 he was made Postmaster-General, and in the following year, after the dissolution of Parliament, was applied to by the incoming Tory Government to preside over a Commission to inquire into the working of the Civil Service. Its report established a completely new system, which has ever since been officially known as the "Playfair scheme." The return of Mr Gladstone to power in 1880 afforded opportunity for Playfair to resume his interrupted parliamentary career, and from that time until 1883 he acted as Chairman of Committees during a period when the obstructive tactics of the Irish party were at their height. On his retirement from the post he was made K.C.B. As illustrative of the many interests which now divided his time, may be mentioned his strong advocacy of the Vaccination Acts; his efforts on behalf of the Tercentenary Commemoration of Edinburgh University in 1884; his presidency of the British Association in 1885; his appointment by Mr Gladstone in 1886 to the office of Vice-President of the Council; his advocacy of medical reform; and his work (as deputy-chairman of the Commissioners of the Great Exhibition) in connexion with Queen Victoria's Jubilee in 1887. In 1892 he was created Baron Playfair of St Andrews, and a little later was appointed Lord-in-Waiting to the Queen. In 1895 he was given the G.C.B. In spite of failing health, the last years of his life were full of activity, one of his latest public acts being his suggestion that Queen Victoria's Diamond Jubilee of 1897 should be commemorated by the completion of the South Kensington Museum. He died in London, after a short illness, on 29th May 1898, and was buried at St Andrews. He was three times married. He was the author of a number of papers on scientific and social topics, a selection from which he published in 1889 under the title of *Subjects of Social Welfare*. A memoir of him by Sir Wemyss Reid appeared in 1899. (R. F. S.)

Plevna, or Pleven, the chief town of a district in the principality of Bulgaria, situated 85 miles north-east of Sofia, on the Toutchinitza, an affluent of the Danube, and on the Sofia–Varna Railway (opened in 1899), where a branch line passes north, 25 miles to Sómavit on the Danube, where a new port has been formed. After the capture of the town by the Russians in 1877, it was forsaken almost entirely by the Turks, and most of the mosques have gone to ruin; but, peopled now mainly by Bulgarians, it has quite recovered its prosperity, and has a large commerce in cattle and wine. A recently introduced manufactory is that of safes. The ancient Turkish kanak is now used as the prefecture of the department. Numerous monuments have been erected by the Russians and Bulgarians to the memory of those killed during the struggles for its possession. Population (1900), 18,709.

Plimsoll, Samuel (1824–1898), British politician and social reformer, was born at Bristol on 10th February 1824. Leaving school at an early age, he became a clerk, and rose to be manager of a brewery in Yorkshire. In 1853 he endeavoured to set up a business of his own in London as a coal merchant. The venture proved a failure, and Plimsoll was reduced to destitution. He has himself related how for a time he lived in a common lodging-house on 7s. 9½d. a week. This experience had a profound influence on his career. He learnt to sympathize with the struggles of the poor; and when the success of his enterprise placed him in possession of a competence, he resolved to devote his leisure to the amelioration of their lot. His efforts were directed more especially against what were known as "coffin-ships"—unseaworthy and overloaded vessels, often heavily insured, in which an unscrupulous owner was allowed by the law of that time to risk the lives of his crew. Plimsoll entered Parliament as Liberal member for Derby in 1868, and endeavoured in vain to pass a Bill dealing with the subject. In 1872 he published a work entitled *Our Seamen*, the sincerity and deep feeling of which made a great impression throughout the country. Though many of its statements were shown to be exaggerated or unfounded, enough remained to prove the crying need for reform. Accordingly, on Plimsoll's motion in 1873, a Royal Commission was appointed, and in 1875 a Government Bill was introduced, which Plimsoll, though regarding it as inadequate, resolved to accept. On 22nd July, the Premier, Disraeli, announced that the Bill would be dropped. Plimsoll lost his self-control, applied the term "villains" to members of the House, and shook his fist in the Speaker's face. Disraeli moved that he be reprimanded, but on the suggestion of Lord Hartington agreed to adjourn the matter for a week to allow Plimsoll time for reflection. Eventually Plimsoll made an apology. The country, however, shared his view that the Bill had been stifled by the pressure of the shipowners, and the popular agitation forced the Government to pass a Bill, which in the following year was amended into the Merchant Shipping Act. This gave stringent powers of inspection to the Board of Trade, and made the old abuses impossible. The mark that indicates the limit to which a ship may be loaded is generally known as Plimsoll's mark. With the passage of this Act Plimsoll's work reached its climax. He was re-elected for Derby at the general election of 1880 by a great majority, but gave up his seat to Sir W. Harcourt, in the belief that the latter, as Home Secretary, could advance the sailors' interests more effectively than any private member. Though offered a seat by some thirty constituencies, he did not re-enter the House, and subsequently became estranged from the Liberal leaders by what he regarded as their breach of faith in neglecting the question of shipping reform. He held for some years the presidency of the Sailors' and Firemen's Union, raised a further agitation, marred by obvious exaggeration, about the horrors of the cattle ships, and visited the United States with the object, in which he proved successful, of securing the adoption of a less bitter tone towards England in the historical text-books used in American schools. He died at Folkestone on 3rd June 1898. (H. SY.)

Płock, a government of Russian Poland, bordering on Prussia, with an area of 4200 square miles, and in 1897 a population of 556,819, of whom 278,104 were women, and 99,821 lived in towns. It is divided into seven districts, of which the chief towns are Płock (*q.v.*), Ciechanow (10,664), Lipno (6753), Mława (13,449), Prasnysz (9136), Rypin (6040), and Sierpiec (8560). The standard of education is very low, and in 1896 the 443 schools were attended by only 13,749 boys and 5386 girls. Agriculture is the main occupation, the average annual yield of the crops from 1895 to 1899 being 1,141,000 cwt. of wheat, 3,252,000 cwt. of rye, 852,000 cwt. of oats, 405,000 cwt. of barley, 6,048,000 cwt. of all cereals, and 9,541,000 of potatoes; considerable quantities of grain are exported. Beetroot is also cultivated for the manufacture of sugar, and gardening and bee-keeping are extensively engaged in for industrial purposes. The live stock included in 1897, 90,000 horses, 213,000 horned cattle, and 393,000 sheep, chiefly of improved breeds. The aggregate output of the factories—chiefly sugar works—was valued at only £335,000.

Płock, the capital of the above government, situated on the right bank of the Vistula, 172 feet above its level, 32 miles from the Kutno Railway station. There is considerable navigation on the Vistula, grain, flour, wool, and beetroot being the chief items of export. Coal, naphtha, salt, and fish are imported. Population (1897), 27,073.

Ploesci, chief town of the district of Prahova, Rumania, situated 38 miles from Bucharest, at the entrance of the valley of the Prahova, in a region which is sufficiently indicated by its name Ploesci (*pluviena*, rainy). It is the headquarters of a military division and seat of a court of first instance, and has a lycée, a school of arts and crafts, and a commercial school, and is besides an important commercial centre, with numerous markets and fairs. It is likely to develop still further, as occupying one of the richest petroleum-bearing districts in Rumania. There is a large number of commercial and banking co-operative societies. It contains nineteen churches, comprising one Roman Catholic church and three synagogues, besides the Church of Our Lady, constructed in 1740 by Matthew Bassaraba. In the neighbourhood are the monasteries of Pargasoru, Crangulu, Peinlui, and Maigineni. Population (1900) 42,687.

Plumptre, Edward Hayes (1821–1891), English theologian and scholar, was born in London on 6th August 1821. Becoming scholar of University College, Oxford, he graduated with a double first-class in 1844, and in the same year was elected fellow of Brasenose College. He was ordained in 1847, and was shortly afterwards elected to the Chair of Pastoral Theology at King's College, London. In 1863 he was given a prebendal stall at St Paul's, and for the period from 1869 to 1874 was a member of the committee appointed by Convocation to revise the authorized version of the Old Testament. After successively holding the livings of Pluckley and Brickley in Kent, he was installed in 1881 as Dean of Wells. Dean Plumptre was a man of great versatility; he is known as the translator of the plays of Sophocles and Æschylus, and of the *Divina Commedia* of Dante. Among his contributions to theological literature may be mentioned *Exposition of the Epistles to the Seven Churches of Asia* (1877), *The Spirits in Prison* (1884), *The Book of Proverbs* (which he annotated in the *Speaker's Commentary*), the *First Three Gospels, the Acts, and the Second of Corinthians*, in Bishop Ellicott's *New Testament Commentary*, and *Life of Bishop Ken* (1886). He died on 1st February 1891.

Plymouth, a municipal, county (1888, extended 1896), and parliamentary borough, and seaport of Devonshire, England, 231 miles by rail west-south-west of London, on Plymouth Sound, which consists of the confluence of the estuary of the Tamar on the west with the estuary of the Plym on the east. With the township of Stonehouse and the borough of Devonport, Plymouth constitutes the aggregate "Three Towns." The municipal borough is distributed into 14 wards, under a mayor, 14 aldermen, 42 councillors, a recorder, town clerk, &c. Bounded on the S. by a line connecting Penlee and Wembury Point, the Sound is 3 miles long from north to south and 2½ to 3 miles broad, covering at high water 4500 acres. Its inlets into the land on the north are, from the east end westwards: (1) Catwater, 200 acres, with accommodation for 1000 vessels, anchorage chiefly for timber vessels and coal-hulks; it was in 1888 provided with a new wharf and hydraulic cranes, and a small breakwater is laid across its entrance. The depth varies from 18 to 24 feet, and in 1902 was increased throughout to the greater depth. (2) Sutton Pool, 90 feet wide at its entrance, with an area of 27 acres, a substantial jetty, and a graving beach 400 feet long. The Pool has been connected with the Great Western and South-Western railways. (3) Mill Bay. Outside its floating dock, 17 feet neaps, is the tidal basin of 35 acres; on its western side is an extension jetty. At low water it accommodates ships of 24 feet draught, free to arrive and discharge at any time. The graving dock, entered from the inner basin (13 acres), is 464 feet long by 92 feet wide, 80 feet width of entrance, and 22 feet depth of water at ordinary spring tides, as in the floating basin. (4) Stonehouse Pool, the anchorage more particularly of ships in the timber trade, and with 22 to 24 feet at low water. New quays have been constructed, and there are two discharging berths. (5) Hamoaze, 4 miles long from Mount Edgcumbe to Saltash, the thoroughly protected harbourage of his Majesty's ships "in ordinary." For 14 miles above Devonport the Tamar is navigable for small vessels. Till 1841 the Sound was exposed to the brunt of the south-western gales. In that year was completed, at a cost of 1½ million sterling, the Great Breakwater. It stretches, an isolated mole of stones, 2½ miles south of the Hoe, 360 feet wide at the base, sloping to 45 feet at the top, 1700 yards long, across the middle of the Sound, its two ends or cants bent inwards at an angle of 120 degrees; an outlying barrier which has since secured to the entire Sound the safety of a harbour. The open channels between breakwater and shore are on the west 4300 feet and on the east 2200 feet broad. A lighthouse stands at the west end of the breakwater, a pyramidal beacon at the east end. The school board has 13 ordinary schools, 3 cooking centres, 2 woodwork centres, &c.; and the municipal, science, art, and technical schools (1892) are attended by 800 students. Other new buildings are an Established church, the Marine Biological Laboratory (1888), the Armada Memorial (1888), a new Corn Exchange, the market, rebuilt, a new fishmarket, an ear and throat hospital, a new wing to the Devon and Cornwall Hospital, an endowed convalescent home, and the Mill Bay station of the Great Western Railway.

A highly important Government station, Plymouth is strongly fortified. On the north the chain of forts around the three towns, stretching in horse-shoe line from the river Tamar to the river Plym, is 14 miles long. The citadel at the east end of the Hoe commands the Catwater. Strong fortifications on Mount Wise command the entrance to Hamoaze. Just inside the breakwater is one of the strongest forts in the world. The channel to the east of the breakwater is further protected by a granite battery at Bovisand, north of which is a strong fort on Staddon Heights, and still farther north the forts of Bellevue and St Ann. The channel to the west of the breakwater is protected from the land by Cawsand Battery. Farther north, on the west side of the Sound, are Picklecombe Fort and Earl's Battery, Western King Fort and Eastern King Battery—the two latter on Stonehouse coast. Whitesand Bay, again, is guarded from the coast by Pollawny Battery and Tregantle Fort. Drake's Island is strongly fortified and garrisoned. The industries of Plymouth include large engineering and shipbuilding works; large exporting starch, blue, and black-lead factories; two soap factories, tanneries, distilleries, &c. There are three daily newspapers. The registered shipping at the port in 1900 was 323 vessels of 55,537 tons, against 345 of 28,087 tons in 1888. In 1900, 2903 vessels of 884,918 tons entered, as compared with 1231 of 480,525 tons in 1888. Clearances numbered 2902 vessels of 833,222 tons in 1900, as compared with 1116 of 433,983 tons in 1888. The total foreign and colonial imports in 1900 were valued at £1,573,049, against £1,416,282 in 1888. The total exports of merchandise of the United Kingdom in 1900 were £154,993, against £162,227 in 1888. Area, 2370 acres. Population (1891), 88,926; (1901), 107,509.

The township of Stonehouse, governed by an urban district council of 15 members, is a western continuation of Plymouth, separated by Stonehouse Pool from Devonport, in the parliamentary borough of which it is included. A bridge across the Pool connects Stonehouse with Devonport; higher up, Mill Bridge connects Stonehouse with Stoke Damerel. A naval and military depôt, Stonehouse contains the Royal William Victualling Yard (14 acres), the western part of which is appropriated to the naval ordnance department, with repairing shops, armoury, &c.; marine barracks, with accommodation for 1500 men; a naval hospital (24 acres); a town hall; and a theatre (1889), seating over 2000 persons. Area, 190 acres. Population (1881), 15,041; (1901), 15,108. (C. N.)

Plymouth, a town of Massachusetts, U.S.A., capital of Plymouth county, comprising 116 square miles of rolling country, dotted with ponds. The principal village bears the same name as the town, and is situated in the northern part, on Plymouth Harbour and on a branch of the New York, New Haven, and Hartford Railroad. It has an irregular plan, a good water supply and sewer systems, and varied manufactures. Population of the town (1890), 7314; (1895), 7957; (1900), 9592, of whom 2274 were foreign-born and 146 negroes.

Plymouth, a borough of Luzerne county, Pennsylvania, U.S.A., on the Susquehanna river, and on the Delaware, Lackawanna, and Western Railroad, at an altitude of 535 feet. It is in the anthracite coal region, and its industries are related to the mining and handling of coal. Population (1890), 9344; (1900), 13,649, of whom 4804 were foreign-born.

Pneumatic Despatch.—The system of pneumatic despatch tubes (for telegrams only) in use in the English Postal Department had in 1902 a total length of over 60 miles, laid underground, of which length 40 miles were in use in the London district. There are also short tubes, known as "house tubes," in use in most large offices; such tubes, which are worked either by power (in the case of the head offices) or by hand pumps, are from $1\frac{1}{2}$ to $2\frac{1}{4}$ inches in diameter, and are used for the purpose of conveying messages from one part of a telegraph instrument-room to another, or from the instrument-room to the public counter. The underground, or "street," tubes in London are chiefly $2\frac{1}{4}$ inches in diameter, but there are also a number of 3-inch tubes in use; those in the large provincial towns (Birmingham, Bradford, Cardiff, Glasgow, Grimsby, Liverpool, Manchester, Leeds, and Newcastle) are $2\frac{1}{4}$ inches in diameter, but in Dublin $1\frac{1}{2}$-inch tubes are employed. There are 50 street tubes in London, varying in length from 100 to 2000 yards (Central Office to the Houses of Parliament), and also 50 house tubes; the pumps for the whole system are worked by four 50-horse power steam-engines. At Cardiff and Leeds the pumps are driven by electric motors.

Carriers. The "carriers" in all cases have gutta-percha bodies and are covered with felt, the front of the carrier being provided with a buffer or piston formed of several discs of felt which exactly fit the tube; the messages are prevented from getting out of the carrier by the end being closed by an elastic band, which can be stretched sufficiently to allow the message forms to be put in. The 3-inch carriers will hold 75 ordinary message forms, the $2\frac{1}{4}$-inch carriers 25 forms, and the $1\frac{1}{2}$-inch carriers 20 forms. ***Tubes.*** The tubes are in all cases of lead, the $2\frac{1}{4}$-inch tubes weighing 8 lb per foot run and being made in lengths of 28 feet; they are enclosed in 3-inch cast-iron pipes made in lengths of 9 feet.

Great care is exercised in making the joints in the lead pipes. Before the tube is placed in its trench a strong chain is passed through it, and a polished steel mandrel, 6 inches long and slightly less in diameter than the diameter of the tube, is heated and attached to the chain, and pushed half its length into the end of the tube already laid; the new length of tube is then forced over the projecting end of the mandrel until the tube ends (which have been previously cut flat) butt perfectly together; an ordinary plumber's joint is then made. By this means the tube is made perfectly air-tight, and the mandrel keeps the surface of the tube under the joint as smooth as at any other part of its length. After the joint is completed, the mandrel is drawn out by the chain attached to it, the next length is drawn on, and the above process repeated. The tubes are laid about 2 feet below the surface of the ground.

The tubes radiate from the central to the branch offices, the principal offices having two tubes, one for "inward" and the other for "outward" traffic. At the smaller offices both the inward and outward traffic is carried on through one tube. ***Working.*** The carriers are propelled in one direction (from the central office) by "pressure," and drawn in the opposite direction by "vacuum," the standard pressure and vacuum being 10 lb and $6\frac{1}{2}$ lb per sq. in. respectively, which values give approximately the same speed.

The time of transit of a carrier through a tube when the air pressure does not exceed 20 lb per square inch is given very approximately by the empirical formula:

$$t = \cdot 00872\sqrt{\frac{l^3}{\mathrm{P}d}};$$

where l=length of tube in yards, d=diameter of tube in inches, P=effective air-pressure in pounds per square inch, t=transit time in seconds. For vacuum the formula is:

$$t = \frac{\cdot 00825}{1 - \cdot 234\sqrt{15\cdot 5 - \mathrm{P}_1}}\sqrt{\frac{l^3}{d}};$$

where P_1=effective vacuum in pounds per square inch.

The horse-power required to propel a carrier is approximately, for pressure—

$$\mathrm{H.P.} = (\cdot 574 + \cdot 0011\mathrm{P})\sqrt{\frac{\mathrm{P}^3 d^5}{l}};$$

for vacuum—

$$\mathrm{H.P.} = (5\cdot 187 - 1\cdot 214\sqrt{15\cdot 5 - \mathrm{P}_1})\mathrm{P}_1\sqrt{\frac{d^5}{l}}.$$

For a given transit time the actual horse-power required is much less in the case of vacuum than in the case of pressure working, owing to the density of the air column moved being much less: thus, for example, the transit time for 10 lb pressure is the same as for $6\frac{1}{2}$ lb vacuum, but the horse-power required in the two cases is as 1·83 to 1. A tube 1 mile long, $2\frac{1}{4}$ inches in diameter, and worked at 10 lb per square inch pressure, will have a transit time of $2\frac{1}{4}$ minutes, and will theoretically require 3·35 horse-power to be expended in working it, although actually 50 per cent. more horse-power than this must be allowed for, owing to losses through various causes. The transit time for a $2\frac{1}{4}$-inch tube is 16 per cent. more than for a 3-inch tube of the same length, when both are worked at the same pressure, but the horse-power required is 50 per cent. less; it is not advisable, therefore, to use a tube larger than is absolutely necessary to carry the volume of traffic required.

Despatching and receiving apparatus. The somewhat complicated pattern of "double sluice valve" originally used at the central stations has been superseded by a simpler form, known as the "D" box—so named from the shape of its cross section. This box is of cast iron, and is provided with a close-fitting, brass-framed, sliding lid with a glass panel. This lid fits air-tight, and closes the box after a carrier has been inserted into the mouth of the tube; the latter enters at one end of the box and is there bell-mouthed. A supply pipe, to which is connected a "3-way" cock, is joined on to the box and allows communication at will with either the "pressure" or "vacuum" mains, so that the apparatus becomes available for either sending (by pressure) or receiving (by vacuum) a carrier.

On the long tubes (over about 1000 yards) a modification of the "D" box in its simplest form is necessary; this modification consists in the addition of a "sluice" valve placed at a distance of about 9 inches (*i.e.*, rather more than the length of a carrier) from the mouth of the tube. This sluice valve, by means of an interlocking arrangement, is so connected with the sliding lid of the box that the lid cannot be moved to the open position unless the sluice valve has closed the tube, nor can the sluice valve be opened unless the sliding lid is closed. The object of this sluice valve is to prevent the back rush of air which would take place into the tube when the sliding lid is opened to take out a carrier immediately on the arrival of the latter; for although the vacuum may be turned off by the 3-way cock, yet, owing to the great length of the tube, equilibrium does not immediately take place in the latter, and the back rush of air into the vacuum when the lid is opened to extract the carrier will cause the latter to be driven back into the tube. The sluice also prevents a similar, but reverse, action from taking place when pressure working is being carried on. As a rule, only one carrier is despatched at a time, and no second carrier is inserted in the tube until the arrival of the first one at the farther end is automatically signalled (by an electric apparatus) to the despatching office. On some of the long tubes a carrier, when it passes the midway point on the tube, strikes a trigger and sends back an electrical signal indicating its passage; on the receipt of this signal a second carrier may be despatched. Recently a signalling apparatus which by a clock movement actuates an indicating hand and moves the latter to "tube clear" a certain definite time (30 to 40 seconds) after a carrier has been inserted in the tube, has been introduced. By this arrangement carriers can be despatched one after the other at comparatively short intervals of time, so that several carriers (separated by distinct intervals) may be travelling through the tube simultaneously. It is necessary that the carriers be separated by a definite interval, otherwise they tend to overtake one another and become jammed in the tube. Although the stoppage of a carrier in a tube is of exceedingly rare occurrence, it does occasionally take place, through picks being driven into the tube by workmen executing repairs to gas or water pipes, but the locality of such a stoppage is easily determined by a simple inspection along the route of the tube. In no case is any special means of testing for the locality from the central office found necessary.

Stoppages and leaks in tubes.

In America, tubes (of brass) up to 8 inches in diameter are in use for the despatch of letters. The system is that of Batcheller, and a total length of several miles is worked.

References.—*General Post Office Technical Instructions*, X., "Pneumatic Tubes"; Kempe's *Engineers' Year-Book*, 1902 edition.

(H. R. K.)

Pneumatic Tools.—The term pneumatic tool is applied to a class of machine-shop appliances of recent origin, which have been developed chiefly in America, and, in the initial stages, in the railway repair and maintenance works of that country. This development was due to the prior existence in these works of means for compressing air. The air-brake is almost universally used on American railways, and in consequence numbers of the air-pumps which are fitted on the locomotives are always to be found in such works, either awaiting or having undergone repair. In these circumstances, when an apparently useful application of compressed air was devised, it became a simple matter to lay the necessary pipes and connect one of the pumps for trial. In many cases these pumps, in spite of their well-known low efficiency, were retained for a considerable time, several being combined in a battery; but when the economy of the new methods had been fully demonstrated, well-designed air compressors of a suitable and economical type were substituted, and are now considered a necessary part of the equipment of a well-organized American railway repair work. From such works the use of the tools has extended to other works, and especially to shipyards.

The machines may be roughly classified into small portable tools, guided largely by the hand, in which the effort exerted is small but fairly continuous, and larger stationary tools, in which a considerable effort is exerted, but intermittently only. All are alike in one particular—the aggregate of power consumed per hour is small. The work done by both classes is chiefly such as has hitherto been done directly by hand, although occasionally they displace other machines, which, however, are in most cases hand-driven. Sometimes, when only a small amount of work is to be done, pneumatic tools are brought to heavy pieces of material which were previously taken to fixed machines. The main sources of economy in the use of pneumatic tools are thus the substitution of mechanical for manual power, and the moving of a small portable machine to a heavy piece of work, instead of moving the work to a fixed machine. As is the fact with most applications of compressed air, the mechanical efficiency, considered as the ratio between input and output, is low, but, as in many other instances connected with applications of power, the commercial efficiency, measured by the cost of the work, is nevertheless high. The increase of output of a workman and his pneumatic tool over that of a workman using the old hand tools is so much greater than the increased cost due to the added expense of maintaining and operating the pneumatic plant, that the work is done at far less cost per unit. Moreover, the output of a given plant or workshop is largely increased, and the owners thereby secure the well-recognized economical advantages of production on a larger scale.

Perhaps the most important of these tools is the hammer (Fig. 1), which was the first to become of commercial importance. It is somewhat similar to the rock-drill, the chief difference, next to that of size, being the free-flying piston. In the rock-drill the piston carries the drilling-tool with it in its reciprocations, but in the hammer it does not. The shank of the tool—chisel, caulking-tool, or whatever it may be—projects slightly through the cylinder head, so that the free piston strikes it at each stroke, the action being precisely like that of a hand hammer. The motion is very rapid, 3600 blows per minute being delivered in the smaller sizes. Originally these tools were of small size only, suitable for holding in the hand, but larger ones are now made, with suitable frames and supports, intended chiefly for driving rivets. For some purposes a heavy blow is needed—a large number of light blows not being the equivalent of a smaller number of heavy blows. For these purposes a new type of hammer, to be held in the workman's hand, and called the long-stroke hammer, is an important development. The piston is heavier and the stroke is much longer than in the older type. This type is especially adapted to riveting, and it is in large use for that purpose on steam boilers, the hulls of ships, and the erection-work of bridges and steel-frame buildings. It can be used in many places in which the application of machines held in yokes or frames would be impossible. The range of application of pneumatic hammers is almost as wide as that of a hand hammer; they have even been used under water by divers working on wrecks. A recent application of the same principle is to be seen in the sand-rammers employed in making foundry moulds (Fig. 2).

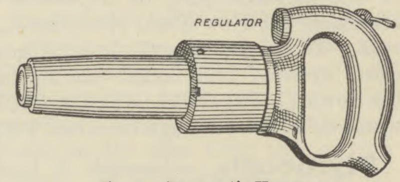

Fig. 1.—Pneumatic Hammer.

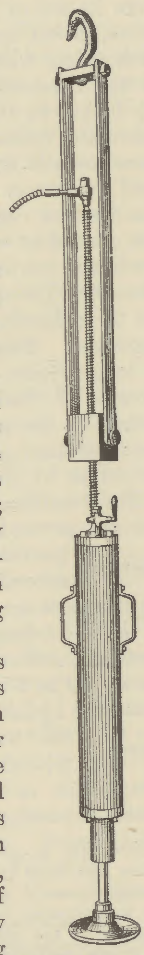

Fig. 2.—Pneumatic Sand-Rammer.

A second tool of similar importance is the rotary drill (Fig. 3). Originally this consisted of a small rotary engine with feeding mechanism for tools suitable for drilling or boring in iron or wood, but the wastefulness of such an arrangement led to the design of small reciprocating engines for the same purpose. For distinction these are called piston air drills, though, as the original construction drops out of use, the distinction in name will naturally be dropped also, the term rotary being probably retained. They are chiefly used where formerly the hand ratchet brace was relied upon. In all heavy machine work cases are of frequent occurrence in which holes are required in inaccessible places. In these the hand ratchet was formerly employed, as well as in those in which small holes, so located as to be easily accessible, were needed in large pieces. The operation of the hand ratchet is slow, laborious, and expensive, while the mere moving and fixing of heavy pieces in position under a stationary drilling machine may cost far more than the actual performance of the work. In both these cases the rotary air drill gives marked economy.

These motors are applied to a great variety of operations besides drilling. Reaming, tapping, expanding boiler tubes, grinding steam joints, sand-papering woodwork, and cleaning castings by their aid, are very common; and a recent application is to the driving of a special tool for the removal of flues from old boilers, an operation that was previously very tedious and expensive. The motors are also employed to drive portable boring-bars, crank pin and car journal turners, and, in emergency work, at night or on Sundays, to drive the standard machine tools of the machine shop.

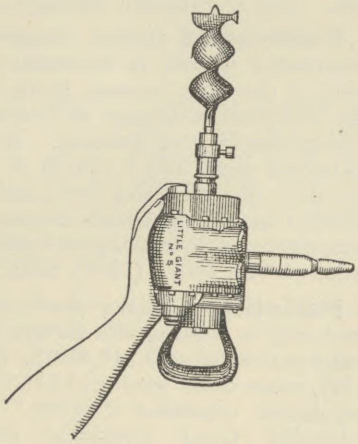

Fig. 3.—Pneumatic Rotary Drill.

Classed among pneumatic tools, perhaps not quite correctly, is the pneumatic hoist, which has come into very extensive use. A long cylinder of bored pipe hangs from the ceiling or from a trolley running on a tram rail attached to the ceiling. Within it is a piston, from which a long piston-rod depends. A simple hook for attaching a chain by which the load is slung, and a valve for admitting and discharging air to and from the lower end of the cylinder, complete the mechanism which has largely displaced the chain hoist. Where head-room is restricted, these hoists are often arranged to lie horizontally under the ceiling, and they are frequently applied to light swing-cranes for yard use. A modification of the device is the pneumatic jack, which is placed below the piece to be lifted, and operates directly. The jack is frequently mounted on wheels, for transporting the load.

Other pneumatic tools are of more restricted and special application. Of these are the stay-bolt cutter, which is simply a powerful pair of nippers, designed to remove by a single movement the surplus ends of locomotive stay-bolts—an operation which, when done by cold chisel and hand hammer, is laborious, and, moreover, tends to loosen the bolts in their holes. The painting machine for painting large surfaces simply atomizes the paint by a jet of air; it was first used on the buildings at the Chicago World's Fair of 1893. The mud-ring riveter is a special device for riveting the seam around the bottom of locomotive fire-boxes, and another special machine cuts the stay-bolts of old locomotive fire-boxes prior to removal. Among other appliances more or less related to the preceding are small presses for forcing work together; small forging and bending presses—commonly known as "bull-dozers"; furnaces for heating and expanding driving-wheel tyres; paint burners for the removal of old paint; cleaning machines for the renovation of the seats and cushions of railway carriages, the efficiency of which is remarkable; bell-ringers for the bells universally used as warning signals on American locomotives; track-sanders for blowing sand under locomotive driving-wheels; fire-kindlers for the use of oil fuel in place of wood in starting fires on locomotives; and sheep-shearers, which are widely adopted in Australia.

Very few trustworthy data of the comparative cost of work done in the old and new way have been published, and, indeed, exactness in such data is scarcely to be expected. The following are given on the authority of Mr Edward C. Schmidt, of the University of Illinois, U.S.A.:—

Tool.	General Character of Work.	Saving per cent. of Cost.
Pneumatic hammer	General foundry work—chipping	67 to 75
" "	Riveting on mud ring and fire-box	67
" "	Chipping flue sheet . . .	84
" "	Beading flues	75
" "	General boiler-shop work . .	60
" "	Cutting out broken fire-box stays	70
" "	Cutting off stay-bolt heads .	58
Riveter . . .	Boiler riveting	66
Drill . . .	Drilling saddles . . .	70
" . . .	In general machine-shop work .	75
" . . .	Drilling for stays . . .	50
" . . .	In general boiler-work shop .	75
" . . .	Facing steam pipes . . .	75
" . . .	Tapping for stays . . .	65
" . . .	Reaming crown sheet . .	70
Breast drill . .	General work	90
Stay-bolt nippers .	Cutting off stays . . .	73 to 90
Driving-box press .	Pressing brasses . . .	68
Paint sprayer . .	Painting box cars . . .	67
" " . .	Painting car trucks . . .	87
" burner . .	Cleaning of passenger cars . .	67
Sand blast . .	Cleaning tanks . . .	90
Air jet . . .	Cleaning cushions . . .	50

These figures relate to the saving at the tool, and do not include the fixed charges and cost of operating the air-compressor. In one work, from which many of these figures were taken, the decrease in the percentage of saving due to the cost of compressing the air was found to amount to about 15 per cent. at the most. Generalization in this respect is scarcely possible.

It is too early to speak with confidence of the ultimate place and importance of these appliances. Compared with the main equipment of a workshop, they are small and apparently insignificant, but it is quite possible that they may eventually be looked upon as the greatest contribution to the methods of machining iron and steel made during the closing decade of the 19th century. The mechanical talent embodied in many of them is of the first order. The hammers and rotary drills especially, whether considered from the standpoint of design or of execution and workmanship, are worthy of high praise. (F. A. H.)

Po, a river of North Italy, draining Piedmont, Lombardy, and the greater part of Emilia, also parts of Venetia.

In the first 21 miles of its course, down to Revello (west of Saluzzo), the Po descends no less than 5250 feet, or a fall of 47·3 : 1000, forming a very remarkable contrast to its fall lower down. From the confluence of the Ticino its fall is about 0·3 : 1000; from the beginning of the delta below Ferrara, 0·08 : 1000. At Turin it has an average width of 400 to 415 feet, a mean depth of 3½ to 5½ feet, and a velocity of 1 to 3 feet in the second. The mean depth from the confluence of the Ticino (altitude 217 feet) downwards is 6 to 15 feet. The river is embanked from Piacenza, and continuously from Cremona, the total length of the embankments exceeding 600 miles. Owing to its confinement between these high banks, and to the great amount of sedimentary matter which the river brings down with it, its bed has been gradually raised, so that in its lower course it is in many places above the level of the surrounding country. A result of confining the stream between its containing banks is the rapid growth of the delta. Lombardini calculated that the annual increase in the area of the Po delta during the period 1300 to 1600 amounted to 127 acres; but during the period 1600 to 1830 it rose to 324 acres. Dr Marinelli estimates that between the years 1823 and 1893 the annual increase has been at the average rate of 173 to 175 acres, and the total accretion at about 20 square miles; and the total area of inundated land north and south of the delta at nearly 60 square miles. He further estimates that the Po della Maestra advances 282 feet annually, the Po delle Tolle, 262 feet, the Po della Gnocca, 111½ feet, and the Po di Goro, 259 feet. All along its course from Chivasso (below Turin) down to the delta the river is connected with several of its tributaries by canals, and at the same time other canals connect the tributaries and carry off their waters and the waters of the Po for purely irrigation purposes. The river is navigable as far as Casale, above the junction of the Sesia, but navigation is attended with great risks, owing to the prevalence of shallows and sandbanks.

See G. Marinelli, in *Atti Inst. Veneto Sci.*, series 8, vol. viii. (1896–97); and "L'Accrescimento del Delta del Po nel Secolo XIX.," in *Riv. Geog. Ital.*, vol. v. (1898).

Pobêdonostsef, Constantine Petrovitch (1827–——), Russian jurist, state official, and writer on philosophical and literary subjects. Born in Moscow in 1827, he studied at the School of Law in St Petersburg, and entered the public service as an official in one of the Moscow departments of the Senate. From 1860 to 1865 he was professor of Russian civil law in the Moscow University, and was entrusted with the task of giving instruction in the theory of law and administration to the sons of Alexander II. In 1868 he became a Senator in St Petersburg, in 1872 a member of the Council of the Empire, and in 1880 Chief Procurator of the Holy Synod, an important post which forms the connecting link between the Russian Church and the Tsar. In all his professorial, administrative, and literary activity he always showed himself a consistent, uncompromising Conservative, and, unlike the majority of Russian Conservatives, he never shrank from expressing boldly his opinions. Consequently, in the so-called Liberal camp he was always denounced as an "obscurantist" and an enemy of progress. In the early years of the reign of Alexander II. (1855–81), when the great majority of his educated countrymen assumed that the duty of Russia was to replace her antiquated and barbarous institutions by the most liberal institutions of Western Europe, M. Pobêdonostsef maintained, though keeping aloof from the Slavophils, that these Occidental institutions were radically bad in themselves and totally inapplicable to Russia. Parliamentary methods of administration, modern judicial organization and procedure, trial by jury, freedom of the press, secular education,—these were among the principal objects of his aversion. Parliamentarism he considered the great curse of the time, because it handed over the mass of the population to the tender mercies of narrow-minded, egotistical, unscrupulous men who have learned the dangerous arts of sophistry and eloquence. In his opinion the modern courts of law were equally objectionable. Barristers were simply adepts in sophistry and logomachy, and juries were a motley, mixed herd, chosen at random and incapable of analysing facts or comprehending the duties of a judge. Still worse, if possible, was the periodical press, for it enabled any ignorant, worthless babbler to pose as a great authority on any conceivable subject. Fortunately these dangerous products of the spirit of Occidental rationalism find a counterpoise in popular *vis inertiæ*, and in the respect of the unsophisticated masses for the old respectable institutions which have developed slowly and automatically during the past centuries of the national life. Among the practical deductions drawn from these premisses is the necessity of preserving in the administration the autocratic power, and of fostering among the people the traditional veneration for the ritual of the National Church. These strange ideas and deductions may be regarded as the natural outcome of the peculiar intellectual condition of the Russian educated classes in the reign of Alexander II. Exaggerations naturally engender exaggerations in an opposite direction: as the ultra-Liberal ideas of that time found their extreme expression in Nihilism, so the ultra-Conservative tendencies culminated in the wildly reactionary doctrines of M. Pobêdonostsef. In the sphere of practical politics he exercised considerable influence by inspiring and encouraging the Russification policy of Alexander III. (1881–94), which found expression in an administrative Nationalist propaganda and led to a good deal of religious persecution. (See also RUSSIA, *History*.)

Podiebrad (Czech, *Poděbrad*), chief town of a government district in Bohemia, Austria, on the right bank of the Elbe, between Kolin and Nimburg. It was the birthplace of George of Podiebrad, the Calixtine or Utraquistic king of Bohemia. It contains the ruins of Podiebrad castle and a church of the 14th century. It has also a mineral spring (iron) and bathing establishment. There is an important trade in corn, and the manufactures comprise sugar, flour, and glass works and breweries. Population (1890), 4807; (1900), 5512.

Podolia, a frontier province of south-west Russia, bordering on Austria, with an area of 16,224 square miles, and a population of 2,242,650 in 1881, and 3,031,513 in 1897, when there were 1,514,753 women and the urban population numbered 220,596. In 1896 there were 2,152,629 Greek Orthodox, 17,648 Nonconformists, 241,742 Catholics, 4137 Lutherans, and 388,437 Jews. It is, after Moscow, the most densely inhabited government of Russia outside Poland. It is divided into twelve districts, the chief towns of which are Kamenets-Podolsk (34,483), the capital of the government, Balta (23,393), Bratslaff (4796), Gaysin (9393), Leticheff (8731), Litin (9428), Moghileff-on-Dniester (43,106), Novaya Ushitsa (5099), Olgopol (8098), Proskuroff (22,915), Vinnitsa (28,995), and Yampol (6709). Tulchin (11,217), Bar (10,614), and Khmelnik (11,215) are also worthy of notice. The sanitary service is fairly well organized by the *zemstvo* (provincial council), and in 1896 there were 1762 schools (exclusive of the Jewish *hedars*), attended by 74,283 boys and 14,500 girls. The chief occupations of the people are agriculture and gardening, both maintained at a high level. Only 12 per cent. of the surface is under forests, and less than 5 per cent. is uncultivable. The annual average yield from 1895 to 1899 of wheat was 10,019,000 cwt., of rye 6,279,000 cwt., of oats 1,963,000 cwt., of barley 3,117,000 cwt.; of all cereals, 29,180,000 cwt.; of potatoes, 6,950,000 cwt.; of beetroot and tobacco, 6250 cwt. Nearly 67,000 gallons of wine are obtained annually. Owing to the green crops, cattle-breeding is flourishing; in 1897 there were 501,860 horses, 665,500 horned cattle, and 829,000 sheep. Bee-keeping is an important industry (annual production about 6000 cwt. of honey). Factories—sugar factories, distilleries, flour mills, woollen mills, tanneries, potteries—give employment to nearly 29,000 persons, and have an annual output valued at about £4,000,000. There is considerable trade in grain, flour, sugar, spirits, leather, and wool, all of which are exported. Grain, timber, firewood, spirits, and fruit are shipped in great quantities down the Dniester, the annual movement of 28 river ports being over 100,000 tons loaded and unloaded. Large fairs are held at Yaronolintsy and Balta. (P. A. K.)

Poissy, a town, arrondissement of Versailles, department of Seine-et-Oise, France, 12 miles north-north-west of Versailles, on the railway from Paris to Havre. The church, supposed to have been built between 1125 and 1130, and restored in modern times under the direction of Viollet le Duc, is of special architectural interest, as affording one of the earliest and best examples of transition from the Roman to the ogival style. The bridge of Poissy, a very ancient foundation, has been widened and modernized, but of the mills, known as Queen Blanche's, which formerly bordered it, only one remains. A statue of the painter

Meissonier was erected in 1894. His house, on the site of an ancient monastery, is now occupied as an asylum for children. Poissy during six centuries supplied butchers' meat to Paris, but in 1867 the market was removed to the metropolis. A handsome fountain stands in the old market-place. Various branches of engineering and important iron foundries are the leading industries, and ragstone is quarried. Population (1881), 3990; (1901), 7406.

Poissy, the ancient *Pinciacum*, was the capital of the country of the Carnutes. In the time of Charlemagne it had a royal palace, where during the 9th century four national assemblies were held. Later it became a favourite residence of Blanche of Castille, and here her son, afterwards St Louis, was born in 1215. Philip the Fair gave the castle to the Dominicans, by whom it was completely transformed, and it was in the refectory of the abbey that the famous conference of Poissy between the Roman Catholics and Protestants took place in 1561.

Poitiers, capital of the department of Vienne, France, 206 miles south-west of Paris, on the railway from Paris to Bordeaux. The Palais des Facultés was enlarged in 1892–94. Near the Pont Joubert has been erected a colossal statue of Notre Dame des Dames. Population (1881), 29,304; (1901), 39,565.

Poker, a card game played by any number of players. It is usual to play with a full pack of fifty-two cards, but occasionally an écarté pack is used. Five cards are dealt to each player, whose object it is to obtain certain combinations of cards, the value of which depends on their infrequency. Each player has the option of exchanging any number of the cards dealt to him for an equal number from the undealt portion of the pack. The pool is started by the player on the dealer's left (called the *age*) depositing a fixed amount (called the *ante*). Every player who, after looking at his cards, decides to enter the game, must in his turn, beginning with the player to the left of the *age*, deposit an amount equal to twice the *ante*, except the *age*, who again deposits the same amount as the *ante*. An essential part of the game is that each player, at the time he makes any contribution to the pool, or signifies his intention to remain in, can make a *raise*, which obliges all the players to make an equal contribution to the pool, or to retire from the game. There is not, however, uniformity of custom; sometimes players are only allowed to make a *raise* after cards have been exchanged. After the draw the raising is started by the player on the left of the *age*. When all the players who remain in have seen the last *raise*, none of them making a further *raise*, the hands are shown, and the best hand takes the pool. The hands are valued in the following order:—1. Straight flush (all the five cards being of the same suit and in sequence). 2. Fours (four cards of the same rank and one other). 3. Full hands (three cards of one rank and two of another rank). 4. Flushes (the five cards being of the same suit, but not in sequence). 5. Straights (the five cards being in sequence, but not of the same suit). 6. Triplets (three cards of one rank and two of different ranks). 7. Two pairs. 8. One pair. 9. All other hands. When there are hands in the same class, the best is determined in the case of fours by the rank of the quartet; in the case of a full hand or a triplet, by the rank of the triplet; in case of two pairs, by the rank of the higher pair; in the case of a pair, by the rank of the pair; in other cases, by the rank of the highest card in the hand, and, if these are equal, by the rank of the second best card.

Advice to Players.—A scientific analysis of the rules of play is to some extent out of place, since scientific play is often one of the last things desired by the votaries of the game. Poker is indulged in for the sake of excitement. The opportunities of showing recklessness with regard to money have made it a favourite pastime with those who are proud of having money to lose, and consequently also with those who are desirous of winning it. In some circles it would be considered bad form to follow the correct methods of play.

The following table gives the probability of a player having dealt to him the various combinations:—

Description of Hand.	Number of Times in 2,598,960 Deals.	Number of Times in 1,000,000 Deals.
Straight flushes . .	40	15
Fours . . .	624	240
Full hands . .	3,744	1,441
Flushes . . .	5,108	1 965
Straights . . .	10,200	3,925
Triplets . . .	54,912	21,129
Two pairs . . .	123,552	47,539
One pair . . .	1,098,240	422,569
Inferior hands . .	1,302,540	501,177

This table, it should be noted, gives only the probabilities before the draw. The probabilities after the cards have been exchanged are dependent on the character of the play, which, in its turn, rightly depends on the number of players. It can, however, be approximately obtained by the use of the following proposition:—If the player exclusively aims at obtaining a given combination, he is equally likely to obtain it in any specified manner; or the probability that he will have dealt to him a particular part of the combination and then fill it, is the same as the probability that the whole of the combination will be dealt to him. For instance, take the case of a straight flush to the ace in hearts. The chance that the player will have ace, king, queen, knave, ten of hearts dealt to him, is the same as the chance that he will have a given four, ace, king, queen, knave (say) dealt to him, and obtain the ten in exchange for his fifth card, or that he will have ace, king, queen, dealt to him, and obtain the knave and ten in exchange. This is on the assumption that the player is striving exclusively for the given combination. If the player's rule is to keep any four in the hope of filling a straight flush, since there are five combinations of four cards, he would be five times as likely to obtain the combination after having had four of the cards dealt to him, as to have the whole of the five cards dealt to him at once. In a similar manner, a player is four times as likely to obtain four of a kind by taking in the fourth card to a triplet, as by having the four dealt to him originally; and six times as likely by taking in two cards to a pair. A disturbing element in the case is that there is a chance that the cards outside the combination may induce him to try for a different combination; still, the rule is sufficiently near the truth for practical use.

Whilst the game is one especially susceptible of mathematical treatment, most attempts to treat of it from a mathematical standpoint have been failures. The fault has been in ignoring the possibility of the other players modifying their play in order to oppose any fixed rule. A fixed rule, to be successful, must be such as to leave the other players frequently in doubt as to their play; whilst advantage must be taken of the possibility of their being frightened and led to abandon hands which would have won. Thus every rule of play must be tested as much by its effect on the other players as by its own apparent chance of succeeding. The following advice may be given with regard to the decision to play a hand. When a player has six players following him, he should stand on nothing less than a pair of aces; when he is followed by only one player, he can stand on a pair of fives; the gradations are fairly regular between these extremes. To oppose a player who has declared to stand, a second player should hold a rather better hand than would justify the first; except the *age*, who may stand on an equal or even an inferior hand.

The two objects of raising are to choke off better hands, and to win more by making the pool larger. With a moderately strong hand it is a mistake to raise, because only opposing hands, that would be beaten, will be choked off; and the hands that see the raise will generally be stronger hands, that will take the pool thus increased. With a strong hand, rather more than twice as rare as what he would expect to find against him, the player should raise the pool; and about half as frequently with a hand too weak to be shown. The most advantageous amount by which to raise is the amount which is already in the pool (if less than the limit). If it is worth raising the pool at all, it is worth raising as much as this. Making any distinction between the amount of *raises* will only give an observant adversary a hint as to the character of the hand.

The number of times that a player bluffs, *i.e.*, raises with a weak hand, should bear such a proportion to the number of times that he raises with a strong hand as to give a fair inducement to the opponent or opponents to see the raise. By seeing the raise, the opponent virtually bets the amount of the raise to the amount in the pool that the player is bluffing. The number of bluffs to the number of genuine raises ought to bear this same proportion. If the proportion of bluffs is greater, the opponent knows that it is worth seeing the raise, and bluffing will fail; if the proportion is less, he will not see the raise, and the pool will be less. In a similar way, the rule as to seeing the raise is connected with bluffing. If the player seldom sees a raise, the opponent will know that he can bluff successfully. If he sees a raise too often, the opponent will avoid bluffing, profiting by the increased value of the pool. By bluffing, a player virtually bets the amount of the raise to the amount in the pool that the opponent will not see the raise. This ought to represent the proportion of the number of times that the hands are abandoned to the times that the raises are seen.

By following correct rules of play, the player can with average luck avoid loss. Nearly the whole of the gain will be made by noticing where the other players follow wrong methods, and modifying one's own play in accordance.

Pola, the principal naval harbour and arsenal of the Austro-Hungarian Monarchy, situated near the southern extremity of the peninsula of Istria, on the Gulf of Venice. The extensive system of fortifications comprises forts and batteries at the adjoining coast village of Fasana, overlooking the channel of the same name, and on the Brionian Islands. Pola is, next to Trieste and Fiume, the most important mercantile harbour of the monarchy. It is an episcopal see. Population (1890), 38,937; (1900), 45,052, including a garrison of 7657.

Poland, Russian, a territory consisting of ten governments which formerly constituted the kingdom of Poland (*Tsaritvo Polskoye*), but now officially described as "governments on the Vistula" (*Privislyanskis Gubernii*), or occasionally as "territory on the Vistula" (*Privislyanskiy Krai*). It has a total area of 49,159 square miles, and its population, which was 7,319,980 in 1881, numbered 9,455,943 (4,764,007 men and 4,691,936 women) in January 1897, counting the domiciled population only, to which about 1,000,000 must be added if the total is to include the inhabitants (foreigners and natives) not living at their regular domicile at the date of the census. Omitting this last class, Poland, with 193 inhabitants per square mile, has a denser population than any other portion of the empire, the next to it being Moscow, with 189 inhabitants per square mile. Poland has thus a more considerable urban population than any other part of the Russian Empire. Twelve per cent. of the aggregate population is gathered in 117 towns, of which 32 have populations of over 10,000, the three largest being Warsaw (638,000), Łódz (315,000), and Lublin (50,000). Nearly one-half of the urban population are Jews, the great bulk of whom are artizans. The distribution of the population is shown in the following table:—

Governments.	Area, Square Miles.	Domiciled Population, 1897.	Urban Population.	Density per Square Mile.
Kalisz	4392	846,719	113,609	194
Kielce	3897	763,746	57,814	196
Lomża	4667	585,781	69,834	144
Lublin	6501	1,159,463	148,196	177
Piotrków	4729	1,409,044	509,699	297
Płock	4200	556,877	89,821	153
Radom	4769	820,363	94,318	171
Siedlce	5535	775,316	110,995	140
Suwałki	4846	604,945	73,308	127
Warsaw	5623	1,933,689	791,746	286
Total	49,159	9,455,943	2,059,340	193

Classified according to nationality and religion, it is estimated that there are about 6,630,000 Poles, 1,225,000 Jews, 1,050,000 Great and Little Russians, 300,000 Lithuanians and Zhmudes, and 250,000 Germans; and that some 75·2 per cent. are Roman Catholics, 14·1 per cent. Jews, 5·8 per cent. Protestants, and 4·9 per cent. of the Greek Orthodox Church. Of the non-domiciled population, nearly 100,000 are estimated to be foreigners, chiefly Germans.

Education.—There were in 1896, under the Ministry of Public Instruction, 3026 schools, with 3729 teachers and 206,973 pupils, while other schools and colleges numbered nearly 4000. The principal among these latter are the University of Warsaw, with 1114 students in 1899, at which instruction is now given in the Russian language; the Agricultural Institute at Nowa Alexandrya; and the Veterinary Institute and the Musical Conservatory at Warsaw. For secondary education there are 31 lyceums for boys and 19 for girls, 9 normal schools for teachers, 5 *realschulen*, 6 Catholic seminaries, and 1 polytechnic at Łódz. There are also a considerable number of smaller technical schools and private schools in the industrial regions. Nearly 70 newspapers were published in 1899, but the censorship is very rigorous.

Land Tenure and Agriculture.—In 1901 the village communities owned 40·9 per cent. of the total area; private owners, 50·3 per cent. (the bulk of which is owned by the nobles); the Crown and the Imperial Family, 6 per cent.; various institutions, 2·8 per cent. The holdings of the peasant families vary, generally speaking, from 13 to 30 acres. By a law of 1891 further subdivision is prohibited when the holding is less than 8·3 acres. Forests cover over 23 per cent. of the surface, or 7,357,000 acres, of which 2,130,400 acres belong to the Crown. Agriculture continues to stand at a higher level than in other Russian provinces. No less than 70 per cent. of the peasants' holdings, and 52 per cent. of the land owned by the landlords, is under crops, while 11 per cent. of the former and 8 per cent. of the latter is meadow land. In 1899, 12,538,000 acres were under crops, yielding 75,548,000 qrs. of rye, 55,392,000 qrs. of oats, 25,838,000 qrs. of wheat, 19,274,000 qrs. of barley, 264,826 qrs. of potatoes, and 1,955,350 tons of hay. After all local wants are supplied, there remains every year a surplus of about 3,500,000 qrs. of grain. Beet-root is largely grown for the manufacture of refined sugar, of which Poland produces more than the rest of Russia put together. The crop in 1898–99 was 838,000 tons, and the production of sugar 68,196 tons. Potatoes are largely grown for use in the distilleries.

Mining and Industries.—Mining and the iron industry have considerably developed in the governments of Piotrków and Radom. The output of coal was 4,025,000 tons in 1898; and in 1899 the output of pig-iron from the 36 private and 4 Crown ironworks was 310,400 tons, of steel 227,500 tons, of iron 71,800 tons, and of zinc 5650 tons. Some salt is extracted from springs in the government of Warsaw. Other industries are steadily progressing. In 1898 there were nearly 30,000 factories and workshops, employing some 250,000 workers of both sexes, the annual output being valued at about £25,000,000, while the total annual output of all industries, including mining and distilleries, was valued at £42,500,000. The districts of Łódz, Rawa, and Łask, in the government of Piotrków, and the provinces of Warsaw and Kalisz, are the main centres of industry. The yearly returns of the different branches of textile industries are: cottons, estimated at £6,000,000; woollens, £4,000,000; and linen and hemp goods, £1,700,000.

Trade.—With the extension of railways (1293 miles), the fairs have lost much of their importance, but their aggregate yearly returns are still estimated at £3,000,000. The chief fairs are held at Warsaw (wool and hemp), Łenczica, Skaryszew, Ciechanoviec, and Łowicz.

(P. A. K.)

POLAR REGIONS.

I. Arctic Exploration.

After the synchronous observations during the years 1882–83, the next important Arctic work was the crossing of the great glacier forming the interior of Greenland by Nansen and Peary. Dr Nansen, with six companions, after overcoming great difficulties in traversing the ice-floes, succeeded in landing on the east coast of Greenland in August 1888, and reached a height of 7000 feet on the glacier, in 64° 50′ N., on the 27th. Here there is an extensive flat plateau resembling a frozen ocean, rising to 8000 and 9000 feet. The cold was intense, and for more than two weeks they travelled over these regions, each man dragging a small sledge, while the two leaders, Nansen and Sverdrup, drew a somewhat larger sledge between them. As they approached the western side their progress was checked by dangerous crevasses, but on the 26th of September Nansen and his gallant little party arrived at the inner end of the Ameralik-fjord, in 64° 12′ N., having traversed 260 miles of glacier. He discovered that in this latitude the inland ice of Greenland has the shape of a shield, rising rather rapidly, but regularly, from the east coast to 9000 feet, flat and even in the middle, and falling again regularly towards the western side.

In 1892 Mr Peary, accompanied by Eivind Astrup, made his great journey across the inland ice to ascertain the northern limit of Greenland. The party consisted of four men and sixteen dogs. Starting in April from Whale Sound, on the west coast, in 77° N., they took a north-easterly course. The highest part of the glacier was 6000 feet above the sea, gradually sloping down on either side. At last they sighted land, indicating the termination of the glacier in 82° 12′ N., on the 26th of June. Soon afterwards they obtained a view of a bold line of cliffs, forming part of the east side of Greenland, in 81° 37′ N. It was discovered that land masses extended to the north where the great glacier terminated, thus establishing the northern limit of the inland ice-cap. Peary's subsequent journey in 1895 did not add much to the information gained in 1892.

The year 1893 saw the departure of Dr Nansen on his famous expedition to cross the polar ocean by trusting to the drift from east to west. This was in several respects the most remarkable northern voyage that ever was undertaken. Dr Nansen had studied the Arctic problem exhaustively and with great care; his conclusions were sound, and he planned the expedition with ability, and with a close attention to details which ensured success. He knew exactly what he intended to do, and he adapted his means to a well-defined end. His ship, the *Fram*, was designed to sustain and rise to great ice pressure, and, in its interior arrangements, to ensure the health and comfort of his people; while minute attention was given to provisions and equipment. In the autumn of 1893 the *Fram* was forced into the ice to the north-west of New Siberia Island, and its memorable drift was commenced, and continued during three winters. Eventually the *Fram* came out of the pack to the north of Spitsbergen. Nansen's chief discovery is that there is a very deep ocean to the north of the Franz Josef group, continuous with that to the north of Spitsbergen, and that this deep sea has a relatively warm temperature in its depths. This ice-bearing ocean extends at least as far as the pole, and the time occupied by the ice in drifting across it from the Siberian side to Spitsbergen is about three years. The existing evidence points to the conclusion that there is a continuous drift from the eastern to the western hemisphere, across an ice-covered ocean uninterrupted by land of any magnitude. The light thrown upon the polar question by Nansen has not only extended our knowledge positively, but has had the effect of piecing together what appeared before to be fragmentary, and of making the detached pieces fit into their proper place and form a consistent whole.

After the second winter Dr Nansen, with a single companion, Johansen, left the ship to examine the nature of the ice to the northward on 14th March 1895. On 8th April, after travelling over very heavy ice for several days, he reached his farthest north in 86° 13′ N. He then returned southwards, and eventually reached an island of the Franz Josef group, where he wintered in a stone hut. In the spring of 1896 the journey was recommenced, and on 17th June Nansen and Johansen met Mr Jackson, and their troubles were at an end.

Mr Jackson was in command of an expedition to explore Franz Josef Land, fitted out at the expense of Mr A. C. Harmsworth. It consisted of Mr Armitage as second in command, and six scientific civilians, who were landed at Cape Flora, where log houses were erected. The vessel which took them out, the *Windward*, had to winter in 1894–95. In the spring of 1895 Mr Jackson made a journey northwards as far as 81° 19′ 30″ N., and discovered a channel leading between groups of islands, to the west of the Austria Sound of Payer. Later in the season he made an exploring boat voyage to the westward along the coast of Franz Josef Land. In June 1896, after the second winter, Mr Jackson's party welcomed Dr Nansen and his companion to their house at Cape Flora. The explorers returned to Norway on board the *Windward*, the *Fram* arriving a few days afterwards. In 1897 Mr Jackson, accompanied by Mr Armitage, made a remarkable journey, during which he discovered the western portion of Franz Josef Land and explored the glaciers of the most western island. The Jackson-Harmsworth expedition returned to England in the autumn of 1897. Mr Jackson had discovered a wide channel opening on a sea to the north, and numerous islands forming the western portion of the Franz Josef group. Careful series of meteorological and magnetic observations were taken during these years, and the geological collections indicated that the Franz Josef group and Spitsbergen were portions or fragments of one extensive land existing in the late Tertiary period.

Since the return of Mr Jackson, a party led by Sir Martin Conway has explored the interior of Spitsbergen, and the Swedish savant, Nathorst, has examined its eastern coast and the off-lying islands on that side. The Danes have established a new colony on the east side of Greenland, and a party under Lieut. Ryder has done some good exploring work along the east coast. A small party of Americans and Norwegians, led by Mr Wellman, was landed on Franz Josef Land in 1898 and wintered there. They returned in the autumn of 1899, and one of the party, Mr Baldwin, completed the discovery of the easternmost islands of the group.

In 1899 Captain Sverdrup, on board the *Fram*, led an expedition up Smith Sound, with the object of discovering the northern coast of Greenland. Lieut. Peary, trusting to the help of the northern Eskimo, pressed northwards by the same route. H.R.H. the duke of Abruzzi, on board the Norwegian whaler *Jason*, which was renamed the *Stella Polare*, proceeded to Franz Josef Land in the summer of 1899. The ship was put into Teplitz Bay in Rudolf Land, where the expedition wintered. The side of the ship was crushed by the ice-pressure. Three sledge expeditions were sent north in the spring of 1900, and one of these, under Captain Cagni, reached 84° 33′ N. at about 56° E., being about 20 miles farther north than Nansen's farthest. It was found that the Petermann Land of Payer does not exist, and the same is believed to be the case with King Oscar Land. The *Stella Polare* was patched up, and in her the expedition reached Norway in the beginning of September. Three members of the expedition, returning from Captain Cagni's party, were never heard of. Lastly, Baron Toll in 1900 led an expedition to discover islands supposed to exist to the north of the New Siberia group.

(C. R. M.)

II. The Arctic Ocean.

According to its geographical position, the Arctic Ocean may be described as the sea situated north of the Arctic Circle; but, according to its natural configuration, we may more adequately say that it is the gulf-like northern termination of the long and relatively narrow Atlantic arm of the ocean which extends north between Europe on one side and America on the other; for by this situation as the northern bottom of such a long arm of the ocean its physical conditions are to a very great extent determined. This Arctic gulf is bounded by the northern coasts of Europe, Siberia, North America, the North American Arctic Archipelago, Greenland, and Iceland. The entrance to this typical gulf, the largest in the world, is the opening between Europe and Labrador divided by Iceland, Greenland, and the American Arctic islands; and its natural southern boundary would be the submarine ridge extending from Scotland and the Shetland Islands over the Faröe Islands and Iceland to Greenland, and continuing on the other side of Greenland across Davis Strait to Baffin Land. This ridge separates the depressions of the Arctic Ocean, filled with cold polar water at the bottom, from the deep depression of the North Atlantic. The Arctic Ocean communicates with the Pacific Ocean through Bering Strait, which is, however, only 49 miles broad and 27 fathoms deep. The area of the Arctic Ocean may be estimated to be about 3,600,000 square miles, of which nearly two-thirds (or 2,300,000 square miles) is continuously covered by floating ice.

The Arctic Ocean may be divided into the following parts:—(1) The *North Polar Basin* (including the Siberian Sea), bounded by the northern coasts of Siberia (from Bering Strait to the western Taimyr Peninsula), Franz Josef Land, Spitsbergen, Greenland, Grinnell Land, the Parry Islands, and Alaska; (2) the *Kara Sea*, between Novaya Zemlya and the Siberian coast, south of a line from the north point of the former to Lonely Island (Ensomheden) and Nordenskiöld Island; (3) the *Barents* and *Murman Sea*, bounded by Novaya Zemlya, Franz Josef Land, Spitsbergen, Bear Island, and the northern coasts of Norway and Russia; (4) the *Norwegian Sea*, between Norway, Spitsbergen, Jan Mayen, Iceland, and the Faröes; (5) the *Greenland Sea*, between Spitsbergen, Jan Mayen, Iceland, and Greenland; (6) *Baffin Bay* and *Davis Strait*, between Greenland, Ellesmere Land, North Devon, and Baffin Land.

Depths.—The Arctic Ocean forms an extended depression separating the two largest continental masses of the world—the European-Asiatic (Eurasia) and America. Along its centre this depression is deep, but along its whole margin, on both sides, it is unusually shallow—a shallow submarine plateau or drowned plain extending northward from both continents, forming the largest known continental shelf. North of Europe this shelf may be considered as reaching Spitsbergen and Franz Josef Land, extending over more than 10 degrees of latitude, although there is a somewhat deeper depression in between. North of Spitsbergen it reaches north of 81° N., and north of Franz Josef Land probably somewhat north of 82° N. North of Siberia the shelf is 350 miles broad, or more, with depths of 50 to 80 fathoms, or less. In longitude 135° E. it reaches nearly 79° N., where the bottom suddenly sinks to form a deep sea with depths of 2000 fathoms or more. Farther east it probably has a similar northward extension. North of America and Greenland the shelf extends into the unknown north. This shelf, or drowned plain, evidently marks an old extension of the continents, and its northern edge must be considered as the real margin of their masses, the coasts of which have probably been overflowed by the sea at some comparatively recent geological period. On this submarine plateau the Arctic lands are situated—Spitsbergen (with Seven Islands to the north, Bear Island and Hope Island to the south), Franz Josef Land, Novaya Zemlya, Lonely Island, the New Siberia Islands, Wrangel Island, the American Arctic Archipelago. The depth of the shelf is, especially north of Siberia, very uniform, and usually not more than 50 to 80 fathoms. North of Europe it is intersected by a submarine, fjord-like depression, or broad channel, extending eastward from the Norwegian Sea. Between Norway and Bear Island this depression is about 240 fathoms deep, and between Novaya Zemlya and Franz Josef Land 100 to 150 fathoms deep. It gives off several submerged fjords or channels towards the south-east into the shallow Murman Sea, *e.g.*, one channel, more than 100 fathoms deep, along the Murman coast towards the entrance of the White Sea; another narrow channel, partly 100 fathoms deep, along the south-west coast of Novaya Zemlya through the Kara Strait. It also extends into the Kara Sea, rounding the north point of Novaya Zemlya and forming a narrow channel along its eastern coast. Just east of Vaigatch Island there are sounded depths of nearly 400 fathoms. On the American side similar but much narrower submarine depressions, or we might here call them submarine fjords, extend from Baffin Bay into the continental shelf, northward through Smith Sound, Kane Basin, and Kennedy Channel, and westward through Lancaster Sound, &c.

The greatest depths in the Arctic Ocean have been found in the North Polar Basin, where depths of 2100 fathoms, in about 81° N. and 130° E., have been measured with certainty. It is deeper than 1650 fathoms along the whole route of the *Fram*, from about 79° N. and 138° E. to near Spitsbergen. In 84½° N. and about 75° E. the depth is 2020 fathoms, and in 83° N. and 13° E. it is 1860 fathoms. The northern and eastern extension of this deep basin is not known. It was formerly believed that still greater depths existed west of Spitsbergen, the so-called Swedish deep, where 2600 fathoms had been sounded, but the Nathorst Expedition in 1898 found no greater depths there than about 1700 fathoms. The Norwegian sea, farther south, is 2000 fathoms deep midway between Iceland and Norway, in about 68° N. This so-called Norwegian deep is, as before stated, separated from the North Atlantic basin by the shallow Wyville Thomson ridge and the Shetland-Faröe-Iceland ridge. Farther north there is a low transverse ridge extending eastward from Jan Mayen, in about 72° N., which is about 1300 fathoms deep. North of this the sea is again deeper—1985 fathoms in 75° N. From the north-west corner of Spitsbergen a submarine ridge extends in a north-westerly direction, with depths of about 430 fathoms in 81° N. and about 4° E. How far this ridge extends is unknown, and there is a possibility that it reaches Greenland, and thus separates the Swedish and the Norwegian deep from the deep depression of the North Polar Basin. Baffin Bay forms, probably, a relatively deep basin of about 1000 or 1200 fathoms, which is separated from the West Atlantic Basin by the shallow submarine ridge from Greenland to Baffin Land in about 65° or 66° N.

The *deposit* composing the bottom of the Arctic Ocean contains in its northern part, in the North Polar Basin, extremely little matter (shells) of organic origin. It is formed by mineral material, sandy clay of very fine grain, to an extent which is hardly found in any other part of the sea with similar depths. It contains only from 1 to 4 per cent. of carbonate of lime. Farther south, in the sea between Spitsbergen and Greenland, the amount of carbonate of lime gradually increases owing to the shells of foraminifera (especially biloculinæ); west of Spitsbergen we may already find the proportion above 20 or even 30 per cent., while more towards Greenland it is considerably lower.

The *circulation* of the Arctic Ocean may be explained firstly by the vertical and horizontal distribution of temperature and salinity (*i.e.*, density); secondly, by the influence of the winds, especially on the ice-covered surface. The currents in this sea may to a very great

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extent be considered as convection currents. The water near the surface is cooled down by radiation of heat; it becomes heavier, sinks to the bottom, along which it creeps slowly southward, while it must be replaced on the surface by warmer water coming from the south. To replace the northward-flowing surface water, the cold, heavy bottom water must again rise towards the surface in more southern latitudes. On account of the rotation of the earth the northward-running water on the surface, as well as the sinking water, will be driven in a north-easterly or easterly direction, while the southward-flowing water along the bottom, as well as the rising water, is driven south-west or westward. This very simple circulation is, however, to a great extent complicated on one side by the irregular configuration of the sea-bottom, especially the transverse submarine ridges—*e.g.*, the Spitsbergen ridge, the Jan Mayen ridge, and the Shetland-Faröe-Iceland ridge; and on the other side by the circumstance that the upper water strata of the sea are comparatively light in spite of their low temperature. These strata, about 100 or 120 fathoms thick, are diluted by addition of fresh water from the North European, Siberian, Canadian, and Alaskan rivers, as well as by precipitation, while at the same time the evaporation from the surface of the mostly ice-covered sea is insignificant. The light surface strata will have a tendency to spread over the heavier water farther south, and thus the polar surface currents running southward along the east coasts of Greenland, Baffin Land, and Labrador are formed, owing their westerly course to the rotation of the earth. These currents are certainly to a great extent helped and increased by the prevailing winds of these regions. The winds have a firm hold in the rough surface of the floating ice, which, with its deep hummocks and ridges, acts as a good stirrer of the water, transferring the movement of the surface immediately down to at least 5 or 10 fathoms.

The chief currents running into the Arctic Ocean are the following :—

1. The *Gulf Stream*, or Atlantic drift, passing northeastward over the Shetland-Faröe-Iceland ridge, along the west coast of Norway, with one arm branching off eastward round North Cape into the Barents Sea, and another branch running northward along the margin of the shelf between Norway, Bear Island, and Spitsbergen, passing as a very narrow current along the west coast of the latter, over the Spitsbergen ridge (at its north-west corner), and into the North Polar Basin, where it flows gradually northward and eastward (on account of the rotation of the earth) below the cold but lighter layer, 100 fathoms thick, of polar water, and fills the whole basin below 100 or 120 fathoms to the bottom with Atlantic water.

2. The *Irminger current*, running north along the west coast of Iceland. One part branches off westward and southward again in Denmark Strait, following the Greenland polar current, whilst another part evidently dives under the polar current and runs as an under-current northward into the Greenland Sea, and partly also eastward and south-eastward to the north and east of Iceland.

3. An Atlantic current runs northward along the west coast of Greenland, passes the ridge across Davis Strait, and flows into Baffin Bay, forming its deeper strata below the polar water in a similar way to the Gulf Stream in the North Polar Basin. There is a possibility that some slight portion of this current even reaches the latter along the bottom of the deep channel through Smith Sound.

4. A small current running northward into the North Polar Basin through Bering Strait.

The Arctic Ocean receives also a contribution of fresh water from the rivers of northern Europe, Siberia, and America, as well as from the glaciers of Greenland and the precipitation over the whole area of the sea itself.

The chief currents running out of the Arctic Ocean are these :—1. The Greenland polar current, running southward along the east coast of Greenland, and dividing into two branches north of Iceland—(*a*) the east Greenland branch, passing south through Denmark Strait and rounding Cape Farewell; (*b*) the east Icelandic branch, running south-eastward between Iceland and Jan Mayen, towards the Faröes. It seems as if only a small portion of this current actually passes the Faröe-Icelandic ridge and reaches the Atlantic Ocean. The greater part is partly mixed with the water of the Gulf Stream and is turned by the latter in a north-easterly direction, forming a kind of eddy in the Norwegian Sea. 2. The Labrador polar current, formed by the water running south through Smith Sound, Lancaster Sound, and Jones Sound, as well as water from Baffin Bay, and also from the east Greenland current rounding Cape Farewell and crossing Davis Strait. 3. Along the south-east coast of Spitsbergen a polar current is also passing in a southwesterly or westerly direction past South Cape, where it meets the Gulf Stream. 4. A very small current probably also runs out along the western side of Bering Strait.

Temperature and Salinity.—While the temperature is comparatively uniform, with small variations, the difference in salinity between the upper and lower strata is greater than in most other parts of the sea. In the North Polar Basin the vertical distribution of temperature as well as salinity is very much the same in all places examined. Near the surface, from 0 down to 100 fathoms, the water is below freezing-point—with a minimum of between 28·75° (−1·8° C.) and 28·57° (−1·9° C.) at a depth of about 30 fathoms—and is much diluted with fresh water (see above), the salinity gradually increasing downward from about 29 or 30 per mille near the surface to nearly 35 per mille in 100 fathoms. Below 100 fathoms the temperature as well as the salinity gradually increases until they approach their maximum in about 160 or 200 fathoms, where the temperature varies between 32·5° (0·3° C.), north of the New Siberia Islands, and about 33·8° (1° C.), north of Franz Josef Land; and the salinity is about 35·2 and 35·3 per mille. From this depth the temperature gradually sinks downward; 32° (0° C.) is found at about 490 fathoms in the western part of the basin—*e.g.*, between about 84° N. 15° E. and 85½° N. 58° E.—while it is found in about 400 fathoms farther east—*e.g.*, in 81½° N. and 123° E. In depths between 1400 and 1600 fathoms the temperature has a second minimum between 30·6° (−0·8° C.) and 30·4° (−0·9° C.), below which depth the temperature again rises slowly, a few tenths of a degree towards the bottom. In all depths below 200 fathoms the salinity of the water remains very much the same, between 35·2 and 35·3 per mille, with very slight variations. This comparatively warm and saline water evidently originates from the branch of the Gulf Stream passing north across the submarine ridge from north-west Spitsbergen (see above). The vertical distribution of temperature and salinity is very much the same, summer and winter, throughout the North Polar Basin, except near the surface, which in summer is covered by a layer of fresh water arising from the melting of the snow-covered surface of the floe-ice. This fresh-water layer may attain a thickness of 5 or 6 feet between the floes. North of the Siberian coast the sea is, during summer, covered with a layer of warm water from the Siberian rivers, and the temperature of the surface may rise to several degrees above freezing-point.

In the Norwegian and Greenland Sea there are greater variations of temperature. Below a certain limit, which in the northern part (on the eastern side) is about 550 fathoms deep, and in the southern part between 300 and 400 fathoms deep, the whole basin of this sea is filled with water which has an unusually uniform salinity of about 35·05 per mille, and the temperature of which is below zero centigrade, gradually sinking downward from the above-mentioned limit, where it is 32° (0° C.); and down to 29·85° (−1·2° C.) or 29·65° (−1·3° C.) near the bottom in 1400 or 1600 fathoms. In the northern part of this sea the bottom temperature seems even to be about 29·5° (−1·4° C.) or 29·3° (−1·5° C.). The origin of this cold underlying water of such a remarkably uniform and comparatively low salinity is not quite clear. On one side, the salinity of this water is considerably higher than that of the equally cold water of the east Greenland polar current (see later); but on the other side it seems to be distinctly different from the hitherto known water filling the deep of the North Polar Basin, as it has a lower salinity and lower temperature; the known bottom temperature of the North Polar Basin being between 30·7° (−0·7° C.) and 30·4° (−0·9° C.), and the salinity about 35·2 or 35·3 per mille. This fact seems to indicate that there can be no direct communication between the deep depression of the North Polar Basin and the Norwegian-Greenland Sea, which are probably separated by a submarine ridge from the north-west corner of

Spitsbergen to Greenland. The cold bottom water of the Norwegian-Greenland Sea may to some extent arise from the cooling down of the Atlantic water of the surface during the winter; to some extent also by mixing with the cold but less saline water of the polar current. There is, however, also another possibility: that the bottom water of the North Polar Basin is colder and less saline in its more northern and western parts, which are still unknown, and that this water has communication with the bottom water of the Norwegian-Greenland Sea through a deep channel along the western side of the sea between Spitsbergen and Greenland.

The above-mentioned underlying layer of uniform cold water of the Norwegian-Greenland Sea is, along its eastern side, covered by the warm and saline water of the Gulf Stream flowing northward along the west coast of Norway, Bear Island, and Spitsbergen, and forming the upper strata of the sea about 300 to 500 fathoms deep. The maximum temperature of this water is on the surface about 46° (8° C.) to 50° (10° C.) west of northern Norway, and about 37° (3° C.) to 39° (4° C.) west of Spitsbergen. The salinity is generally about 35·2 or 35·3 per mille, varying between 35·1 and 35·5 per mille.

Along the western side of this sea, towards the east coast of Greenland, the underlying cold water is covered by the less saline water of the polar current, which in the upper strata of the sea, from the surface down to about 100 fathoms, has very much the same temperature and salinity as in the upper cold and less saline strata of the North Polar Basin. Near the east coast of Greenland, as far north as 74° 45′ N., a layer of comparatively warm and saline water, with a temperature of 32·7° (0·4° C.) and a salinity of 35·2 per mille, has been found (by the Ryder Expedition in 1891) below the cold and lighter polar water in a depth of 70 to 90 fathoms. This warmer undercurrent probably runs northward, being a continuation of the warm Irminger current passing north along the west coast of Iceland.

In *Barents Sea* the temperature and salinity are highest in the western part near Norway or between Norway and Bear Island, where the eastern branch of the Gulf Stream enters and where in summer the salinity generally is about or a little above 35 per mille from the surface down to the bottom, and the surface temperature generally is about 41° or 43° (5° C. or 6° C.), and the bottom temperature is above zero centigrade. The eastern part of Barents Sea is filled with water of a little lower salinity, often below 35 per mille—the deeper strata of which are very cold, with temperature even as low as 28·9° (−1·7° C.). The bottom temperature is everywhere in the eastern part below zero centigrade and generally below −1° C.

The *Kara Sea* is, near the surface, covered with a layer of cold water much diluted by the fresh water from the Siberian rivers, especially the Obi and the Yenisei. The salinity varies between 29 and 34 per mille; near the mouth of the rivers it is naturally much lower. The deeper western parts of Kara Sea are filled with unusually cold and more saline water, with a temperature of about 28·4° (−2° C.) and a salinity of about 34·9 per mille. This water is colder and more saline than the water at similar depths in the North Polar Basin, which indicates that there is no direct communication between the deeps of the two basins.

The vertical distribution of temperature and salinity in *Baffin Bay* seems to be very similar to that of the North Polar Basin, with a cold but less saline upper stratum of water—with a minimum temperature of about 28·9° (−1·7° C.)—and a warmer and more saline deeper stratum from 100 or 200 fathoms downward, with a maximum temperature of 33·6° (0·9° C.) in about 200 fathoms, and the temperature slowly decreasing towards the bottom.

The Ice.—As before mentioned, at least two-thirds of the Arctic Ocean is constantly covered by drifting ice. This ice is mostly formed on the surface of the sea itself by freezing, the so-called floe-ice or sea-ice. A small part is also river-ice, formed on the rivers, especially the Siberian, and carried into the sea during the spring or summer. Another comparatively small part of the ice originates from the glaciers of the Arctic lands. These pieces of glacier-ice or icebergs are, as a rule, easily distinguished from the floe-ice by their size and structure. They occur almost exclusively in the seas round Greenland, where they originate from the glaciers descending into the sea from the inland ice of Greenland. Some small icebergs are also formed in Franz Josef Land, Spitsbergen, Novaya Zemlya, Grinnell Land, &c., but they are comparatively insignificant, and are not as a rule carried far from the coasts. Sea-ice or floe-ice is formed during the autumn, winter, and spring, especially in the North Polar Basin, but also in Kara Sea, a greater part of Barents Sea, the northernmost part of the Norwegian Sea (near Bear Island and towards Jan Mayen), Greenland Sea, and Baffin Bay. The floe-ice does not, as a rule, grow thicker than 7 or 8 feet in one year, but when it floats in the water for some years it may attain a thickness of 16 feet or more directly by freezing. By the constant upheaval from pressure much greater thicknesses are attained in the piled-up hummocks and rubble, which may be 20 to 30 feet high above the water when floating. During the summer the floe-ice decreases again by melting, partly on the surface owing to the direct radiation of heat from the sun, partly on the under side owing to the higher temperature of the water in which it floats. The first kind of melting is the prevailing one in the North Polar Basin, while the latter kind occurs in more southern latitudes. The floe-ice is constantly more or less in movement, carried by winds and currents. The changing wind, or also to a great extent the changing tide current, causes diverging movements in the ice by breaking it into larger or smaller floes. When these separate, lanes and channels are formed; when they meet, ice-pressures arise, and the floes are piled up to form hummocks or ridges, and thus the uneven polar ice arises. In the North Polar Basin the floe-ice is slowly carried by the prevailing winds and the currents in an average direction from Bering Strait and the New Siberia Islands, north of Franz Josef Land and Spitsbergen, more or less near the North Pole, towards the Greenland Sea and southward along the east coast of Greenland. Such a drift of an ice-floe from the sea north of Bering Strait to the east coast of Greenland probably takes, as a rule, four or five years, and the floes found in this part of the sea are not, therefore, generally older. How the drift of the ice is on the American side of the North Polar Basin is little known. But here it is probably more or less blocked up in its southward drift by the islands of the American Arctic Archipelago, and the ice-floes may thus grow very old and thick. The southward distribution of the drifting floe-ice (the pack ice) in Barents Sea, Norwegian-Greenland Sea, and Davis Strait, may differ much from one year to another, and these variations are evidently due to more or less periodical variations in the currents and also the directions of the prevailing winds. In most places the ice has its most southerly distribution during the late winter and spring, while the late summer and autumn (end of August and September) is the most open season.

Biological Conditions.—The development of organic life is comparatively poor in those parts of the Arctic Ocean which are continuously covered by ice. This is, amongst other things, proved by the bottom deposits, which contain exceptionally little carbonate of lime of organic origin. The reason is evidently that the thick ice prevents to a great extent the development of plant life on the surface of the sea by absorbing the light; and as the plant life forms the base for the development of animal life, this has also very unfavourable conditions. The result is that—*e.g.*, in the interior of the North Polar Basin—there is quite exceptionally little plant life in the sea under the ice-covering, and the animal life both near the surface and in deeper strata is very poor in individuals, whilst it is comparatively rich in species. Near the outskirts of the Arctic Ocean, where the sea is more or less open during a greater part of the year, the pelagic plant life as well as animal life is unusually rich, and, especially during the early summer, there is often here such a development of plankton (*i.e.*, pelagic life) in the sea-surface as is hardly found in any other parts of the ocean. It seems as if the polar water has specially favourable conditions for the development of the pelagic plant life, which makes the flora, and consequently also the fauna, flourish as soon as the ice-covering disappears and the water surface is exposed to full sunlight. At the same time the temperature of the water also rises, and thus the conditions for the chemical changes of matter and the nutritive assimilation are much improved. The Arctic Ocean, or more especially the North Polar Basin, might thus be considered as a lung or reservoir in the circulation of the ocean where the water produces very little life, and thus, as it were, gets time to rest and accumulate those substances necessary for organic life, which are everywhere present only in quite minimal quantities. It is also a remarkable fact of interest in this connexion, that the greatest fisheries of the world seem to be limited to places where water from the Arctic Ocean and from more southern seas meet—*e.g.*, Newfoundland, Iceland, Lofoten and Finmarken in Norway.

The mammal life is also exceptionally rich in individuals along the outskirts of the Arctic Ocean. We meet there, especially along the margin of the drifting ice, the enormous quantities of seals of various kinds, as well as whales, which live on the plankton and the fishes in the water. A similar development of mammal life is not met with anywhere else in the ocean, except perhaps in the Antarctic Ocean and Bering Sea, where, however, similar conditions are present. In the interior of the Arctic Sea or the North Polar Basin the mammal life is very poor, and consists mostly of some straggling polar bears, probably occasionally wandering everywhere over the whole expanse of ice; some seals, especially *Phoca fœtida*, which has been seen as far north as between 84° and 85° N.; and a few whales, especially the narwhal, which has been seen in about 85° N.

The bird life is also exceptionally rich in the outskirts of the Arctic Ocean, and the coasts of most Arctic lands are every summer inhabited by thousands and millions of sea-birds, forming great colonies almost on every rock. These birds are also dependent for their living on the rich plankton on the surface of the sea. In the interior of the Arctic Ocean the bird life is very poor, but straggling sea-birds may probably be met with occasionally everywhere during summer-time, even over the whole North Polar Basin.

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(F. N.)

III. ANTARCTIC REGIONS.

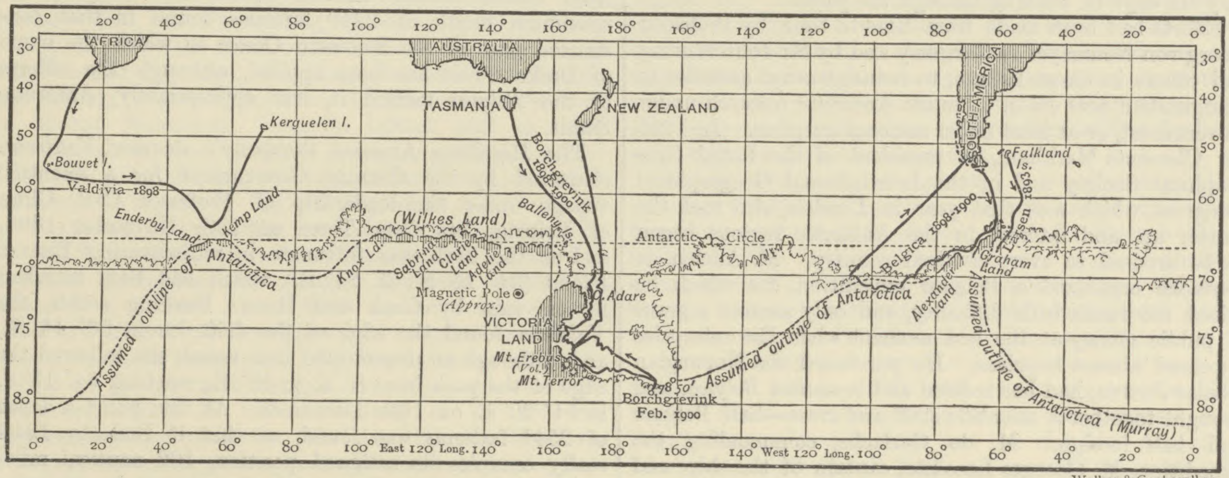
Strictly speaking, the Antarctic Regions are the portion of the Earth's surface lying south of the Antarctic circle, but it is usual to extend the term so as to include that part of the surrounding ocean which is influenced by Antarctic drift ice. The limits cannot be exactly defined. The long-cherished belief in a great Antarctic continent which extended into temperate and even tropical latitudes was disproved by Captain Cook in his second voyage of circumnavigation, and the fact was clearly established before 1839 that any southern land which may exist only extends appreciably beyond the Antarctic circle in one place—to the south of South America. The voyage of Weddell in 1824 to 74° 15′ in 34° 17′ W., and that of Ross in 1841–42 to

78° 10′ in 161° 27′ E., proved that navigable water extended into high latitudes on opposite sides of the polar circle.

Recent Exploration.—The first steamer to cross the Antarctic circle was H.M.S. *Challenger* on 16th February 1874: she only penetrated to 66° 40′ S., in 78° 30′ E., south of Kerguelen Island; but she continued her course to Australia for some distance in a high latitude, passing within 15 miles of the position assigned to Wilkes's Termination Land without seeing any sign of land. Her dredgings and soundings yielded indirect evidence as to the nature of the unknown region farther south. Sir John Murray believed that the soundings showed a general shoaling of the ocean towards the Antarctic ice, indicating the approach to a continent. By collecting and analysing all samples of deep-sea deposits which had been secured from the far south, he discovered a remarkable symmetry in the arrangement of the deposits. The globigerina ooze, or in deeper waters the red clay, carpeting the northern part of the Southern Ocean, merges on the southward into a great ring of diatom ooze, which gives place in turn, towards the ice, to a terrigenous blue mud. The fine rock particles of which the blue mud is composed are such as do not occur on oceanic islands, and the discovery of large blocks of sandstone dropped by icebergs proved the existence of sedimentary rocks within the Antarctic circle. The marine fauna discovered by the *Challenger* contained many species very similar to those common in the Arctic regions, if not identical with them. The suggestion of identical forms occurring in the two polar areas, and absent from the intervening seas, has given rise to a lively discussion amongst biologists.

During the southern summer in which the *Challenger* visited Antarctic waters, a German whale-ship, the *Grönland*, under Captain Dallmann, visited the western coast of the Antarctic land south of Tierra del Fuego, and rectified the chart in several particulars. The chief discovery was a channel, named Bismarck Strait, in 65° S., which seemed to run between Palmer Land and Graham Land.

When the International Circumpolar observations were set on foot in 1882, two scientific stations were maintained for a year in the southern hemisphere in order to obtain data for comparison with the observations at twelve stations round the North Pole. One of these was occupied by French observers in Tierra del Fuego in 55° S., the other by German observers at Royal Bay on South Georgia in 54° 30′ S. The magnetic and meteorological observations were of considerable importance.



Walker & Cockerell sc.

Sketch Map of the Antarctic Regions, showing Tracks of Recent Expeditions.

In 1892 four steamers of the Dundee whaling fleet—the *Balæna*, *Active*, *Diana*, and *Polar Star*—went out to test Ross's statement that the "right whale" inhabited Antarctic waters. The surgeons of two of the vessels—on the *Balæna* Mr W. S. Bruce, on the *Active* Dr C. W. Donald—were selected at the instance of Mr Leigh Smith and the Council of the Royal Geographical Society for their scientific tastes, and equipped with all requisite instruments for observations and collecting. The result of the experiment was disappointing. No whales were obtained, and all the ships devoted their attention to sealing on the east of Joinville Island and Louis Philippe Land, not going farther south than 65° S., although the floes were found fairly open, with numerous water channels. Some small changes were made on the chart, and the few opportunities which were permitted for scientific work were taken advantage of by the surgeons (*Geographical Journal*, vii., 1896, pp. 502–521, 625–643). The experiment has not been repeated by British ships.

During the summer of 1892–93 a Norwegian sealer, the *Jason*, Captain Larsen, also visited those seas, but did not go farther than about 65° S. The captain landed and collected fossils at several points. In 1893–94 the *Jason*, accompanied by two other Norwegian vessels, the *Hertha* and the *Castor*, returned to the Antarctic and entered the ice-laden waters in November at the very beginning of summer. Captain Larsen in the *Jason* made his way as far south as 68° 10′ in 60° W. on the eastern side of Graham Land, but several miles from the coast, which was bordered by a high ice-barrier. The most prominent headland, in 66° S., was named Cape Framnes. Returning northwards, two small islands, Lindenberg and Christensen, were discovered and found to be active volcanoes. Meanwhile the *Hertha*, Captain Evensen, had reached the South Shetlands on 1st November 1893, and worked her way southward along the west side of Palmer Land and past the Biscoe Islands, reaching the Antarctic circle on 9th November without meeting ice. This was the first time the Antarctic circle had been crossed since the *Challenger* did so twenty years before. Captain Evensen sighted Alexander Land, but did not follow the coast to find whether it is continuous with Graham Land; and without experiencing any trouble from ice-floes he reached his farthest south, 69° 10′ S. in 76° 12′ W. (*Mittheilungen der Geographischen Gesellschaft*, Hamburg, 1895, pp. 245–304). After visiting Tierra del Fuego, both the *Jason* and the *Hertha* returned to Antarctic waters towards the end of January, but went no farther than Joinville Island, and then sailed for Europe.

In 1894 the well-known Norwegian whaler, Svend Foyn, sent out one of his vessels, the *Antarctic*, Captain Christensen, to try his luck off the coast of Victoria Land. The *Antarctic* sailed from Melbourne in September, having on board C. E. Borchgrevink, a young Norwegian resident in Australia, who, being determined to take part in a voyage he could join in no other way, shipped as an ordinary seaman. He made notes of the voyage, and published an account of it on his return to Europe (*Report of Sixth International Geographical Congress*, London, 1895, pp. 169–175). The *Antarctic*, after being compelled to put back for repairs, left Stewart Island, New Zealand, on 28th November 1894, and entered the pack in 62° 45′ S., 171° 30′ E., on 8th December. The Balleny Islands were sighted on 14th December, and Cape Adare on Victoria Land two days later. On 22nd January 1895 the farthest point was reached at Coulman Island in 74° S.; the sea was then easily navigable to the south. On 23rd January a small party, including the captain and Mr Borchgrevink, landed on the mainland near Cape Adare, the first people to set foot on what is probably the Antarctic continent. On the return voyage the ship was only six days in working through the pack.

Efforts had been made from time to time, by Professor Georg von Neumayer in Germany and by Sir John Murray and others in Great Britain, to induce learned societies to inaugurate a new era of scientific Antarctic research under Government, or at least under national auspices. In 1895 Sir Clements Markham, as president of the Royal Geographical Society and of the International Geographical Congress, which met that year in London, also took the matter up, and interest in the Antarctic regions began to be aroused in every civilized country. M. Adrien de Gerlache organized a Belgian expedition, for which he raised the funds with difficulty, and only secured a grant of public money at the last moment when the enterprise appeared almost hopeless. He purchased the Norwegian whaler *Patria*, had her refitted and re-named *Belgica*, and brought together a scientific staff and crew—half Belgian and half foreign. M. de Gerlache, commanding the expedition, M. Georges Lecointe, captain of the ship, and Lieutenant Danco, magnetic observer, were Belgians; Mr Amundsen, the mate, a Norwegian; M. Arçtowski, the geologist and physicist, a Pole; M. Racovitza, the biologist, a Rumanian; and Dr F. A. Cook, the surgeon, an American. The *Belgica* sailed from Antwerp on 16th August 1897, but it was 14th January 1898, already long past midsummer, before she left Staten Island for Antarctic waters. She sighted the South Shetlands on the 21st, and proceeded to Hughes Gulf, from which a channel was explored leading south-westward between continuous land, named Danco Land, on the east (possibly the northern extension of Graham Land), and Palmer Land on the west. Palmer Land was found to be a group of large islands. Both coasts of Belgica Strait, as the new channel was named, were surveyed and twenty landings made, so much time being occupied that it was 12th February when the *Belgica* re-entered the open sea to the west at Cape Tuxen in 65° 15′ S. A large bay opening eastward was so encumbered with ice that it was impossible to find whether or not it led to Bismarck Strait. Much fog was experienced, but on the 16th Alexander Land was sighted in the distance. Continuing on a westerly course, the *Belgica* made every effort to enter the pack, which was successfully accomplished after a heavy storm on the 28th. By taking advantage of the leads, the expedition advanced to 71° 30′ S. in 85° 15′ W. by 2nd March, but the ship was blocked next day by the growth of young ice soldering the pack into one continuous mass. For more than a year further independent movement was impossible; but the ship drifted with the ice between the limits of 80° 30′ W. and 102° 10′ W., and of 69° 40′ and 71° 35′ S., which was the highest latitude attained (31st May 1898). The sun did not rise for seventy days, and all on board suffered severely from depression of spirits and disorders of the circulation, which Dr Cook attributes to the darkness and to improper food. Lieutenant Danco died during the period of darkness. On 13th March 1899, when a second winter in the ice began to seem probable, the *Belgica* was released in 69° 50′ S. and 102° 10′ W. (*Bulletin de la Société Royale Belge de Géographie*, 1900, *passim*). The geographical results of this expedition were insignificant so far as the discovery of land or penetration to a high latitude is concerned. The ship passed several times to the south and west of Peter I. Island, proving that the land seen by Bellingshausen at that point is of very limited extent. During the drift in the ice the soundings were usually between 200 and 300 fathoms, which, compared with the great depths to the north, clearly indicated a continental shelf of considerable breadth, probably connected with land in the south (*Geographical Journal*, xiv., 1899, pp. 77–82). A line of soundings was carried from Staten Island to the South Shetlands, and a maximum depth of 2210 fathoms found in that constricted part of the Southern Ocean to which the name of Drake Strait has been applied, although the officers of the *Belgica* termed it, less appropriately, Antarctic Strait.

The Hamburg America Company's steamer *Valdivia*, chartered by the German Government for a scientific voyage under the leadership of Professor Carl Chun of Leipzig, left Cape Town on 13th November 1898, and on the 25th was fortunate in rediscovering Bouvet Island (54° 26′ S., 3° 24′ E.), which had been searched for in vain by Cook and Ross. Steering south, the *Valdivia* found the edge of the drift ice in 56° 45′ S., and, although an unprotected iron vessel, she followed the edge of the pack from 8° E. to 58° E., reaching 64° 15′ S. in 54° 20′ E. on 16th December. At this point a depth of 2541 fathoms was found, so that if Enderby Land really occupies its assigned position, 102 nautical miles farther south, the sub-oceanic slope must be of quite unusual steepness. The rocks dredged up contained specimens of gneiss, granite, and schist, and one great block of red sandstone weighing 5 cwt. was secured, confirming the theory of the continental nature of the land to the south. From her farthest point the *Valdivia* returned northward *viâ* Kerguelen Island. Although only an incident in a voyage from the Cape to Kerguelen, this trip allowed of twenty-nine deep-sea soundings being made south of 50° S., where only fifteen had been recorded before. The general depth of the Southern Ocean proved to be much greater than had been formerly supposed, the greatest depth being 3155 fathoms in 58° S. No conclusion as to the existence of an Antarctic continent could be drawn from the soundings south of 55° S. between 0° and 50° E. (For abstract of observations, see *Geographical Journal*, xv., 1900, pp. 518–528; and for fuller report *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, xxxiv., 1899, pp. 75–192.) The physical and biological conditions of the water and the nature of the ice were very carefully investigated.

On his return to England in 1895 Mr C. E. Borchgrevink made strenuous efforts to organize an Antarctic expedition under his own leadership, and in August 1898 he left the Thames on the *Southern Cross*, a Norwegian whaler formerly known as the *Pollux*, in charge of a private expedition equipped by Sir George Newnes. His scientific staff included Lieutenant Colbeck, R.N.R.; Mr Louis Bernacchi, a trained magnetic observer; Mr N. Hanson and Mr H. Evans, biologists; and Dr Klövstad. About fifty dogs were taken out, the intention being to land at Cape Adare and advance towards the magnetic, and perhaps also towards the geographical, pole by sledge. The *Southern Cross* reached the edge of the ice in 52° S. and 154° E. on 30th December 1898; one of the Balleny Islands was sighted on 14th January 1899, and after in vain attempting to get south about the meridian of 164° E., the ship forced her way eastward and emerged from the pack (after having been beset for forty-eight days) in 70° S., 174° E. She reached Cape Adare, and anchored in Robertson Bay on 17th February. The land party, consisting of ten men, was established in a house built on the strip of beach at the base of the steep ascent to the mountains, and the ship left on 2nd March. Mr Borchgrevink found it impossible to scale the slopes to the snow-fields, which he believed to occupy the surface of a great plateau in the interior, and the party, except for short trips along the shore or on the sea-ice, spent the year of their sojourn—the first year ever passed by man on Antarctic land—in making natural history collections and keeping up meteorological and magnetic observations. The *Southern Cross* returned to Cape Adare on 28th January 1900, and after taking the winter party on board —diminished by the death of Mr Hanson—set out for the south on 2nd February. Landings were made on Possession Island, Coulman Island, on the mainland at the base of Mount Melbourne, Franklin Island, and on 10th February at the base of Mount Terror, near Cape Crozier. From this point the ship steamed eastward along the great ice-barrier to a point in 164° 10′ W., where an inlet in the ice was found, and the ship reached her highest latitude, 78° 34′ S., on 17th February. The edge of the ice was found to be farther south than it had been when Ross visited it in 1842. About 5000 square miles of open water are shown on Borchgrevink's map, where Ross's showed the solid ice-barrier. Mr Borchgrevink was able to land on the ice with sledges and dogs, and advanced southward about 16 miles, reaching in 78° 50′ the farthest south yet attained. On the 19th the *Southern Cross* started on her return, and, without encountering any pack ice, reached Stewart Island, New Zealand, on 30th March (*Geographical Journal*, xvi., 1900, pp. 381–414).

In the autumn of 1901 three well-equipped expeditions left Europe for Antarctic exploration. The British National Antarctic expedition was organized by a joint committee of the Royal Society and the Royal Geographical Society, and equipped under the superintendence of Sir Clements Markham. One half of the cost was borne by the Government, the rest mainly by Mr Ll. W. Longstaff, who provided £30,000, the Royal Geographical Society, and Mr A. C. Harmsworth. A strong wooden ship of about 700 tons register (1700 tons displacement) was built at Dundee, and named the *Discovery*. She was barque-rigged, with auxiliary engines, and amidships entirely non-magnetic, so that magnetic observations might be carried on without interference from local attraction. The vessel was equipped with all necessary scientific apparatus, and the expedition sailed under the command of Commander R. F. Scott, R.N., with Lieutenant Armitage, R.N.R., as second in command, Lieutenants Royds and Barne, R.N., Lieutenant Shackleton, R.N.R., and Mr Skelton, R.N. The crew of forty men were almost entirely sailors of the Royal Navy. The scientific staff included Dr Koettlitz, who had shared with Mr Armitage in the Jackson-Harmsworth Arctic expedition; Mr Louis Bernacchi, who had sailed with Mr Borchgrevink in the *Southern Cross*; Dr Wilson, Mr Hodgson, and Mr Ferrar. The scientific director, Mr George Murray, accompanied the vessel to Cape Town, and Dr H. R. Mill also went part of the way as instructor in oceanography. The *Discovery* left Cowes on 6th August 1901 and Simon's Bay on 14th October, and on the voyage to New Zealand entered the ice-pack and reached 62° 50′ S., 139° 40′ E., where a sounding of 2300 fathoms was obtained. She reached Lyttelton on 28th November, and finally, having embarked a number of dogs, she sailed from Port Chalmers for Victoria Land on 24th December.

The German expedition sailed from Kiel on 11th August 1901 in the *Gauss*, a vessel similar in size to the *Discovery*, and similarly equipped for scientific work, though of a different model and sail plan. The commander of the expedition was Professor Erich von Drygalski, of the University of Berlin, and he was supported by an able scientific staff of four specialists. The sailing-master, Captain Ruser, and crew were of the merchant service, although the vessel, unlike the *Discovery*, carried the naval flag. The *Gauss* reached Cape Town on 23rd November, and sailed for Kerguelen a few days later, taking in stores at that island, and departing southwards at the end of January 1902, with the object of penetrating the absolutely unknown part of the Antarctic area in the neighbourhood of Enderby Land. Simultaneous meteorological and magnetic observations were arranged to be carried out on both vessels and at a land station which has been established at Kerguelen Island, and the two expeditions, although entirely distinct, acted in perfect harmony. Magnetic and meteorological observations were also arranged for comparison at Lyttelton in New Zealand, and at Staten Island in Argentina.

Dr Otto Nordenskjöld organized a Swedish expedition on board the whaler *Antarctic*, Captain Larsen, and sailed from Falmouth on 26th October 1901 for Buenos Aires; he left on 24th December, bound for the coast of Graham Land, where he was landed with a wintering party in order to carry out exploration and scientific observations simultaneously with the British and German expeditions.

Arrangements were completed for two additional expeditions to sail in 1902, each employing an old Norwegian whaling vessel purchased for the purpose. The Royal Geographical Society sent out the *Morning* under Lieutenant Colbeck, R.N.R., as a relief ship to the *Discovery*; she sailed from the Thames on 9th July. Mr W. S. Bruce, who had experience of both Antarctic and Arctic exploration, completed the plans of a Scottish expedition under his command in the *Hecla*, which was greatly strengthened and refitted at Troon and renamed the *Scotia*. Captain Thomas Robertson went as master of the ship. Mr Bruce proposed to turn his attention to Weddell Sea.

The full results of the work of the *Belgica*, *Valdivia*, and *Southern Cross* were not available at the time of writing; but the preliminary observations convey much new information, especially with regard to climate.

Land.—No new land has been discovered south of the Antarctic circle, if we except the southern prolongation of what is probably the east coast of Graham Land, reported by Larsen. The observations of the *Belgica* increase the probability that the land known to exist to the south of South America is an archipelago, the islands being perhaps locked together by ice in the south. The relatively shallow water in which the *Belgica* drifted when fast in the floe indicates an extensive land or numerous islands of a continental character to the south on that side, while the very deep water found by the *Valdivia* to the north of Enderby Land appears to justify the supposition that the sea penetrates far to the south in that region. Active volcanoes have been seen both in the Graham Land and Victoria Land areas, and there is some probability that violent earthquakes are occasionally experienced. It has been suggested that the great increase in the amount of drift-ice from the Antarctic, and in the size of the bergs, observed in the period 1891–96, was due to the disruption by earthquakes of vast masses from the seaward ends of the Antarctic ice-sheet. Borchgrevink's observation of the apparent retreat of the southern ice-barrier is in accordance with this view. The hypothesis of a great Antarctic continent or continental archipelago continuously covered by an ice-sheet is confirmed by the observations of recent expeditions, but the evidence is not yet direct or conclusive.

Land-Ice.—The ice-barriers which have been seen extending for hundreds of miles along the coast of Antarctic lands, and reaching the height of from 100 to 200 feet, have hitherto been viewed as the seaward face of a vast ice-sheet or confluent glacier, the only analogous phenomena in the north being the great glaciers of northern Alaska. Mr Bernacchi, however, suggests that they may be the sides of great spurs of ice projecting at right angles from the land. The ice wall at the place of its greatest extension in Victoria Land is evidently afloat, for deep soundings have been obtained near the edge, but it is probably in continuous contact with the land. Borchgrevink advanced about 16 miles on it, and found a rising gradient all the way; but he does not report a crevassed zone, which analogy with Greenland would lead us to expect. East of Mounts Erebus and Terror, Ross reported that the ice-barrier was from 180 to 200 feet high; but Borchgrevink assigns to it only a height of 60 or 70 feet, and at the place where he landed the ice was only 3 feet above the sea. The fact that flat-topped icebergs of enormous dimensions, such as could only be produced by ice faces similar to that of Victoria Land, are found in large numbers wherever the Antarctic region has been approached, makes it probable that an ice-barrier girdles the Earth some short distance within the Antarctic circle. M. Arçtowski points out, with regard to the land bordering Belgica or Gerlache Strait, that small icebergs are formed from the ice-foot produced by the regelation of ice which has fallen from the glaciers on the upper part of the steep slopes.

Sea-Ice.—The pack formed of sea-ice and fragments of bergs appears to surround the Antarctic circle as a floating breakwater, and open water sometimes occurs to the south of it. So far as already known, this is the case only off the east coasts of land projecting northward from the unknown region; at least, it is only in such positions that latitudes beyond 72° S. have been reached, and farther to the east sea-ice has prohibited the advance of ships both in Ross Sea and Weddell Sea. The Antarctic pack differs from that of the Arctic region chiefly in the large number of bergs and fragments of hard land-ice frozen up in it, this unequal structure increasing the dangers of ice navigation. The northern edge of the pack appears to lie nearly along the parallel of 60° S. in summer; its position in winter is unknown. Drift-ice, consisting mainly of large, flat-topped bergs, is usually met with in the Southern Ocean at all times of the year south of 50° S., but most abundantly in the months of November and December (the southern summer), and least frequently between April and July. The drift-ice comes farthest north on the Atlantic side; an occasional berg may be sighted off the Cape of Good Hope, and the extreme limit at which ice has been seen was 26° 30′ S. in the very centre of the Atlantic in April 1894.

Magnetism and Aurora.—Mr Borchgrevink was led by the magnetic observations taken by Lieutenant Colbeck and Mr Bernacchi to assign to the magnetic pole the position of 73° 20′ S. and 146° E. The observations at Cape Adare, however, were rendered unsatisfactory by the local attraction exercised by the masses of volcanic rocks in the neighbourhood, and by frequent magnetic storms, the difference between the maximum and minimum declination in a single day sometimes amounting to 3°. Magnetic observations were made from the *Belgica* on the ice-floe, but the want of stability of the ice made the work difficult. During the drift of the *Belgica* the aurora was observed with great attention during the period 11th March to 10th September, when there was no daylight or strong twilight, although the cloudiness of the sky only allowed it to be seen on sixty-two occasions. A diurnal period was observed, the maximum intensity occurring between 9 and 10 P.M. The brilliance and variety of the display were less marked in July than in the other months. The commonest form was a luminous arch, the culminating point of which almost always bore S.S.W.; the arch did not attain so great an altitude at the solstice as at the equinoxes, the auroral phenomena appearing to retire towards the magnetic pole in midwinter. (H. Arçtowski, *Geographical Journal*, xvi., 1900, pp. 92–94.) At Cape Adare the aurora was observed "nearly every night," the prevailing form being a luminous arch, the centre of which always lay to the north, never to the south. This would appear to indicate an unsymmetrical distribution of the aurora with regard to the pole. The period of diurnal maximum was between 8 and 9 P.M., and here also the annual minimum seemed to occur at midwinter.

Climate.—The summer climate of the Antarctic region has long been known to be extremely cold and ungenial. Bruce on the *Balæna* found the average temperature during the three summer months of 1892–93 to be rather under 31° F. for latitude 62° S. The actual figures were December 31·1°, January 31·1°, February 29·6°. The following table shows the monthly mean temperatures observed on the *Belgica* west of Graham Land in the pack about latitude 70° S. (H. Arçtowski, *Geographical Journal*, xiv., 1900, p. 417), and of Borchgrevink's expedition at Cape Adare in latitude 71° S. (C. E. Borchgrevink, *Geographical Journal*, xvi., 1900, p. 405):—

Average Temperature in the Antarctic Regions.

	W. of Graham Land, 1898–1899. March 1898 to February 1899. Means of hourly observations.			Cape Adare, 1899–1900. February 1899 to January 1900. Means of daily maximum and minimum.		
	Mean.	Max.	Min.	Mean.	Max.	Min.
January	29·8	...	17·4	33·0	48·9	22·5
February	30·2	...	14·7	(26·4)	...	...
March	15·6	...	− 4·5	17·7	31·1	− 2·5
April	10·8	...	−15·7	10·3	30·0	−10·0
May	20·3	...	−13·4	− 4·6	23·2	−31·1
June	4·1	...	−22·0	−11·8	14·1	−36·0
July	−10·3	...	−34·8	− 8·6	23·8	−39·9
August	11·7	...	−21·3	−13·4	18·9	−43·1
September	− 1·3	...	−45·6	−11·9	11·5	−36·1
October	17·8	...	−15·3	− 1·8	19·6	−35·5
November	19·6	...	− 6·5	17·8	45·7	− 4·0
December	28·0	...	5·9	31·8	42·2	20·4
Year	14·7	...	−45·6	7·0	48·9	−43·1

The temperatures in the pack were, as might be expected, less extreme than those on the land, and subject to great variations as the wind blew from the ice on the south or from the open ocean on the north. The temperature found by the *Belgica* for August is remarkably high, so high that it is advisable to say that it is +11·7° F., not a slip for −11·7°. The summers are remarkably cold, the winters by no means extraordinarily so. Indeed, the severity of the climate at Cape Adare seems to be due to the fact that the mean temperature remained below zero Fahrenheit for six consecutive months; the minima were not lower than occur every year in lower latitudes in central Canada and Siberia. At the southern ice-barrier a minimum of −12° was found by Borchgrevink in February, during the height of summer. A rise of temperature was found to be a sure indication of an approaching storm; at Cape Adare the thermometer was more sensitive than the barometer in prognosticating gales.

Pressure and Wind.—The barometric observations at Cape Adare are not available for discussion, but the maximum observed was 30·182 inches and the minimum 27·860 inches. On the *Belgica* the mean pressure for the year was 29·319 inches. The maximum pressure observed was 30·400 and the minimum 28·022. The isobaric charts compiled from all previously existing data show the isobar of 29·30 running slightly to the north of 60° S.; and as the same pressure occurs again in 70° S., it seems fair to infer that the belt of minimum mean pressure lies somewhere about 65° S., and that higher pressures will be found farther south. A belt of comparative calm appears to lie between the "roaring forties" and the tempestuous margin of the Antarctic continent. This was particularly noticed by the *Valdivia*. The record kept on the *Belgica* showed that the number of hours when the wind blew from southerly or easterly directions was slightly less than from northerly or westerly directions; in other words, the probability appeared to be slightly greater that the pressure was, on the whole, lower to the south than to the north. However, the vessel was drifting over a considerable area during the time of observation, and there was also a well-marked seasonal range. Westerly winds predominated in winter (June to August), and easterly winds in summer (December to February); the northerly and southerly components show no clear seasonal range, and are nearly equal in frequency. The weather as a whole was due to a succession of cyclones. At Cape Adare winds from southerly directions predominated, and especially heavy gales from E.S.E., affording some evidence of a permanent south polar anticyclone. As the latitude differs but slightly from that of the mean position of the *Belgica*, it would seem that the anticyclone lay towards the Victoria Land side; and this in turn suggests that the main body of the land lies in that direction, an inference supported by the temperature observations also. But the records of a single year do not allow of any definite conclusions being arrived at; they furnish at most a legitimate basis for tentative hypotheses. At both positions terrific storms of wind were very frequent, making the cold unbearable while they lasted. These are probably due to the proximity of the relatively warm sea to the cold ice or land, and it is probable that farther in the interior there will be a region of relative calm, although of lower temperature.

Precipitation.—Frequent mists and snow squalls have been reported by all voyagers in the Antarctic seas, even in the height of summer. The immense thickness of snow necessary to form the Antarctic icebergs presents a problem of great difficulty. If the prevailing winds were northerly, a heavy precipitation would be a natural consequence; but if there is an anticyclone over the land, giving rise to prevailing southerly winds, the source of moisture is a mystery. A ring of high pressure near the Antarctic circle, surrounding a low pressure area lying over an open polar sea, might account for observed facts; but there are no observational data for or against this fancy.

Flora and Fauna.—Terrestrial flora and fauna have been discovered on Victoria Land and in the Palmer Archipelago, but both are very limited. Borchgrevink reports five species of lichens, including the ordinary reindeer moss. Lichens were found as far south as 78° S. Insects of three species were discovered, all very minute, but capable of being detected by the naked eye as they moved about on the lichen. The *Belgica* found a more extensive flora on the shores of Belgica Strait, mosses and a single species of grass being observed as well as lichens. The insects found there included a species of diptera with rudimentary wings, poduridæ, and minute acarides. Marine life was very abundant even in the highest latitudes. It included a great number of species representing plankton, littoral forms, and fishes, as well as benthos. The seals and sea-birds have for the most part been described before. The right whale seems to be absent. There is no walrus nor narwhal, and no trace of land mammals has been found.

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Pole, William (1814–1900), English engineer, was born at Birmingham on 22nd April 1814. He was a man of many accomplishments. Having spent his earlier years in various engineering occupations in England, he went out to India in 1844 as first professor of engineering at Elphinstone College, Bombay, where he had to organize the course of instruction for native students, but his health obliged him to return to England in 1848. For the next ten years he worked in London under James Simpson and J. M. Rendel, and the high reputation he achieved as a scientific engineer gained his appointment in 1859 to the chair of civil engineering in University College, London. He obtained a considerable amount of official work from the Government. He served on the committees which considered the application of armour to ships and fortifications (1861–64), and the comparative advantages of Whitworth and Armstrong guns (1863–65). He was secretary to the Royal Commission on Railways (1865–67), the duke of Richmond's Commission on London Water (1867–69), also taking part in the subsequent proceedings for establishing a constant supply, the Royal Commission on the Disposal of London Sewage (1882–84), and the Departmental Committee on the Science Museums at South Kensington in 1885. In 1871 he was employed by the War Office to report on the Martini-Henry rifle, and in the same year was appointed consulting engineer in London to the Japanese Government, a position through which he exercised considerable influence on the development of the Japanese railway system. He was elected a fellow of the Royal Society in 1861, in recognition of some investigations on colour-blindness. Music was also one of his chief interests. At the age of twenty-two he was appointed organist of St Mark's, North Audley Street, in open competition, the next selected candidate being Dr E. J. Hopkins (1818–1901), who subsequently was for fifty years organist of the Temple Church. He took the degree of Bachelor of Music at Oxford in 1860, proceeding to his doctor's degree in 1867, and in 1879 published his *Philosophy of Music.* He was largely concerned in the institution of musical degrees by the University of London in 1877, and for many years acted as one of the examiners. His mathematical tastes found congenial occupation in the study of whist, and as an exponent of the scientific principles of that game he was even earlier in the field than "Cavendish." His literary work included treatises on the steam engine and on iron construction, biographical studies of famous engineers, including Robert Stephenson and I. K. Brunel, Sir William Fairbairn and Sir C. W. Siemens, several books on musical subjects and on whist, and many papers for reviews and scientific periodicals. He died on 30th December 1900. His son, William Pole (b. 1852), is known, under the stage-name of William Poel, for his studies in Shakespearian drama and his work in connexion with the Elizabethan Stage Society.

Police.—The powers and duties of the police in England and Wales with respect to the detection and prevention of crime have not been materially altered since 1884, but in each session of Parliament new offences are created, and an enormous amount of subordinate legislation in the form of bye-laws has added to the duties of the force. The summary remedy given by the Prevention of Crimes Act, 1871, § 12, for assaults on the police in the execution of their duty was in 1885 extended to cases of resistance or wilful obstruction. The usefulness of constables in cases of serious accident has been much increased by systematic instruction in the modes of giving first aid to injured persons; and they are now authorized to destroy at once animals seriously injured in the streets (57 and 58 Vict. c. 22). It is now usual, in order to ensure the proper treatment of women on arrest, to employ police matrons at the police stations, and to arrange for the presence of female attendants or searchers when required. Under the Sheriffs Act, 1887, courts of quarter sessions may direct the attendance of constables at the assizes to keep order, and when such direction is given the sheriff is relieved of his common-law duty to provide javelin men for the purpose. Under the Police Act, 1890, § 25, provision is made for sending constables of one force to the assistance of those of another authority at the request of the latter, and at the expense of the police area to which they are sent.

In 1897 was established a uniform system for dealing with property coming into the hands of the police in connexion with a criminal charge or in execution of certain of their duties. Courts of summary jurisdiction are empowered to make orders for the restitution of the property to the owner. If not claimed, it is dealt with under regulations made by the Home Secretary on 14th February 1898, which include a power of sale at the end of a year after the police got possession of the property (see 60 and 61 Vict. c. 30). The constables of a borough police force may now be employed as firemen, and constables of any force who under general or special directions act as firemen, or assist in extinguishing fires, or in saving life or property, are entitled, in the event of injury, to pensions, &c., as for injury in the execution of their duty (56 and 57 Vict. c. 10). In 1887 policemen were allowed to vote at parliamentary elections, and in 1893 at municipal elections and the like.

Management.—On the establishment of county councils in 1888 the police of each administrative county (except London) were put under the control of a standing joint committee composed of an equal number of justices, appointed by the court of quarter sessions, and of members of the county council, appointed by the council, subject to the power of the Home Secretary to fix the number of each if the council and the quarter sessions cannot agree. The joint committee appoints the chief constable, divides the county into police districts, and generally controls the police of the county, subject to the rights of the justices as conservators of the peace, and to the rights of quarter sessions or of the county council to impose additional duties on the force under the Police Act, 1856. It is also the duty of the standing joint committee in a county, and of the watch committee in a borough, to transmit as soon as possible after the end of each calendar year an annual return of offences reported to the police, of persons arrested by the police, the charges against them, the result of the proceedings there, and such other particulars as to the state of crime in their district as they think material (55 and 56 Vict. c. 38). By the Act of 1888 the police forces of liberties or of boroughs with less than 10,000 inhabitants in 1881 and lying within an administrative county were merged in the county force.

The cost of the police in England and Wales for the year 1900,[1] including salaries and pay allowances, contributions of deficiency in the pension account, clothing and accoutrements, the cost of buildings, and the other expenses incidental to the maintenance of the force, was £4,822,886.

Separate Forces.	No. of each Force: average Daily Strength.	Population Policed; by Census of 1891.	Gross Cost.
Counties and boroughs (185) . . .	26,376	23,384,932	£2,802,212
Metropolitan police .	13,588	5,595,638	1,871,363
City of London . .	1001	37,705[2]	149,311

The cost of maintenance of the force is now defrayed in the following manner :—From the local taxation grant from the Imperial Exchequer to each county there is transferred to the police account of the county fund half the cost of the pay and clothing of the county police, and there is paid over to the council of each borough within the county which has a separate police force half the cost of the pay and clothing of the borough force, including the cost, &c., of any extra police temporarily added from another force and paid for under agreement under the Police Act, 1890. The balance of the expense of the force is defrayed from the county or borough fund. The Government inspection of local police is unaffected by the Act of 1888, but if the Home Secretary withholds his certificate of efficiency in point of numbers and discipline, the authority in default forfeits the amount applicable for police out of the local taxation grant, and must pay the whole cost of the force out of its own funds. The county council of any county within the Metropolitan Police District has to transfer to the receiver of police a sum bearing such proportion to the police rate levied in the parts of the county lying within that district as the Home Secretary certifies would have been proper under the arrangements in force from 1875 to 1899.

In 1890 a complete system of superannuation and pensions was established for every force in England except that of the City of London. The pensions are awarded in accordance with a prescribed scale, and under certain conditions: (*a*) On retirement after 25 years' service; (*b*) on retirement after 15 years' service or certificate of incapacity for duty; (*c*) at any time in the event of certified incapacity for duty in consequence of mental or bodily infirmity due to injuries in service as a constable or at a fire. Gratuities may be granted on retirement with less than 15 years' service on a medical certificate of incapacity for duty, and pensions and allowances may be given to the widows or children of deceased constables.

Elaborate machinery is created for settling the amount of pension and the mode of calculating service and to prevent fraud. The cost of the pensions is defrayed from the pension fund of each force, to the account of which are carried certain deductions from the pay of the force and certain classes of fines imposed by courts of summary jurisdiction. But the chief item is the Exchequer contribution of £300,000 a year made to the pension funds of authorities outside the Metropolitan Police District from the proceeds of the local taxation customs and excise duties (56 and 57 Vict. c. 45, § 17; 56 and 57 Vict. c. 60). The contribution is forfeited where a force is certified not to be efficient. Any deficiency in the pension fund is made good from the police fund.

United States.—The organization of police forces in the United States differs more or less in the different states of the Union. As a rule the force in cities is under municipal control, but to this rule there are numerous exceptions. In Boston, for instance, the three commissioners at the head of the force are appointed by the Governor of Massachusetts. The force in New York City, alike from the standpoint of numbers and of the size and character of the city, is the most important in the United States, and in its general composition may be taken as typical. It includes a commissioner appointed by the mayor for a term of years and exercising a wide range of authority; a chief of police, who has immediate charge of the force and through whom all orders are issued; he is assisted by four deputies; inspectors, who are in charge of different sections of the city, and who carry out the orders of the chief; captains, each of whom is in direct charge of a precinct; sergeants; roundsmen; and last of all, the ordinary policemen, or patrol men as they are often called from the character of their duties. There is a separate branch, the detective bureau, composed of picked men, charged with the investigation and, still more, the prevention of crime. The total number is about 4000. Appointments are for life, with pensions in case of disability and after a given number of years of service. The cost of the police department in New York in the year 1900 approximated $12,000,000, and in Chicago $3,800,000.

As regards the prevention of ordinary crime, the preservation of the peace, the protection of life and property, the American police is probably about as effective as that in English or Continental cities. But in certain cities there have been serious scandals. Under the Tammany government in New York City a system of almost organized blackmail came into existence, by which the keeper of the saloon and the house of ill-fame paid regularly and liberally to the police captains for impunity in breaking the law; and it was repeatedly shown that candidates for the position of captain paid large sums to their superiors for appointment to that post. The demoralizing effect of such a system needs no demonstration. (W. F. C.)

[1] See *Parl. Paper*, 1901 (200).

[2] Sleeping population. The day population is over 300,000.

Pollokshaws, a burgh of barony and police burgh of Renfrewshire, Scotland, now, by the extension of the city and itself, virtually a suburb of Glasgow, with which it is connected by rail and tram. A great many houses have been built in recent years for the accommodation of the working classes and Glasgow business people. A public hall has been presented to the town by Sir John Stirling-Maxwell, Bart., the feudal superior. The academy is a secondary school with an elementary department. Population (1891), 10,228; (1901), 11,169.

Polna, a town in the government district of Deutschbrod, in Bohemia, Austria, on the frontier of Moravia, north-east of Iglau, and just beyond the bounds of the German-speaking enclave. It has manufactures of starch and syrup, glass-cutting and brewing. On the 29th of March 1899 Polna was the scene of a sensational murder of a young girl (Agnes Hruza), which led to a revival of the accusation of "Ritual Murder" against the Jews, and was made the starting-point of an anti-Semitic agitation. The trial of the accused, a Jew named Hilsner, which took place at Kuttenberg on the 12th–16th September, ended in his conviction on purely circumstantial evidence. The sentence was subsequently commuted to a term of imprisonment. Population (1890), 4923; (1900), 5013.

Polo.—Since the article on polo was written for the earlier volumes of the *Encyclopædia Britannica* (ninth edition), the game has altered in character and increased in popularity. There were over sixty clubs in the United Kingdom in 1902, besides many others in British colonies and dependencies. In France and Russia, and in Spain, as well as all over America and the Argentine Republic, polo has taken root and flourishes greatly, games, matches, and tournaments being played throughout the season. As the game differs slightly in the United Kingdom and its colonies from that played in America and India, it will be convenient to consider its present conditions under these three heads.

The United Kingdom and Colonies.—The game of polo is ruled by the code of laws and by-laws laid down by the committee of the Hurlingham Club, which, with some few inconsiderable exceptions, are everywhere in force. The height of the ponies played is in England 14 hands 2 inches. Every pony is measured by an official measurer, and registered in a book kept for that purpose at Hurlingham. No ponies above that height are permitted in any circumstances to play in matches or tournaments. A polo ground should be a parallelogram 300 yards in length by 200 yards in breadth. The longer sides are boarded with planks from 9 to 11 inches in height. Full-sized grounds, however, are not entirely satisfactory in practice, and it is probable that 300 yards by 150 or 170 will become the standard size in England. So large a ground as 300 by 200 is found to keep the ball in play too long, and to be tiring to the players and hard on the ponies. It must be remembered that good polo is played at full gallop. At each end of the ground are two goal-posts, which are placed 8 clear yards apart in the centre of the back line, which is marked with lime-wash. At a distance of 30 yards from the back line a second line is marked parallel to the back one. Then, taking the point midway between the goal-posts, a half circle of 25 yards should be described in white lime-wash. A scoring board, a clock to mark the time, a bell to sound the close of the periods of play, and a pavilion or dressing tent, are also necessaries of a well-appointed polo ground.

The game is played by eight players, four a-side. Each of the four players has his appointed place in the game and his particular duties, which may consist either in forwarding the progress of the ball towards the adversaries' goal or impeding its course towards his own. Taking the players in order of importance, number 4 is the back; and his ultimate duty is to guard his own goal in defence, and in attack to prevent the ball from coming back, and, having stopped it, to pass it forward to the man in front of him, who should be number 3. This player, whose position is one of great responsibility, should either help the back in defence, or support his own forwards when they are attacking. Number 2, who should ride a fast pony and be a brilliant and hard hitter with control of the ball, generally leads the attack on the enemies' goal. Number 1 is supposed to hamper the movements of the opposing number 4, and by "riding him off" to clear the way for number 2 on his own side. It will thus be seen that the players are in pairs, whose duty in attack is to press the ball forward, and in defence to impede the corresponding man. Thus, let A and B be two sides: number 1A will impede number 4B; number 2A will try to carry the ball on, be impeded by number 3B; number 3A will endeavour to place the ball so that number 2A can obtain possession, or, if the game is against him, hinder number 2B, while number 4A will be impeded by number 1B doing the like. Both backs will use every endeavour to place the opposing number 1 off side, while both numbers 1 will endeavour to ride off the backs.

The rules as to off side and riding off are given here:—

Off side (Rule 18).—No player who is off side shall hit the ball, or shall in any way prevent the opposite side from reaching or hitting the ball.

Definition of off side.—A player is off side when at the time of the ball being hit he has no one of the opposite side nearer the adversaries' goal line, or that line produced, or behind that line, and he is neither in possession of the ball nor behind one of his own side who is in possession of the ball. The goal line means the 8 yards line between the goal-posts. A player, if off side, remains off side until the ball is hit or hit at again.

Riding out an antagonist.—A player may ride out an antagonist, or interpose his pony before his antagonist so as to prevent the latter reaching the ball, but he may not cross another player in possession of the ball, except at such distance that the said player shall not be compelled to check his pony to avoid a collision.

It is thus evident that polo is a game in which combination and tactics count for much. In order to prevent the game from becoming a mere rough-and-tumble, there are always on the ground, besides the players, two experienced and well-mounted men who have the rules of polo at their finger-ends, and whose duty it is to check all unfair play and enforce the penalties on the offending side. The position of umpires is one of great responsibility and importance, and the whole welfare of the game of polo depends on their duties being thoroughly and efficiently carried out. In addition to the umpires there should be a referee, to whom appeal may be made if the two umpires differ.

Penalties (Rule 22).—Any infringement of the rules constitutes a foul. In case of an infringement of Rules 16, 17, 19, 20, and 21, the umpire shall stop the game; and in case of an infringement of Rule 18, the umpire shall stop the game on an appeal by any one of the side which has been fouled. On the game being stopped as above, the side which has been fouled may claim either of the following penalties:—(*a*) A free hit from where the ball was when the foul took place, none of the opposing side to be within 10 yards of the ball. (*b*) That the side which caused the foul take the ball back and hit it off from behind their own goal line. The side injured by the foul may claim either penalty. There is also the extreme penalty of disqualification of the whole team for disregarding the umpire's decisions. There is also a minor penalty (New Rule, May 1898) inflicted on a side which, when being hard pressed, hits the ball behind their own goal line, thus putting the ball out of play and of course depriving the adversary of the chance of making a goal. Rule 14. If the ball be hit behind the back line by one of the opposite side, it shall be hit off by one of the side whose line it is, from a spot as near as possible to where it crossed the line. None of the attacking side shall be within 30 yards of the back line until the ball is hit off. If, however, the ball be hit behind the back line by one of the players whose line it is, they shall hit it off from behind the goal line between the posts, and all the defending side shall, until the ball is hit off, remain behind their back line, and between two lines which shall be drawn at right angles to the goal line produced, from points 10 yards distant from the centre of the goal on either side, the attacking side being free to place themselves where they choose, but not within 25 yards of the centre of the goal-posts. The penalty shall not be exacted should the ball glance off a player or pony.

The game is played with a ball made of willow root, about 3 inches in diameter and painted white. No ball should be over 5 ounces in weight. The sticks used are made of cane and wood, white Malacca cane being the best. There is no rule as to the length or weight of the stick; each player is left to suit himself. Whippy canes, however, are dangerous; those too stiff are apt to strain the wrists of the players. The stick is most important, and good players spare no pains to obtain suitable ones. The heads are usually square in England and cigar-shaped in India, these forms being found better for soft and hard ground respectively.

The full match time in England is one hour. This is divided into six periods of ten minutes each. As the players do not leave the ground until the ball is actually out of play by having been hit over the boundary boards or back line, a period of actual play may, and sometimes does, exceed ten minutes; but in this case the excess is deducted from the following period, so that if, for example, a period of play lasted twelve minutes, the next one would only last eight. At the close of each period of ten minutes two minutes are allowed for changing ponies, and after each twenty minutes there is an interval of five minutes. In the event of the scores being equal at the close of the hour of actual play, the rules provide that the period shall be prolonged till the ball goes out of play. Then, if it is still a tie, after an interval of five minutes the ball shall be started from where it went out of play, and the game continued as before, until one side obtain a goal which shall determine the match. In the earlier matches of tournaments the whole period of play is often reduced to forty minutes.

The polo pony is any small horse of 14·2. There are animals from America, Canada, Argentina, Africa, India, and Australia playing, as well as a considerable but diminishing number of Arabs. The polo pony must be fast, docile, and well-mannered, and thoroughly trained to the game. The best ponies are those obtained by crossing a thoroughbred sire with a mare having some Arab, or Welsh, or Exmoor pony blood. There are a few dwarf thoroughbred horses playing, but these are accidents, though it will be noted that the best-known are all descendants of Newminster. A considerable trade exists in polo ponies, and there is a stud book under the supervision of the Polo Pony Society. The qualities of a first-rate pony are so many and so rare, that high prices are often paid for really high-class specimens.

The principal tournaments of the year in England are the Inter-Regimental and Championship played at Hurlingham, the Hunt Cup and Subalterns' Cup played at Ranelagh, the Rugby Tournament and the County Cup; the All Ireland, Dublin Inter-Regimental and Phœnix Park are also important fixtures. The ties of the County Cup tournament are played off at different centres under the control of the County Polo Association, the final only being played on the grounds of the Hurlingham Club at Fulham.

America.—The game of polo, which is very popular in America, differs a good deal from that in England. Whereas in the latter country the whole conception of correct play is based on combination, in America individual brilliance counts for more. The American Association thus promotes games of two and three a-side, which are never attempted in England. Each player has his handicap, as at golf, which is based on the number of goals he is supposed to be worth to his side. When two sides meet for a match, the handicaps of the players on either side are added together and the less subtracted from the greater; thus, A side with a handicap of twelve meets B side with a handicap of ten. Then A would have to make two goals to start on even terms with B. Polo was introduced into America by Mr James Gordon Bennett in 1876, and has gradually grown in popularity. The American regulation ground is 250 by 166 yards. They have no off side, and it is not permitted to crook the stick of an adversary. America has produced some fine individual players, but no team, so far, equal to the English Rugby, Freebooter, or Hurlingham teams.

India.—Polo in India is under the control of the Indian Polo Association, which is responsible to the military authorities that the game is played in such a way as to make the danger as little as possible and to avoid needless expense to players. The Indian game is in the main the same as that in England, with the following exceptions:—The height of ponies is 14·1. The rules as to riding off are much stricter, or it would perhaps be true to say more strictly enforced by the umpires. The time allowed for a match is forty minutes. In order to avoid a tie, the subsidiary goal is scored. The following is a definition of a subsidiary goal: "A subsidiary goal is obtained in the same way as a true goal, except that to score a subsidiary goal—11 feet from outside of each goal post—the ball must pass between the subsidiary goal mark and the goal post which is nearest to it." (*Riding and Polo*, p. 377 (ed. 1899), Rule 37.) Left-handed players are forbidden altogether. The Indian grounds are usually 300 by 200, and there are no boards. In India polo is a much less expensive game than in England, and is almost universally played by officers of the British army stationed in that country, and to a less extent by civilians. There are 120 clubs in India affiliated to the Indian Polo Association. In addition to these there are many small associations for polo which are not registered. There are about 600 ponies holding the Indian Polo Association certificate of age and height, without which no pony can play in a tournament.

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Poltava, a government of south-west Russia, to the north of Kherson, has an area of 19,265 square miles. The population was 2,418,870 in 1881 and 2,794,727 in 1897, of whom 1,406,736 were women, and 271,459 lived in towns. The government is thus the fourth in Russia in respect of density of population outside Poland, although considerable numbers of people have emigrated to Siberia. The land is chiefly owned by the peasants, who possess 52 per cent. of the cultivable land; 42 per cent. belongs to private persons, and the remainder to the Crown, the clergy, and the municipalities. In 1895, 283 private owners held over 2700 acres each, 380 held from 1350 to 2700 acres, 2092 from 270 to 1350 acres, 1966 from 135 to 270 acres, and 22,570 persons owned less than 135 acres each. Twenty per cent. of the peasants hold no field-land, and 26 per cent. hold less than 8 acres per family. Land is sold and rented at very high rates. The average yield per annum from 1895 to 1899 was of wheat 9,361,000 cwt., of rye 9,679,000 cwt., of oats

3,882,000 cwt.—of all cereal crops 29,664,000 cwt.; of potatoes 9,010,000 cwt. Nearly 670,000 cwt. of beetroot are grown annually, while tobacco plantations cover 2310 acres and yield some 302,500 cwt. annually. Gardening for commercial purposes (melons, sunflower, &c.) is extensively carried on, as also is bee-keeping. There were in the province in 1898, 289,400 horses, 793,500 horned cattle, 1,530,960 sheep, and 390,000 swine. Domestic industries are but slightly developed, and the factories (flour mills, tobacco and sugar works, and distilleries) afford employment to only 9200 persons, and have an output valued at only 23,000,000 roubles a year. The Dnieper is the chief artery for the exports—grain, live stock, hides—and imports—timber. The chief river ports are Kremenchug and Poltava. Steamers ply between Kieff and Ekaterinoslav.

Owing to the efforts of the *zemstvo* (provincial council), there were in 1896, 721 primary schools, attended by 52,242 boys and 7154 girls; the total number of schools of all kinds in the government in 1898 was 2142 (87,227 boys and 17,960 girls). Poltava is divided into fifteen districts, of which the chief towns are Poltava, Gadyach (7714 inhabitants), Khorol (8390), Kobelyaki (11,936), Konstantinograd (6456), Kremenchug (58,648), Lokhvitsa (8917), Lubny (10,108), Mirgorod (10,023), Pereyaslav (14,609), Piryatin (8545), Priluki (19,055), Romny (22,539), Zenkoff (10,542), and Zolotonosha (9900). Several villages have from 7000 to 9000 inhabitants each.

Poltava, capital of the above government, is situated on the Vorskla river, 88 miles by rail west-south-west of Kharkoff. Its population was 53,060 in 1897, as compared with 41,050 in 1881. The great fair is gradually losing its importance since Kharkoff has become the centre of the wool trade. The stock at the fair was valued at only £142,880 in 1895, as compared with £2,800,000 in 1865; and the sales amounted to £110,700. Industrial establishments (flour mills and tobacco works and tanneries) give employment to 1000 persons. The town is well built, and has beautiful public and private gardens.

Polynesia.—Under this general expression are comprised three great oceanic divisions: *Melanesia* (*q.v.*), *Micronesia* (*q.v.*), and *Eastern Polynesia*, but it is to the third that, according to present usage, the term Polynesia (Polynesia proper) is commonly restricted. Between this eastern section and the two western divisions the parting line runs from New Zealand somewhat obliquely between Fiji and Tonga north-eastwards to Hawaii, but north of Fiji is deflected considerably westwards, so as to bring the Ellice and Phœnix groups within the eastern area. Polynesia proper thus lies roughly between the two tropics, dipping southwards below 30° S. to include Kermadec, and extending from about 180° to a little beyond 110° W., so as to take in the outlying Easter Island, about 400 miles from South America. A certain ethnical unity is imparted to this fragmentary oceanic world by its inhabitants, who are all without exception members of the large brown Polynesian race, and speak closely related dialects of the Polynesian stock language. But of political unity there can be no question, since the whole region has been partitioned between France, Great Britain, Germany, the United States, and the Republic of Chile. The partition began in 1841, when the Marquesas were occupied by the French, and was completed in November 1899, when Samoa was divided between Germany and the United States.

Before 1893 Hawaii (the Sandwich Islands) had been recognized as an independent kingdom by Great Britain, France, the United States, and other governments. But in that year the reigning Queen, Liliuokalani, was deposed, and after the proclamation of a republic in 1894 the archipelago was formally annexed to the United States in August 1898, and constituted the *Territory of Hawaii*. All whites, people of colour, and Hawaiian natives who were free citizens prior to the annexation, became citizens of the United States; and all who could speak, read, or write either Hawaiian (a pure Polynesian dialect) or English have the right to vote. For details, see HAWAII.

Partition of Polynesia.

In the subjoined table is shown the distribution of all the Polynesian archipelagoes and islands amongst the five above-mentioned Powers:—

	Area in Square Miles.	Population.
Great Britain:		
Kermadec	15	10
Tonga	374	17,500
Cook (Hervey)	142	8,400
Savage (Niuë)	24	5,000
Tokelau (Union)	7	1,050
Ellice (Lagoon)	14	2,400
Phœnix	16	60
Gilbert	166	35,200
Ducie	...	...
Pitcairn	2	126
Manahiki (Humphry), Tongarewa (Penrhyn), Caroline (Voslok, Flint)	12	1,000
Suvarof	2	...
Dudoza	2	...
Malden	35	170
Christmas	234	100
Fanning	15	150
Total	1,060	71,166
France:		
Tahiti	410	10,300
Moorea	50	1,600
Tuamotu	600	6,000
Marquesas	500	6,500
Gambier	...	300
Tubuai	...	1,000
Rapa	20	200
Tetiaroa	...	...
Raiatea	110	2,300
Wallis	50	3,500
Total	1,740	31,700
Germany:		
Marshall Group	150	10,000
Savaii } Samoa	600	12,000
Upolu } Samoa	250	20,000
Total	1,000	42,000
United States:		
Hawaii	6,640	109,000
Tutuila (Samoa)	180	4,000
Total	6,820	113,000
Chile:		
Easter Island	110	100
Total Polynesia	10,730	257,966

Subjoined are particulars of those Polynesian islands belonging to Great Britain which are not described in separate articles:—

Kermadec, a small group of hilly islands 500 miles north of New Zealand, named from D'Entrecasteaux's able captain, Huon Kermadec, in 1791. The largest is 12 miles round, 1600 feet high, and thickly wooded. The flora and fauna belong for the most part to those of New Zealand, on which colony the islands are also politically dependent.

Niuë, or *Savage*, a raised mass of coral rock 9 miles long, mid-way between the Tonga and Samoa groups, is very fertile, and inhabited by a mixed Polynesian and Melanesian people of Samoan speech; an intelligent Christian community, said to be increasing.

Tokelau, or *Union*, a group of three islets about 350 miles north-east of Samoa, produces little but copra; the natives are all Christians, akin to the Samoans in type and speech.

Manahiki, a scattered group, sometimes also called *Penrhyn*, lying north of Samoa about the equator, and comprising *Manahiki*, *Penrhyn*, or *Tongarewa*, *Caroline* or *Thornton*, *Suvarof*, *Flint*, *Vostok*, *Starbuck*, *Malden*, *Funafuti*, and a few other typical lagoon islets, sparsely peopled and producing a little copra and guano. There are pearl and pearl-shell fisheries at Suvarof and Penrhyn, and the natives, of Polynesian stock, are all nominal Christians.

Christmas is the largest lagoon island in the Pacific, a little north of the equator, 154° W.

Fanning and *Palmyra* are lagoon islets lying north-west of Christmas.

These last three are commonly known as the *America Islands*, because chiefly frequented by traders from the United States. There is a settlement at English Point on Fanning, where good drinking water is procurable.

Phœnix is a small scattered cluster a little south of the equator and north of Samoa, between 170° and 180° W. The rich guano deposits formerly worked by the Phœnix Guano Company have been exhausted, and all the buildings, wharves, &c., abandoned. The group appears to be now uninhabited.

Decay of the Polynesian race.

That the Polynesian race has been continuously, and in some places rapidly, decreasing since their first contact with Europeans, is the unanimous opinion of all observers. But doubts have been thrown on the current statements regarding the rate of decrease, which some good authorities believe to be not so great as is commonly represented. They hold that former estimates of the number of inhabitants in the various insular groups were mere guesswork, and often far in excess of the real facts. Thus it is pointed out that Cook's estimate of 240,000 for the Society Archipelago (Tahiti) was at the time reduced by his associate, Forster, to 150,000, so that the 300,000 credited by him to the Sandwich Islands should also be heavily discounted. That is probably true, and it may be admitted that, as a rule, the early calculations erred on the side of excess. But when full allowance is made for all such exaggerations, the following considerations will show that, except in a few small areas subject to special conditions—Lukunor in Mortlock (Carolines), Futuna in Wallis, Niuë or Savage—the falling off has been excessive both in Polynesia proper and in Micronesia. For the last-mentioned division some 50,000 must be added to the 257,966 given in the preceding table, besides 40,000 for the Maori of New Zealand, all true Polynesians, but excluded from the table as belonging to the Australian area. We should thus get a present total of 350,000, from which, however, have to be deducted some 80,000 of the inhabitants of Hawaii, where the Polynesian aborigines now number only about 30,000, all the rest being Chinese (22,000), Japanese (25,000), Portuguese (15,000), Europeans, Americans, and half-castes (20,000). Thus is reached an absolute total of 270,000 as the probable number of pure and mixed (Micronesian) Polynesians in 1900. But the careful observers George and J. R. Forster gave as a moderate estimate 650,000 at the time of Cook's last voyage (1774), showing an absolute decrease of 380,000, or about three-fourths. This conclusion is fully borne out by a detailed study of all the larger insular groups, where more accurate figures are available since the occupation of the islands by the European Powers. Thus in the Marianas the Chamorro aborigines had fallen from 50,000 or 60,000 in 1700 to less than 2000 in 1760, and the group had to be repeopled from the Philippines. Even now the whole population scarcely exceeds 10,000, mostly centred in Guam. The neighbouring Pelew Islanders, numbering 50,000 in 1800, had been reduced to 12,000 in 1880 and about 10,000 in 1900. The Tahitians, 150,000 in 1774, fell from 17,000 in 1880 to 10,300 in 1899; and in this group, while the pure stock appears to be dying out, there is a small increase amongst the half-breeds. When New Zealand was occupied (1840) the Maori were said to number 120,000, and were doubtfully stated to be still 56,000 in 1857; since then the returns of the 1881 and 1891 censuses gave 44,000 and 40,000 respectively. During the last two decades of the 19th century the decrease has been from 30,000 to 17,500 in Tonga; from 11,500 to 8400 in the Cook group; from 8000 to 3600 in Wallis; from 1600 to 1000 in Manahiki; from 1400 to 1000 in Tubuai; and from 600 to 100 in Easter Island. A general decline seems thus to be placed beyond doubt, though it may be questioned whether it is to be attributed to a decayed vitality, as some hold, or to external causes, as is the more general opinion. The prevalence of elephantiasis and the occurrence of leprosy, for instance, in Hawaii, would seem to point at least in some places to a racial taint, due perhaps to the unbridled licentiousness of past generations. On the other hand, the rapid disappearance of whole communities, as in the Marianas, and the reduction of others to one-half or even one-fourth of their former numbers, as in Tahiti and Tonga, can be accounted for only by an accumulation of outward causes, such as wars, massacres, and raidings for the Australian and South American labour markets before this traffic was suppressed or regulated. Other destructive agencies were epidemics, such especially as measles and small-pox, which swept away 30,000 Fijians in 1875; the introduction of strong drinks, including, besides vile spirits, a most pernicious concoction brewed in Tahiti from oranges; the too sudden adoption of European clothing, rendering the body supersensitive to changes of temperature; lastly, the action of over-zealous missionaries in suppressing the dances, merry-making, and free joyous life of pagan times, and the preaching of a sombre type of Christianity, with deadening effects on the buoyant temperament of these blithesome children of nature. Most of these abuses have been checked or removed, and the results may perhaps be detected in a less accelerated rate of decline, which no longer proceeds in geometric proportion, and seems even almost arrested in some places, as in Samoa and New Zealand. If such be indeed the case, perhaps the noblest of all primitive races may yet be saved from what at one time seemed inevitable extinction; and the Maori, the Samoans, and Tahitians may, like the Hawaiians, take their place beside the Europeans as free citizens of the various states of which they are now subjects. For the original home and dispersion of the Polynesian race over the Pacific Ocean, see SAMOA.

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(A. H. K.)

Polytechnics.—The word "Polytechnic" (πολύς many, and τέχνη an art) may be held to designate any institution formed with a view to encourage or to illustrate various arts and sciences. It has, however, been used with different applications in several European countries. In France the first *école polytechnique* was founded by the National Convention at the end of the 18th century, as a practical protest against the almost exclusive devotion to literary and abstract studies in the places of higher learning. The institution is described as one "où l'on instruit les jeunes gens, destinés à entrer dans les écoles spéciales d'artillerie, du génie, des mines, des ponts et chaussées, créé en 1794 sous le nom d'école centrale des travaux publiques, et en 1795 sous celui qu'elle porte aujourd'hui" (*Littré*). In

The term and its applications.

Germany there are nine technical colleges which, in like manner, have a special and industrial rather than a general educational purpose. In Switzerland, as will be found explained in the article EDUCATION, the principal educational institution, which is not maintained or administered by the communal authorities, but is non-local and provided by the Federal Government, is the Polytechnikum at Zurich. In all the important towns of the Federation there are trade and technical schools of a more or less special character, adapted to the local industries; *e.g.*, schools for silk-weaving, wood-carving, watchmaking, or agriculture. But the Zurich Polytechnikum has a wider and more comprehensive range of work. It is a college designed to give instruction and practical training in those sciences which stand in the closest relation to manufactures and commerce and to skilled industry in general.

The first polytechnics in England.

To the English public the word *polytechnic* has only recently become familiar, in connexion with some London institutions of an exceptional character. In the reign of William IV. there was an institution in London called after the name of his consort—"The Adelaide Gallery"—and devoted rather to the display of new scientific inventions and curiosities than to research or to the teaching of science. It enjoyed an ephemeral popularity, and was soon imitated by an institution called the Polytechnic in Regent Street, with a somewhat more pretentious programme, a diving-bell, electrical and mechanical apparatus, besides occasional illustrated lectures of a popular and more or less recreative character. Both of these institutions, after a few years of success, failed financially; and in 1880, Mr Quintin Hogg, an active and generous philanthropist, purchased the disused building in Regent Street, and reopened it on an altered basis, though still retaining the name of Polytechnic, to which, however, he gave a new significance. He had during sixteen years been singularly successful in gathering together young shopmen and artisans in London in the evenings and on Sunday for religious and social intercourse, and in acquiring their confidence. But by rapid degrees his enterprise, which began as an evangelistic effort, developed into an educational institution of a novel and comprehensive character, with classes for the serious study of science, art, and literature, a gymnasium, library, reading circles, laboratories for physics and chemistry, conversation and debating clubs, organized country excursions, swimming, rowing, and natural history societies, a savings bank, and choral singing, besides religious services, open to all the members, though not obligatory for any. The founder, who from the first took the closest personal interest in the students, well describes his own aims: "What we wanted to develop our institute into was a place which should recognize that God had given man more than one side to his character, and where we could gratify any reasonable taste, whether athletic, intellectual, spiritual, or social." The success of this effort was remarkable. In the first winter 6800 members joined, paying fees of 3s. per term, or 10s. 6d. per year; and the members steadily increased, until in 1900 they reached a total of 15,000. The average daily attendance is 4000; six hundred classes in different grades and subjects are held weekly; and upwards of forty clubs and societies have been formed in connexion with the recreative and social departments.

Later institutions of this class.

The precedent thus established by private initiative has since been followed in the formation of the public institutions which, under the name of "Polytechnics," have become so prominent and have exercised such beneficent influence among the working population of London. It has been shown in the article on EDUCATION that the principal resources for the foundation and maintenance of these institutions have been derived from two funds—that administered under the City Parochial Charities Act of 1883, and that furnished to the London County Council under the terms of the Local Taxation (Customs and Excise) Act of 1890. More detailed reference to these two Acts seems to be necessary in this place.

The City Parochial Charities Act.

The Royal Commission of Inquiry into the Parochial Charities of London was appointed in 1878, mainly at the instance of Mr James Bryce, and under the presidency of the Duke of Northumberland. Its report appeared in 1880, giving particulars of the income of the parishes, and revealing the fact that the funds had largely outgrown the original purposes of the endowments, and were ill adapted to the modern needs of the class for whose benefit they were intended. The Act of Parliament of 1883 was designed to give effect to the recommendations of the Commissioners. It provided that while five of the largest parishes were to retain the management of their own charitable funds, the endowments of the remaining 107 parishes in the City should be administered by a corporate body, to be entitled "the Trustees of the London Parochial Charities," this body to include five nominees of the Crown and four of the Corporation of London. The remaining members were to be chosen under a subsequent scheme of the Charity Commission, which added four nominees of the London County Council, two of the Ecclesiastical Commissioners, and one each by the University of London, University College, King's College, the City and Guilds Institute, and the governing body of the Bishopsgate and the Cripplegate foundations. For the purpose of framing the scheme, a special commissioner, Mr James Anstie, Q.C., was temporarily attached to the Charity Commission, and it thus became the duty of the Commission to prepare a statement of the income possessed by the 107 parishes, distinguishing between the secular and the ecclesiastical parts of the endowments. The value of the estates and stocks rendered available for the purposes of the scheme amounted to £1,590,442; the annual income derived from the ecclesiastical fund was £35,000, and that from the secular portion of the fund £50,000. The scheme assigned capital grants amounting to £155,000 to the provision of open spaces, and £149,500 to various institutions, including free libraries in Bishopsgate and Cripplegate, the People's Palace, the Regent Street and Northampton Institutes, and the Victoria Hall. A capital sum of £49,355 out of the ecclesiastical fund was devoted to the repair of City churches; and the balance of this fund, after allowances for certain vested interests, was directed to be paid annually to the Ecclesiastical Commissioners. This balance has varied by slight increases from year to year, and amounted in 1899 to £11,545. The remaining fund thus set free for secular purposes was by the scheme largely devoted to the erection and maintenance of polytechnic institutions, or "industrial institutes," as they were at first called. It was the opinion of Mr Anstie and his fellow-commissioners that in this way it would be possible to meet one of the most urgent of the intellectual needs of the metropolis, and to render service nearly akin to the original purposes of the obsolete charitable endowments.

A typical scheme under the Act.

The general scope and aims of the institutions thus contemplated by the Commissioners are defined in the scheme for the Borough Road (Southwark) Polytechnic, which may be taken as a fairly typical example of the rest:—

The object of this institution is the promotion of the industrial skill, general knowledge, health, and well-being of young men and women belonging to the poorer classes by the following means:

I. Instruction in—

(*a*) The general rules and principles of the arts and sciences applicable to any handicraft, trade, or business.

(*b*) The practical application of such general rules and principles in any handicraft, trade, or business.

(*c*) Branches or details of any handicraft, trade, or business, facilities for acquiring the knowledge of which cannot usually be obtained in the workshop or other place of business.

The classes and lectures shall not be designed or arranged so as to be in substitution for the practical experience of the workshop or place of business, but so as to be supplementary thereto.

II. Instruction suitable for persons intending to emigrate.

III. Instruction in such other branches and subjects of art, science, language, literature, and general knowlege as may be approved by the governing body.

IV. Public lectures or courses of lectures, musical and other entertainments, and exhibitions.

V. Instruction and practice in gymnastics, drill, swimming, and other bodily exercises.

VI. Facilities for the formation and meeting of clubs and societies.

VII. A library, museum, and reading room or rooms. Within the limits prescribed, the governing body may from time to time, out of the funds at their disposal, provide and maintain buildings and grounds, including workshops and laboratories suitable for all the purposes herein specified, and the necessary furniture, fittings, apparatus, models, and books, and may provide or receive by gift or on loan works of art or scientific construction, or objects of interest and curiosity, for the purpose of the institute, and for the purpose of temporary exhibition.

Other provisions in the scheme require: (1) that the educational benefits of the institute shall be available for both sexes equally, but that common rooms, refreshment rooms, gymnasia, and swimming-baths may be established separately, under such suitable arrangements as may be approved by the governing body; (2) that the fees and subscriptions shall be so fixed as to place the benefits of the institute within the reach of the poorer classes; (3) that no intoxicating liquors, smoking, or gambling shall be allowed in any part of the building; (4) that the buildings, ground, and premises shall not be used for any political, denominational, or sectarian purpose, although this rule shall not be deemed to prohibit the discussion of political subjects in any debating society approved by the governing body; (5) that no person under the age of sixteen or above twenty-five shall be admitted to membership except on special grounds, and that the number thus specially admitted shall not exceed 5 per cent. of the total number of members.

The Technical Board of the London County Council. These and the like provisions have formed the common basis for all the metropolitan polytechnics. When in 1890 a large sum was placed by the Local Taxation Act (Customs and Excise) at the disposal of the county and county borough councils for the general purposes of technical and secondary education, the London County Council determined to devote a considerable portion of this revenue to the further development and sustentation of polytechnics. While the funds granted by the City Parochial Trustees may be employed in aid of the social and recreative as well as the educational purposes of the various institutes, it was decided by the County Council that the sums contributed by its Technical Board should be applied to educational work only.

Dr Garnett, the secretary and educational adviser of the Technical Board of the London County Council, has, in a published lecture delivered before the International Congress on Technical Education in June 1897, thus described the conditions under which that Board offers financial help to the London polytechnics:—

The objects which the Technical Education Board has had in view in its dealings with the polytechnics have been:—

1. To allow to the several governing bodies the greatest possible freedom in the conduct of social, recreative, and even religious work within the provisions of the schemes of the Charity Commissioners.

2. To secure to each polytechnic the services of an educational principal, who should be responsible to his governing body for the organization and conduct of the whole of the work of the institution.

3. To provide in each polytechnic a permanent staff of teachers, who should be heads of their respective departments and give their whole time to the work of the institution, and thus to establish a corporate or collegiate life in the polytechnic.

4. To ensure that all branches of experimental science are taught experimentally, and that the students have the opportunity of carrying out practical laboratory work, at an inclusive fee not exceeding ten shillings for any one subject.

5. To provide efficient workshop instruction in all practical trade subjects.

6. To secure that the number of students under the charge of any one teacher in laboratory or workshop classes, or in other classes in which personal supervision is of paramount importance, shall not exceed a stated limit (fifteen in the workshop, or twenty in the laboratory).

7. To exclude from classes students who, for want of preliminary training, are incapable of profiting by the instruction provided; and to this end to restrict the attendance at workshop classes to those who are actually engaged in the trades concerned, and have thus opportunities of acquiring the necessary manual dexterity in the performance of their daily duties.

8. To furnish an adequate fixed stipend for all teachers, in place of a contingent interest in fees and grants.

9. To encourage private subscriptions and donations.

10. To establish an efficient system of inspection.

11. To facilitate the advertisement of polytechnic classes, and especially to invite the co-operation of trade societies in supporting their respective classes.

12. To encourage the higher development of some special branch of study in each polytechnic.

13. To utilize the polytechnic buildings as far as possible in the day time by the establishment of technical day schools, or otherwise.

14. To secure uniformity in the keeping of accounts.

In furtherance of these objects, the Technical Education Board has offered to each polytechnic—

(*a*) Such equipment grants as may from time to time be made by the Board for specific purposes on the application of the governing body.

(*b*) A fixed contribution of £1000 a year.

(*c*) Three-fourths (not exceeding £500 a year) of the stipend of the educational principal.

(*d*) Ten per cent. on the fixed salaries of the teachers.

(*e*) One penny for each hour's attendance of each student.

(*f*) Fifteen per cent. on all voluntary subscriptions and donations from private sources.

Provided that the total payment to any polytechnic in any one year under (*b*), (*c*), (*d*), and (*e*) does not exceed £3000, and under (*f*) does not exceed £2000.

London Polytechnic Council. With a view to a due division of labour, and also to the co-operation of the public bodies concerned, the "London Polytechnic Council" was created in 1894. It is composed of representatives of the City Parochial Trustees, the Technical Education Board of the London County Council, and the City and Guilds of London Institute, and its duty is to consult together as to the appropriation of funds, the organization of teaching, the holding of needful examinations, and the supervision of the work generally. The statement on the following page shows the number and names of the several institutions, and the extent to which they have been severally aided by the trustees of the two funds.

The People's Palace. The "People's Palace" owes its origin in part to the popularity of a novel by Sir Walter Besant, entitled *All Sorts and Conditions of Men*, in which the writer pointed out the sore need of the inhabitants of East London for social improvement and healthy recreation, and set forth an imaginary picture of a "Palace of Delight," wherein this need might be partly satisfied. Much public interest was awakened, large subscriptions were given, and the trustees of the Parochial Charities Fund aided the project; but the munificence of the Drapers' Company in setting aside £7000 a year for its permanent maintenance has released the London County Council from any obligation to make a grant out of its technical fund. Apart from the social and recreative side of this popular institution, the educational section, under the name of the East London Technical College, has steadily increased in numbers and influence since it has enjoyed the fostering care of the Drapers' Company.

	Grants from City Parochial Charities.		Grants from London County Council.	
	For Building.	For Annual Maintenance.	For Building and Equipment.	For Annual Maintenance.
	£	£	£	£
1. The City Polytechnic, including—	...	...	...	2000
*(a) Northampton Institute	45,000	4700	2240	2195
(b) The Birkbeck Institute	...	1250	600	1245
(c) City College, Moorfields	...	1500	150	545
*2. East London Technical Institute (People's Palace)	6,750	3650	...	...
*3. Regent Street Polytechnic	11,750	5350	250	4659
*4. Battersea Polytechnic	...	3750	760	3488
*5. Borough Polytechnic	...	3750	6050	5269
*6. Northern Polytechnic, Holloway	...	3000	1000	3482
7. Victoria Hall (Morley College)	6,000	1500	...	...
*8. Woolwich Polytechnic	...	1500	600	2797
*9. South-Western Polytechnic, Chelsea	...	2750	1800	4966
*10. Sir John Cass's Polytechnic, Aldgate	...	1500	...	...
*11. Goldsmiths' Institute, New Cross	...	...	...	...

The institutions marked thus * are fully equipped, and are the best examples of polytechnics in the stricter sense of the term.

The Birkbeck Institute and the City College are older institutions, which have been long very successful rather with educational than with social work. By the scheme of the Commissioners they have been federated with the Northampton Institute, a large and fully equipped establishment of the best modern type, with unusual provision for recreation and for workshop training. The three institutions together form the City Polytechnic.

The Goldsmiths' Institute in like manner owes its existence and its annual maintenance to the generous initiative of the ancient City Guild whose name it bears. It is therefore entirely independent of pecuniary subsidy from any other public body. In the year 1900 the number of class entries to the institute at New Cross was 7574. The Clothworkers' Company has also contributed £18,000 to the Northern Polytechnic at Holloway.

Aims and methods.

In all these institutions the general aims have been practically the same, although special features have been differentiated in order to meet the local needs and the wishes of the inhabitants. In all there are laboratories and lecture rooms, trade classes, art studios, gymnasia, provision for manual training and domestic economy, and applied science. In nearly all, at first, mechanical and manual instruction were the prominent objects in view, partly owing to the conditions under which grants were made by the Science and Art Department of the Board of Education. But of late increased attention has been paid year by year to literary and humaner studies, and to general mental cultivation, pursued *pari passu* with technical and scientific training. The aid of the London organization for University Extension has been especially serviceable in providing courses of lectures and classes in literary subjects at nearly all of the polytechnics. As subsidiary to their main work, each of them has established a junior continuation school, with a view to provide suitable instruction for scholars who have left the public elementary schools and are not yet prepared to enter the technical and trade classes. Although the workshops and the classes for artisans are used chiefly in the evenings, there is an increasing number of day students: *e.g.*, in the Birkbeck Institute, classes in natural science, mathematics, and languages; at Chelsea, a domestic economy school and an arts school; at the East London Technical College and at Regent Street, engineering departments; at the Goldsmiths' Institute, a "Commercial and Civil Service" department, largely attended by young women; at Battersea, regular day classes for mathematics, building and machine construction, wood work, and metal work. In short, the schemes of the several institutions are so elastic that the governing bodies are at liberty to open any classes or to try any educational or recreative experiment for which they can find a genuine local demand.

It is computed by Dr Garnett that the sites, buildings, and equipment of the London polytechnics represent a total capital outlay of £500,000, and that the annual revenue required for their sustentation is about £120,000. Of this sum about one-fourth is contributed by the City Parochial Charities, one-fourth by the Technical Education Board, one-fourth by the fees of students and members, and the remaining fourth by the subscriptions of the City Guilds and the grants received from the Science and Art Department of the Board of Education. The total number of scholars in the polytechnics and their branch institutions is variously estimated at from 40,000 to 50,000, and the total number of regular scholars in the evening schools of the London School Board does not exceed 100,000. These figures may be usefully compared with the census returns, which show that within the Metropolitan area there are 704,414 young persons between the ages of thirteen and twenty-one. It is a noteworthy fact, that whereas in the population statistics for the whole of England and Wales the number at each year of age is regularly diminished by death from eight years onwards, there is a steady increase in London, year by year, from fourteen up to the age of thirty. This fact is owing to the constant immigration of young men and women from the provinces to the metropolis. The Census Commissioners in their report for 1901 (p. 15) compute that more than one-third of the population of London are not natives. They show also that, if all England and Wales be taken together, the number of persons between twenty and twenty-one is less by 12·8 per cent. than the number between thirteen and fourteen; but that, taking London alone, the number of persons between twenty and twenty-one is greater by 14·4 per cent. than the number between thirteen and fourteen. Hence the proportion of the inhabitants who are of an age to benefit by polytechnics and continuation schools is in London exceptionally large. It would not be right for Londoners to complain that there is thus cast upon them the duty of providing suitable instruction for so many immigrants, for if the great city drains the rural districts of some of their best brain and muscle, she gains much from their industry and productive power.

But it follows from the particulars thus given that at present neither the supply of suitable provision for mental improvement and rational recreation for the wage-earning classes, nor the demand for such provision on the part of the workers themselves, is commensurate with the moral and intellectual needs of a community of nearly seven millions of people. The provision in evening schools, institutes, classes, and polytechnics is still far inferior to that which is to be found in most German and Swiss towns, and needs to be greatly increased. In matters relating to the higher life, demand does not always precede supply; it is supply which is needed not only to satisfy the public demand, but to create it. As new and well-devised opportunities for mental culture are placed within reach, they will be more and more appreciated, new and healthier appetites will be stimulated, the art of employing leisure wisely and happily will be more systematically studied, and the polytechnics will become still more important centres of civilizing and educating influence than they have already become.

In particular, the reconstituted University of London will probably be placed in new and most helpful relation to the best of the polytechnics. By the statutes which have recently come into force, the Senate of the University is empowered to include in the list of "schools of the University" all institutions which are duly equipped and able to furnish suitable instruction of an advanced and scholarly type; and also to recognize all thoroughly qualified professors in their several faculties and subjects as "teachers of the University," although some of their classes may meet in the evening only. There is thus a way open for the due admission of the best polytechnics to the University, and for the recognition of the best students as undergraduates, with all the rights of internal students. At present the great possibilities of the metropolitan University under its new conditions are hardly revealed or accurately foreseen. But it is probable that while the greater and older colleges of the University—such as University and King's—will devote their efforts largely to such post-graduate lectures and intellectual and scientific research as are the special province of the higher order of professors, most of the aid required by the ordinary undergraduate will be provided in institutions of minor rank, officered by experienced and well-accredited teachers, who are fully able to give the needful instruction and preparation for a degree in arts and science. The best of the polytechnics are already competent, both as regards their staff and their equipment, to perform this task adequately, and thus to become integral parts of the London University of the future. There is no reason to fear that the recreative, social, manual, and industrial training, to which at first the special attention of the founder was directed, will suffer from a fuller expansion of the academic and literary side of "polytechnic" life. Rather it may be hoped that the due co-ordination of the practical with the purely intellectual purposes of these institutions will serve to give to all the students, whatever their future destination may be, a truer and broader conception of the value of mental culture for its own sake.

See also a paper by Mr SIDNEY WEBB, *The London Polytechnic Institutes*, in the second volume of special reports on educational subjects (1898) issued by the Education Department; the *Report of the Central Governing Body* (1900) *of the London Parochial Charities*; the *Annual Reports* and the *Monthly Gazette of the Technical Board of the London County Council*; the *Polytechnic Magazine*, published from time to time at the institute in Regent Street; and various memoirs and papers contained in the *Proceedings of the International Congress on Technical Education* (1897), especially two—that by Mr QUINTIN HOGG, detailing his own early experience in founding the first polytechnic, and that of Dr WILLIAM GARNETT, the secretary of the Technical Education Board. (J. G. F.)

Polyzoa.—The researches of the last few years have gone far to show that the classification adopted in the earlier volumes (9th edition) of this *Encyclopædia* can no longer be accepted. *Cephalodiscus* and *Rhabdopleura*, then regarded as constituting the Section PTEROBRANCHIA, have been proved to possess unexpected resemblances to Balanoglossus. *Phoronis*, the solitary member of the Section Vermiformia, appears to have affinities in the same direction. By the removal of these two Sections to another group (see HEMICHORDA), the remaining Section, Eupolyzoa, acquires the same limits as the Class Polyzoa, and the term Eupolyzoa hence becomes unnecessary. The Class Polyzoa as thus restricted includes only the Subclasses *ENTOPROCTA* and *ECTOPROCTA*. The recent Ectoprocta are divided into A. GYMNOLAEMATA, with the Sub-orders CYCLOSTOMATA, CHEILOSTOMATA, and CTENOSTOMATA; and B. PHYLACTOLAEMATA.

The association of the Polyzoa with the Sipunculoidea and the Brachiopoda in a phylum Podaxonia rested mainly on the belief that *Phoronis* is an annectant form between the three groups. Delage and Hérouard introduce the term Vermidia as the name of a group including the Gephyrea in the widest sense, with the Polyzoa, Pterobranchia, Rotifera, Gastrotricha, Kinorhyncha, Chaetognatha, and Brachiopoda. The Polyzoa here occupy a central position, leading through *Phoronis* and the Sipunculoidea to the remaining Gephyrea, and in other directions to the Brachiopoda, the Pterobranchia, and the Rotifera respectively; the last being believed to lead to the Gastrotricha, Kinorhyncha, and Chaetognatha. Cori, basing his views principally on the excretory organs of fresh-water Polyzoa (Phylactolaemata), supports the association of *Phoronis* with the Polyzoa; but it may be noted that the Phylactolaemata are in certain respects highly specialized forms, whose peculiarities are not likely to have an ancestral significance. Hatschek separates the Entoprocta from the Ectoprocta as a division of his group Scolecida, characterized by the possession of a primary body-cavity and of protonephridia, the Ectoprocta being placed in a group Tentaculata, which nearly corresponds with the Molluscoidea after the removal of the Tunicata. Against this view may be urged the essential similarity between the processes of budding in Entoprocta and Ectoprocta (cf. Seeliger, *Zeitschr. wiss. Zool.* xlix. 168; l. 560), and the resemblances in the development of the two groups. These instances will show the wide discrepancies which exist between current views. Without disputing the possibility that the Polyzoa are distantly related to other animals, it will be best to regard them as an isolated Class which is not proved to have close affinities to any other group.

Adult Structure and Vital Phenomena.—The general account of the adult structure, habits, &c., of the Eupolyzoa given in the earlier volumes is still valid, though certain points, which were then imperfectly understood, have since been investigated more thoroughly. The problematical "intertentacular organ" (Fig. 1, *int.*) of Farre has been considerably elucidated by Prouho (*Arch. Zool. Exp.*(2) x. 557). In *Alcyonidium duplex* a male "polypide" (= alimentary canal, tentacles, &c.) occurs in a "zoœcium" (= body-wall) and produces spermatozoa, though it has no intertentacular organ. It then degenerates to the condition of a "brown body," its place being taken by a new polypide, produced as a bud, which develops ova. The female polypide is provided with an intertentacular organ, a tubular passage from the body-cavity to the exterior, situated between the bases of the tentacles on the anal side; and through this passage the eggs pass into the tentacle-sheath. The structure plays the part of an oviduct

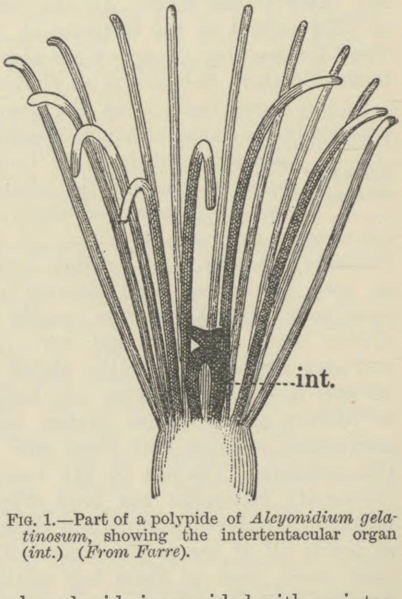

FIG. 1.—Part of a polypide of *Alcyonidium gelatinosum*, showing the intertentacular organ (*int.*) (*From Farre*).

in three species investigated by Prouho, although there is evidence that spermatozoa and fragments of brown bodies may also be evacuated by the same passage. The external opening of the excretory organs described in some Phylactolaemata may be a homologous structure. These organs (see Verworn, *Zeitschr. wiss. Zool.* xlvi. p. 114; Braem, *Bibl. Zool.* ii. Heft 6, p. 51; Cori, *Zeitschr. wiss. Zool.* lv. p. 626; Oka, *J. Coll. Japan*, iv. p. 108; viii. p. 339) are specially ciliated portions of the lophophore-cavity (a space which is incompletely separated from the principal body-cavity), at the regions where its two halves unite on the distal side of the cavity of the epistome, at the base of the anal tentacles. The "oral glands" of certain Cheilostomata, developed in connexion with the distal end of the tentacle-sheath, are believed by Waters to be excretory in their nature; but they cannot be regarded as corresponding in any way with the organs just mentioned. The body-cavity of Gymnolaemata is not lined by a ciliated epithelium; and it is, indeed, seldom possible to distinguish a cœlomic epithelium of any kind in the adult zoœcium. The structure of the Phylactolaemata has been further elucidated by the researches of Kraepelin (*Abh. Ver. Hamburg*, x. No. ix.; xii. No. ii.), Braem (*loc. cit.*), Cori (*loc. cit.*), and Davenport (*Bull. Mus. Harvard*, xx. p. 101). Wesenberg-Lund (*Vidensk. Meddel. Copenhagen*, 1896, p. 253) gives interesting information regarding their biology. The form of *Plumatella* known as *Alcyonella fungosa* is usually the result of the simultaneous germination of numerous sessile statoblasts, whereby a composite colony results and the crowded tubes take on their characteristic parallel arrangement. Colonies which persist through several years may show distinct annual rings of growth. The statoblasts are said to be derived partly from an ectodermic core of the funiculus, and partly from its external mesoderm (Braem, *loc. cit.*), the former giving rise to the chitinous envelope and to a nucleated layer (Fig. 2, *ect.*) immediately inside the chitin, which later invaginates to form the inner vesicle of the polypide-bud. The mesodermic portion becomes charged with a yolk-like material (*y*), and, on the germination of the statoblast, gives rise to the outer layer (*mes.*) of the bud. The production of a polypide by the statoblast thus differs in no essential respect from the formation of a polypide in an ordinary zoœcium. The statoblasts require a period of rest before germination, and Braem has shown that their property of floating at the surface may be beneficial to them, by exposing them to the action of frost, which in some cases improves the germinating power. The occurrence of Phylactolaemata in the tropics (see Meissner, *Zool. Anz.* xx. 173) would show, however, without further evidence, that frost is by no means a factor essential for germination. Important memoirs have been published on the structure of the Entoprocta, of which those by Foettinger (*Arch. Biol.* vii. 299), Ehlers (*Abh. Ges. Göttingen*, xxxvi.), Davenport (*Bull. Mus. Harvard*, xxiv. p. 1), and Prouho (*Arch. Zool. Exp.* (2) ix. p. 91) may be specially mentioned. There is no confirmation of the view that the lophophore of *Pedicellina* has the structure indicated in Fig. 15 c of the article in *Ency. Brit.* vol. xix. p. 438. The budding of Polyzoa has been studied by Seeliger (*loc. cit.*), who finds, with most others who have investigated this subject, that the polypide-bud is derived from ectoderm and mesoderm only (see, however, Calvet, *C. R.* cxxvii. pp. 79, 194). Ladewig (*Zeitschr. wiss. Zool.* lxvii. p. 323) controverts Calvet's statements. The ectoderm forms the inner layer of the two-layered vesicle, and gives rise to the lining of the tentacle-sheath ("kamptoderm," Kraepelin), the ganglion, and the whole of the epithelium of the alimentary canal. The mesoderm constitutes the outer layer, and forms the muscles, the reproductive organs, and other structures. The periodical histolysis of the polypide, leading to the formation of a "brown body," may partly be due to the accumulation of excretory substances in the cells of the alimentary canal (Harmer, *Quart. J. Micr. Sci.* xxxiii. p. 123); but the effects of artificially introduced pigments (indigo-carmine, &c.) suggest that the excretory function is in part performed by some of the mesodermic tissues.

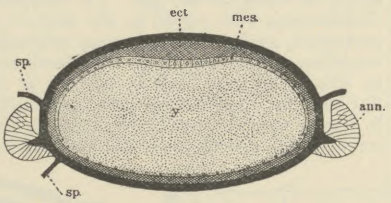

FIG. 2.—Section of a germinating statoblast of *Cristatella mucedo*:—*ann.*, chitinous annulus, containing air-cavities, which enable the statoblast to float; *ect.*, thickened part of the ectoderm, which will give rise to the inner layer of the polypide-bud; *mes.*, mesoderm, forming the outer layer of the bud; *sp.*, anchoring spines of the statoblast; *y*, the yolk-like mesodermic mass of the statoblast. (*After Braem.*)

Development.—The eggs are rarely laid (*Cyphonautes* type), but in the great majority of cases undergo their early development in some part of the parent. The vestibule of the adult may be employed as a brood-chamber (Entoprocta, *Alcyonidium duplex*); the eggs may pass into the tentacle-sheath of a degenerated polypide, or even develop in the body-cavity (Prouho, *Arch. Zool. Exp.* (2) x. p. 625); but in a large proportion of the marine forms they develop in ovicells. The ovicell of the Cheilostomata is a derivative of a zoœcium, and is usually situated just above the orifice, while that of the Cyclostomata is a modified zoœcium. The egg may be without yolk, but it commonly possesses a moderate quantity of yolk, which, however, does not interfere with the regularity of the segmentation. Two polar bodies have been observed in some cases. Some of the details of fertilization have been made out in Phylactolaemata (Kraepelin, *loc. cit.*). The segmentation of the egg of marine Ectoprocta is remarkably regular, and leads to the formation of a hollow blastula. The endoderm is formed by invagination; and in *Cyphonautes* (Prouho, *loc. cit.*) it gives rise to the mid-gut; the stomodaeum being represented by the large vestibule, and the anus being formed as a proctodaeum. The origin and complete history of the mesoderm have not been satisfactorily made out in Ectoprocta. There is hence no embryological evidence that the large body-cavity which characterizes these forms is to be regarded as a space which precisely corresponds with that of other "Coelomata"; and it is not impossible that it may have been evolved by the enlargement of the space between the alimentary canal and the skin in the Entoprocta, in order to permit of the complete retraction of the part of the body which bears the tentacles. The stages which succeed the completion of segmentation are much obscured in most Ectoprocta. This depends on the facts that no functional alimentary canal is developed by the larva, and that the larval organs are merely of a temporary nature, destined to be profoundly modified by the complicated metamorphosis which follows fixation. The larva of *Pedicellina* (the epistome of which must be regarded as ventral) fixes itself by its *oral* surface (Barrois, *Ann. Sci. Nat.* (7), i. No. 1; Harmer, *Quart. J. Micr. Sci.* xxvii. p. 239), and the mouth and anus are carried away from the plane of fixation by a rotation of the entire alimentary canal about an axis cutting the middle of the two sides through an angle of 180°. This movement is permitted by the histolysis of most of the larval vestibule; part of this passes to the side remote from the object on which fixation has taken place, and there forms the adult vestibule, by acquiring a new opening to the exterior. The "ciliated disc" and the cephalic ganglion atrophy during the metamorphosis. This is the only case in which the larval digestive apparatus is known to become that of the primary individual of the colony.

The *Cyphonautes* larva, distinguished by the possession of a functional alimentary canal, was formerly supposed to be peculiar to the Cheilostome genus *Membranipora*, but has been shown by Prouho (*loc. cit.*) to occur in *Alcyonidium* and *Hypophorella* among the Ctenostomata. The marked similarity between the *Cyphonautes* larvae of these three genera, which have no special connexion with one another, may indicate that the larva itself has a phylogenetic significance; it may, in fact, be regarded as a modification of the Entoproct larva. Fixation takes place, as in the Entoprocta, by the oral surface, and is effected by the eversion of a special organ ("sucker" or "internal sac") which opens to the exterior, between the mouth and the anus. The alimentary canal undergoes histolysis (Ostroumoff, *Arch. Slaves Biol.* ii. p. 333). In larvae of the type shown in *Ency. Brit.* vol. xix. p. 440, fig. 20, the alimentary canal may still be recognizable (Harmer, *Arch. Zool. Exp.* (2) v. p. 443), though it is no longer functional; *st* is the internal sac, and *m?* is a problematical larval structure known as the "pyriform organ" (*x* in fig. 21). The vestigial mouth is situated between *st* and *m?* The metamorphosed larva of the Ectoprocta becomes the primary zoœcium of the colony. Its definitive alimentary canal is developed in the same way as that of any of the secondary zoœcia formed by budding; that is to say, by the formation of a polypide-bud, which appears on the aboral surface, and therefore in the position finally acquired by part of the larval vestibule, with the alimentary canal, of the fixed larva of *Pedicellina*.

The spermatogenesis, oogenesis, and development of Phylactolaemata are described by Kraepelin (*loc. cit.*) and Braem (*Bibl. Zool.* Bd. x. Heft 23). The ovum is taken up by a special polypide-bud which grows into a protecting envelope for the embryo, the early development of which somewhat resembles that of the Cyclostomata. Larval organs are hardly represented, and the embryo, before birth, becomes a zoœcium, with one, two, three, or more polypides, produced as buds from its two-layered body-wall. After a short period, during which it swims by means of its uniformly ciliated ectoderm, it fixes and forms a new colony. This type of development may be regarded as a further modification of that found in Gymnolaemata. The Cyclostomata are characterized by the occurrence of a remarkable process of embryonic fission (Harmer, *Quart. J. Micr. Sci.* xxxiv. p. 199; xxxix. p. 71; xli. p. 73), which is most nearly paralleled in certain Hymenopterous insects (Marchal, 1898), and by the fact that eggs which actually develop are restricted to a few individuals of the colony. A zoœcium in which the egg develops becomes an ovicell; it differs to a conspicuous extent from the other individuals of the colony, and often acquires a complicated form. Its orifice ("oœciostome") is valuable for the discrimination of the species.

Classification. — The existing classifications of the Cheilostomata, the largest division of recent Polyzoa, will probably be much modified when the details of their anatomy are more fully worked out. It may be expected that the arrangements in connexion with the protrusion and retraction of the polypide will prove to give important indications of affinities. The view that the characters of the front wall (that on which the operculum is situated) of the Cheilostomata is of primary importance in the classification of this group, has already been maintained by Jullien. The retracted polypide of the Ectoprocta (Fig. 3) lies in a cavity which contains a considerable quantity of fluid and is bounded by the body-wall. The protrusion of the tentacles and other parts of the polypide implies the temporary removal of some of the organs in the body-cavity. It is possible to imagine two methods by which this movement can be permitted without producing a partial vacuum in the body-cavity. The body-wall must either be flexible, so that the volume of the zoœcium may diminish when the polypide is protruded; or, in cases in which the body-wall is rigid, there must be some arrangement by which the amount of fluid it contains can be altered from time to time, in order to permit of the free movements of the polypide. In the Phylactolaemata the body-wall is muscular, and can thus exert a pressure on the fluid of the body-cavity sufficient to cause protrusion. In the Gymnolaemata the body-wall is not muscular, and protrusion of the polypide is effected by the contraction of the parietal muscles (*p.m.*), which pass freely across the body-cavity from one part of the body-wall to another. In the more delicate branching Ctenostomes (Vesicularina) the entire body-wall is flexible, so that the contraction of a parietal muscle acts equally on the two points of the body-wall with which it is connected. In encrusting Ctenostomes (Alcyonellea) and in the *Membranipora*-like Cheilostomes (Figs. 3, 4, A) the zoœcia are attached by their basal wall and united to one another by their vertical walls, so that the free surface or front wall is the only one in which any considerable amount of movement can take place. The parietal muscles (*p.m.*), which pass from the vertical walls to the front wall, thus act by depressing the latter and so exerting a pressure on the fluid of the body-cavity, as shown to be the case by Nitsche in 1871. This explanation of the movement will obviously not apply to Cheilostomata in which the front wall is rigid; and in 1888 Jullien showed that the protrusion and retraction were rendered possible by the existence of a "compensation-sac," lying inside the body-cavity and in communication with the external water (*Bull. Soc. Zool. France*, xiii. p. 67).

A renewed investigation of this subject proves that this sac is present in a considerable number of the Cheilostomata. In its most fully developed condition (Figs. 3, 4, C, *c.s.*) it is a large cavity, with delicate walls of great tenuity, which lies beneath the calcified front wall of the zoœcium, and opens to the exterior at the proximal border of the chitinous operculum (Fig. 5, C). This structure is not hinged to the calcareous wall which is adjacent to its base-line, but it is continuous with the floor of the compensation-sac, a passage by which water can pass in and out of the sac existing between its base and the calcareous body-wall. The sac is joined to the rigid body-wall by numerous muscle-fibres, the contraction of which must therefore exert a pressure on the fluid of the body-cavity in which the sac lies. The comparison of various genera of Cheilostomes with regard to the method in which the polypide is protruded, leads to the following conclusions. The most primitive condition is that shown in the Membraniporidae, Flustridae, &c., in which the front wall is entirely or partially membranous or flexible, the membranous part constituting the "aperture" (Fig. 5, A, *ap.*), so called from the fact that its disappearance in fossil forms leaves a wide opening into the body-cavity. The parietal muscles

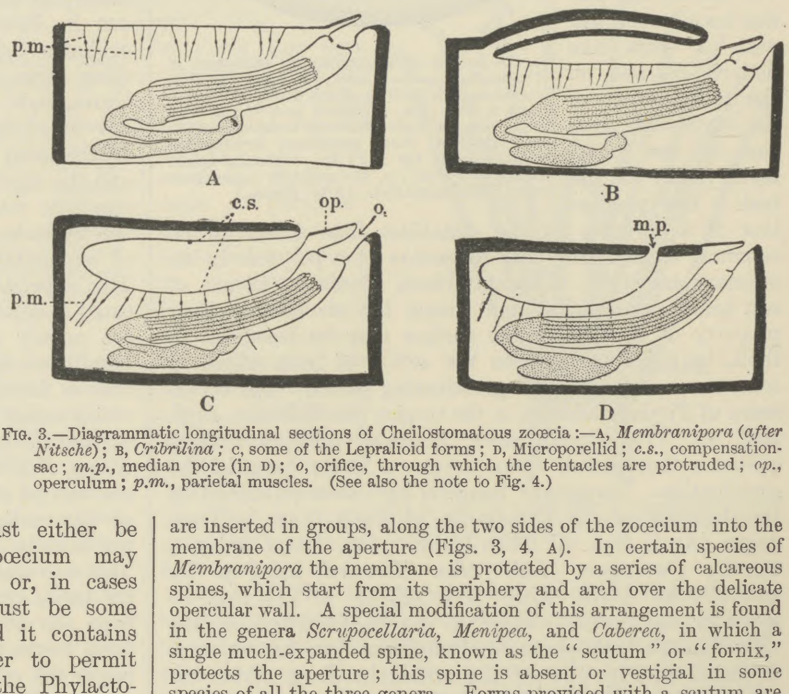

FIG. 3.—Diagrammatic longitudinal sections of Cheilostomatous zoœcia:—A, *Membranipora* (*after Nitsche*); B, *Cribrilina*; C, some of the Lepralioid forms; D, Microporellid; *c.s.*, compensation-sac; *m.p.*, median pore (in D); *o*, orifice, through which the tentacles are protruded; *op.*, operculum; *p.m.*, parietal muscles. (See also the note to Fig. 4.)

are inserted in groups, along the two sides of the zoœcium into the membrane of the aperture (Figs. 3, 4, A). In certain species of *Membranipora* the membrane is protected by a series of calcareous spines, which start from its periphery and arch over the delicate opercular wall. A special modification of this arrangement is found in the genera *Scrupocellaria*, *Menipea*, and *Caberea*, in which a single much-expanded spine, known as the "scutum" or "fornix," protects the aperture; this spine is absent or vestigial in some species of all the three genera. Forms provided with a scutum are probably related to one another, and they are usually characterized by the high development of avicularia or vibracula. Cheilostomata first become common in Cretaceous strata, in which a large propor-

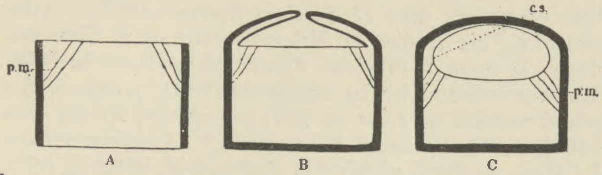

FIG. 4.—Diagrammatic transverse sections:—A, of *Membranipora;* B, of an immature zoœcium of *Cribrilina;* C, of a Lepralioid form [1]; *c.s.*, compensation-sac; *p.m.*, parietal muscles.

tion of the genera belong either to the Membraniporidae or to a family known as the Cribrilinidae, which is represented at the present time by the genera *Membraniporella* and *Cribrilina.* In these a series of calcareous spines are formed, in the young zoœcium (Fig. 4, B), round the membranous aperture, as in the species of *Membranipora*

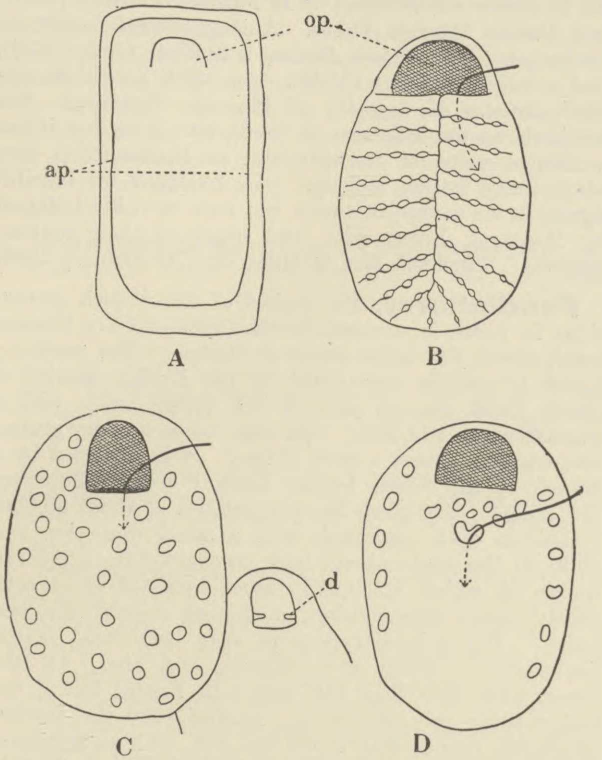

FIG. 5.—Zoœcia of A, *Membranipora;* B, *Cribrilina;* C, *Lepralia;* D, *Microporella.* The arrow shows the entrance to the compensation-sac in B, C, and D; in D passing through the "median pore"; *ap.*, "aperture," or membranous front wall (in A); *d.*, the "denticles," forming the hinge of C (seen after the removal of the operculum); *op.*, operculum.

referred to above. While in these latter the spines remain free from one another, they unite to a greater or less extent in the Cribrilinidae (Fig. 5, B), thereby forming a secondary front wall pierced by slits or rows of pores, corresponding with the intervals between the original spines. The operculum retains its connexion with the membranous aperture (Fig. 3, B), into which the parietal muscles are still inserted. The condition found in a certain proportion of existing Cheilostomes is probably a further development of the Cribrilinidan arrangement. The original spines are no longer distinct in ontogeny, but are represented by the calcareous wall, which is usually pierced by irregular pores (Fig. 5, C), now filled with living protoplasmic structures, instead of by the regularly arranged slits or pores of most Cribrilinidae. This conclusion is arrived at by the study of the compensation-sac (Figs. 3, 4), the floor of which is seen to correspond with the aperture of Membraniporidae by its relations to the parietal muscles and to the operculum. The compensation-sac may develop by the formation of a calcareous lamina which overarches the membranous aperture (*Umbonula* (Fig. 6, A)), differing from the condition found in Cribrilinidae only in the fact that the original spines are not distinct from one another; or the calcareous front wall is formed first and the sac is developed as an invagination (Fig. 6, C) from the region of the base of the operculum (*Lepralia, Schizoporella, Euthyris, Calwellia,* &c.). This may be regarded as a modification in ontogeny of the phylogenetic history of the organ.

In certain Lepralioid forms (*Microporella, Calwellia,* &c.) the operculum becomes separated from the floor of the compensation-sac by a portion of the calcareous front wall (Figs. 3, 5, 6, D). The sac now opens to the exterior by the so-called "median pore" (*m.p.*), which has probably been formed by the closure of the "sinus," which receives a small, median, tongue-like projection of the proximal side of the operculum in such genera as *Schizoporella* (Fig. 6, B). It remains to be seen whether all forms which possess this arrangement are really related, or whether the median pore has been evolved independently in several cases.

The development of the compensation-sac can be studied in the young zoœcia which are formed at the margins of a growing colony. The primary individual ("ancestrula," Jullien), formed by the metamorphosis of the larva, commonly shows characters different to those of the other zoœcia, and confirming the views above suggested.

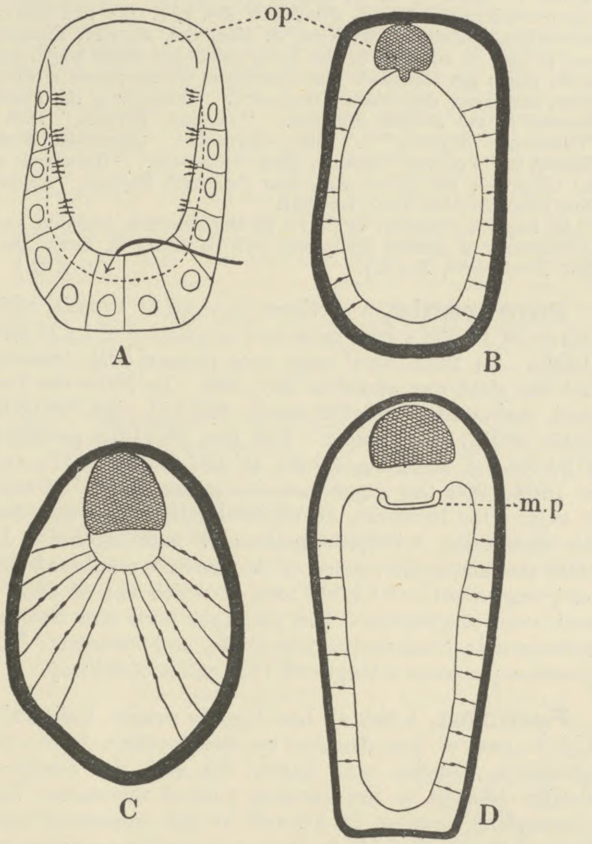

FIG. 6.—A, *Umbonula verrucosa,* at an early stage of its calcification; a calcareous wall is overarching a *Membranipora*-like aperture (cf. Fig. 5), into which the parietal muscles are inserted; B, *Schizoporella,* showing the "sinuate" operculum (*op.*); the compensation-sac opens at the sinus, and is attached to the wall of the zoœcium by parietal muscles; C, a young zoœcium of *Lepralia pallasiana;* the front wall (not shown) is completely calcified; the compensation-sac, from which the parietal muscles radiate, is still small; D, *Calwellia sinclairii,* showing the compensation-sac opening by the median pore (*m.p.*).

It results from an examination of the compensation-sac that many of the existing divisions of the Cheilostomata are unnatural. This applies particularly to the so-called Cellularina, an assemblage of erect and branching forms, of delicate habit. Some of these, such as the Bicellariidae, are quite *Membranipora*-like in the character of their front wall and in the arrangement of their parietal muscles. Others, such as the genera *Catenicella, Calwellia, Ichthyaria, Urceolipora,* &c., are Lepralioid forms with a completely calcareous front wall and a typical compensation-sac.

In the Microporidae and Steganoporellidae, and perhaps in many of the Lepralioid Cheilostomata, the body-cavity is partially subdivided by a calcareous lamina ("cryptocyst," Jullien) which grows from the proximal side, parallel

[1] It appears probable that in most Lepralioid forms the calcareous front wall (upper in figures) is not arranged as in Fig. 3 (C, D?) and in Fig. 4 (C); but that it may (in some cases) correspond with the *inner* layer of the *Cribrilina* spines (Figs. 3, 4, B), the outer layer of which is then represented by a membranous layer known as the "epitheca."

to the opercular wall, which remains membranous. The parietal muscles are here reduced to a single distal pair, which may pass through foramina ("opesiules," Jullien) to reach their insertion into the aperture.

The determination of the recent marine Polyzoa has been greatly facilitated by the publication of Miss Jelly's *Synonymic Catalogue*. Bibliographies of recent and fossil Polyzoa have been published by Vine (*Brit. Assoc. Reps.*, 1880–85, 1890, 1892), and by Nickles and Bassler (*Bull. U.S. Geol. Survey*, No. 173, 1900). Important work on recent marine Polyzoa has been done by Hincks, Waters, MacGillivray, Levinsen, and others. The most complete classification of recent marine forms is that given by MacGillivray (*Proc. Soc. Victoria*, xxiii. p. 187), but the works of Vine and of Delage and Hérouard (*Traité de Zoologie Concrète*, vol. v. Paris, 1897) will also be found specially helpful. The fossil forms have been studied by Gregory, Pergens, Waters, Neviani, and others. The English edition of Zittel's *Palaeontology* contains an elaborate account of them by E. O. Ulrich, who accepts the sub-orders TREPOSTOMATA (Ulrich, *J. Cincinnati Soc.* v. p. 151) and CRYPTOSTOMATA (Shrubsole and Vine, *J. Geol. Soc.* xxxviii., *Proceedings*, p. 245) in addition to the three sub-orders under which the recent forms are classified. In addition to the references already given, the reader may consult GREGORY. *Catalogue of the Fossil Bryozoa in the British Museum.* "Jurassic Bryozoa," 1896; "Cretaceous Bryozoa," i. 1899.—HARMER. *Cambridge Nat. History*, ii. "Polyzoa," London, 1896.—SIMPSON. "Handbook of the Genera of the North American Palaeozoic Bryozoa," *Report State Geologist New York*, for 1894.

[An important memoir by Calvet on the structure, budding, and development of marine Ectoprocta will be found in *Trav. Inst. Zool. Montpellier*, No. 8.] (S. F. H.)

Pomerania, a northern province of Prussia, with an area of 11,628 square miles and population of 1,634,832 (1900). In 1897, 3600 acres were planted with tobacco, and the yield was valued at £85,500. In 1900 the live stock embraced 1,296,832 sheep, 935,043 pigs, 685,509 cattle, and 213,637 horses. The iron foundries produced 9724 tons of materials, valued at £87,300 in 1897; and in 1899–1900 the sugar factories produced 89,192 tons of sugar; the breweries, 18,766,000 gallons of beer; and the distilleries, 9,123,400 gallons of pure alcohol. In 1899 the mercantile marine of the province numbered 356 sea-going vessels of 82,523 tons, of which 124 of 65,979 tons were steamboats. The principal ports are Stettin, Swinemünde, Stralsund, Stolpmünde, and Sassnitz. The province possesses a length of 1128 miles of railway.

Pomona, a city of Los Angeles county, California, U.S.A., east of Los Angeles, on the Southern California (Atchison, Topeka, and Santa Fé) and the Southern Pacific railways, in the southern part of the state. The surrounding country is devoted to the culture of subtropical fruits, for which Pomona serves as a shipping point. Population (1900), 5526.

Ponce, town on the south coast of Porto Rico, 50 miles south-west of San Juan. It is the largest commercial place in the island, and was founded in 1752, and is second to San Juan in population, having in 1899 27,952 inhabitants. It consists of two parts, Ponce and Ponce Playa. Ponce, the residence and business portion, is situated at the interior margin of a beautiful plain, where the latter meets the foot-hills. It has a handsome plaza, hospitals, municipal hall, barracks, and other public buildings. There are medicinal springs and baths. Ponce Playa is the seaport. It is two miles from Ponce, and lies on a spacious bay. The custom-house, shipping offices, and wholesale stores are situated at Playa. An electric railway connects the city and port. A short line of railway runs from Ponce to Yauco to the west, and good highways extend to San Juan, 80 miles, and to Guayama, about 44 miles.

Ponchielli, Amilcare (1834–1886), Italian musical composer, was born near Cremona on 1st September 1834. He studied at the Milan Conservatoire. His first dramatic work, written in collaboration with two other composers, was *Il Sindaco Babbeo* (1851). After completing his studies at Milan he returned to Cremona, where his opera *I Promessi Sposi* was produced in 1856. This was followed by *La Savojarda* (1861, produced in a revised version as *Lina* in 1877), *Roderigo, Rè dei Goti* (1864), and *La Stella del Monte* (1867). A revised version of *I Promessi Sposi*, which was produced at Milan in 1872, was his first genuine success. After this came a ballet, *Le due Gemelle* (1873), and an opera, *I Lituani* (1874, produced in a revised version as *Alduna* in 1884). Ponchielli reached the zenith of his fame with *La Gioconda* (1876), written to a libretto founded by Arrigo Boito upon Victor Hugo's tragedy, *Angelo, Tyran de Padoue*. *La Gioconda* was followed by *Il Figliuol Prodigo* (1880) and *Marion Delorme* (1885). Among his less important works are *Il Parlatore Eterno*, a musical farce (1873), and a ballet, *Clarina* (1873). In 1881 Ponchielli was made *maestro di cappella* of Piacenza Cathedral. His music shows the influence of Verdi, but at its best it has a distinct value of its own, and an inexhaustible flow of typically Italian melody. His fondness for fanciful figures in his accompaniments has been slavishly imitated by Mascagni, Leoncavallo, and many of their contemporaries. Ponchielli died at Milan on 17th January 1886.

Pondicherry, the capital of the French possessions in India, is situated on the Coromandel or western coast, about 100 miles south of Madras. The territory, which is entirely surrounded by the British district of South Arcot, has an area of 115 square miles, with a population of 182,000. The chief crops are dry grains, rice, earth-nuts, and a little indigo. It is traversed by a branch of the South Indian Railway from Villupuram (24 miles). The town has a population of about 50,000. It has an open roadstead, with a small iron pier. In 1900–01 the total seaborne trade was valued at 13,257,116 francs, of which 8,329,013 francs consisted of exports, chiefly cotton manufactures, earth-nuts, cleaned rice, and hides. The principal imports were betel-nuts, cotton manufactures, wines and liqueurs, and oils. Of the export trade more than half was with France, but of the import trade only one-fourth. During 1900 the number of British vessels that called was 204, with an aggregate tonnage of 312,488 tons. A cotton mill has recently been opened by a company with a capital of £200,000. In 1900 there were altogether 4 mills, with 1144 looms and 71,432 spindles, employing 2628 persons.

Pondoland. See CAPE COLONY.

Pont-à-Mousson, town, arrondissement of Nancy, department of Meurthe-et-Moselle, on the river Moselle, 17 miles north-north-west of Nancy by rail. It is of considerable antiquarian interest, and has a library, three hospitals, engineering workshops, blast furnaces, and manufactures of lacquered ware, paper, cardboard, cables, and electrical apparatus. Population (1901), 12,847.

Pontarlier, a fortified town and chief town of arrondissement, department of Doubs, France, 37 miles south-east of Besançon, on the railway from Dijon to Berne. It forms a very important strategic point at the mouth of the Cluse, one of the principal passes across the Jura. It was here that the French army of the east made its last stand against the Prussians in 1871, in order to cover the retreat of the main army into Switzerland. The distillation of herbs, extensively cultivated for absinthe, gentian, kirsch, and liqueurs, occupies several establishments. The town has considerable commerce with Switzerland in spirits and agricultural produce, &c. Population (1901), 8031.

Pont Audemer, chief town of arrondissement, department of Eure, France, 43 miles north-west of Evreux, on the Risle, a left-bank affluent of the Seine, and on the railway from Evreux to Honfleur. The churches of St Ouen and St Germain date in part respectively from the 11th and the 12th centuries. Local institutions are a hospital, chamber and tribunal of commerce, and small public library. Manufacturing industry is very active, and includes the founding of malleable metal, a large spur factory, and various important branches of leather manufacture. There is considerable trade in flax, wool, grain, cattle, cider, paper, iron, wood, and coal. The port has a length of about half a mile on the Risle, navigable to this point. It is bordered by quays for 450 yards, and vessels drawing 6½ to 9½ feet of water are towed up by horses from Roque, 17 miles below. Population (1901), 5908.

Pontefract, a municipal and parliamentary borough (since 1885 returning only one member) and market-town of Yorkshire, England, 13 miles south-east of Leeds by rail. An isolation hospital was erected in 1900, costing £9000. New waterworks have been constructed by the corporation at a distance of 8 miles from the town at a cost of £30,000. Population (1881), 8798; (1901), 13,422.

Pontevedra, an Atlantic province of Spain; area, 1739 square miles; population (1897), 447,612; death-rate 2·38 per cent.; birth-rate 2·66 per cent. It is divided into 11 districts and 65 parishes.

Much business is done at the great fairs held at several towns, where the country folk bring in live stock, poultry, and dairy produce. The foreign trade is considerable. The exports are cattle to England and Portugal, hams, salt meat and fish, eggs, bread-stuffs, leather, wine. Vigo, Carril, Marin, Villagarcia, Bayona are the principal ports. In 1898 wheat was grown on 5865 acres; rye, oats, barley, and maize on 249,527 acres; pod fruit and beans on 88,635; vines on 13,022; live stock included 3928 horses, 1282 mules, 623 asses, 73,531 cattle, 42,201 sheep, 14,840 goats, and 32,581 pigs. The mines are not important.

Pontevedra, capital of the above province, near the coast, on the river Lerez, here spanned by a bridge of twelve arches. The country around produces wheat, wine, and fruit. It is a station on the Monforte-Vigo Railway. The institute and primary schools are well attended. The town contains many convents, some of which have been turned into public buildings, refuges, hospitals, schools. Some of the modern provincial and municipal buildings are very handsome. Population (1897), 19,986.

Pontiac, a city of Michigan, U.S.A., capital of Oakland county, on the Clinton river, and the Grand Trunk and the Pontiac, Oxford, and Northern railways, in the south-eastern part of the state, at an altitude of 932 feet. It is surrounded by many small lakes and ponds, which have become well-known resorts for sportsmen. The city is the site of the Eastern Michigan insane asylum. Population (1880), 4509; (1890), 6200; (1900), 9769, of whom 2020 were foreign-born and 151 negroes.

Pontivy, formerly NAPOLEONVILLE, chief town of arrondissement, department of Morbihan, France, 32 miles north-north-west of Vannes, on the Blavet. The town comprises two distinct parts: that built by order of Napoleon I., who desired to make it the military head-quarters for Bretagne, and consisting chiefly of barracks, subsequently gave name to the whole town, but in 1871 the former name was resumed. The ancient castle of the dukes of Rohan, built in 1485, is now occupied by the Musée Le Brigant of art and archæology. A monument to commemorate the Breton-Angevin Union was erected in 1894, and there are statues of Dr Guépin, a Democrat, and General de Lourmel (d. 1854). Population (1881), 5720; (1901), 9359.

Pontoon.—The pontoon equipments of European armies have undergone few changes in recent years. In the British army Colonel Blood's equipment has been modified by the introduction of a bipartite pontoon designed in 1889 by Lieut. Clauson, R.E.

Each pontoon is carried on one waggon with a bay of superstructure, and consists of two sections, a bow-piece and a stern-piece, connected together by easily manipulated couplings of phosphor bronze. Decks and "coamings" are dispensed with, and the rowlock holes are sunk in a strong gunwale. The detachable saddle-beam, which receives the load on the centre of the thwarts, is made in sections, so as to form a continuous saddle of any length required. The baulks (or road-bearers) and chesses (or planks) remain unaltered, but chess-holders and chess-bearers are added for use in constructing light bridges for infantry in file. In this kind of bridge each pontoon section is used separately, with a roadway of chesses placed longitudinally four abreast. In the normal or medium bridge two sections, and in heavy bridge three sections, are joined together. The chief advantages of the equipment are (1) the buoyancy of the piers can be proportioned to the weight of traffic and to the roughness of the water; (2) owing to the special design of the bows, boats and rafts are easy to row, while the pontoons in bridge oppose little resistance to the current, and so require less anchor power; (3) transport rafts, pier-heads, and flying bridges can be constructed with great ease, owing to the flush gunwales on which baulks can rest if necessary; (4) the pontoon sections are convenient to handle, easy to ship or to transport by rail, and can readily be replaced singly if damaged in bridge. A canoe pontoon and superstructure adapted for pack transport has also been adopted from designs by Colonel Elliott Wood, C.B., R.E. The pontoon consists of four sections laced together, each section being a framework of wood covered with waterproof-sheeting. Three pontoons and eight composite planks form a "unit," from which can be constructed 48 feet of bridge for infantry in file, 84 feet for infantry in single file, or a raft to carry 15 men or an empty waggon. The Indian demi-pontoon is of the same length (22 feet) as the Blood pontoon, but is sheathed with copper. It has a square stern, to enable it to be used in pairs. The Chitral Relief Expedition, 1895, brought to light some defects in this pontoon. The shape of the bows proved unsuited to rapid currents, the balance was unsatisfactory, and cracks developed in the copper sheathing. Experiments have been made with bipartite pontoons.

The French pontoon is a somewhat cumbrous wooden boat. The German army is equipped with a galvanized iron pontoon in one piece, handy as a boat, but of insufficient buoyancy to form a satisfactory bridge support, as the spans have to be unduly diminished for heavy traffic, and the waterway is consequently obstructed. The Bavarian equipment has been improved; it approximates to the Austrian type. Aluminium pontoons have been tried in Germany, but have not been adopted. For the German cavalry the Berthon folding-boat equipment has been introduced. Each regiment has a waggon carrying sufficient equipment to form a road-bridge 26 feet long, a foot-bridge 65 feet long, or a raft capable of ferrying a field gun and limber, 45 sets of saddlery and kits, or 25 equipped infantrymen. In Austria, repeated but unsuccessful efforts have been made to reduce the weight of the Birago pontoon sections still in use, by the substitution of steel for iron. The Russian pontoon, of Birago type, with sheer sides, and the heavy wooden boat of the Italian equipment, have not been modified.

The methods of constructing pontoon bridges have been simplified of late years in most armies, and are usually restricted to (1) adding pontoons one by one to the head of the bridge; (2) connecting rafts of two or more pontoons into bridge by intermediate bays of superstructure; and (3) swinging across the river a bridge previously prepared alongside the shore. The formation of a bridge from rafts touching one another consumes an excessive amount of equipment, and opposes unnecessary resistance to the stream; it is therefore being discarded in most armies. "Booming out" the bridge bay by bay from the shore until the head reaches the opposite bank is unsuited for rapid currents, and is almost obsolete except for light infantry bridges.

The organization of bridging *personnel* in different armies shows as much divergence of opinion as the design of pontoon equipment. In the British army a pontoon troop, R.E., is included in the corps engineers of each army corps, with a war establishment of 5 officers, 81 dismounted men, 132 mounted men, and 186 horses.

In peace the pontoon troops constitute an administrative unit called the bridging battalion, with an establishment of 197 all ranks and 70 horses. A pontoon troop can make 185 yards of light bridge, 105 yards of normal, or 75 yards of heavy bridge. Each of the four field companies R.E. in an army corps can make 25 yards of light, 15 yards of normal, or 10 yards of heavy bridge, the equipment being of the same pattern as that of the pontoon troop. In France an important change was made in 1894, when the two pontoon regiments were transferred from the artillery to the engineers. In war these regiments furnish five army bridge trains, forming 280 yards of bridge each, besides supplying to each army corps a pontoon company with 140 yards of bridge. The requirements of divisions are met by an advanced guard bridge train (33 yards of bridge) carried on two waggons with each divisional company of sappers and miners. In the German army the pioneer company attached to each division can throw 47 yards of bridge. The corps pontoon train carries 133 yards of bridge, which is constructed by one of the pioneer companies of the army corps. The cavalry equipment has already been described. In Austria the pioneers are in charge of the pontoon equipment. Forty-five normal bridge trains, each carrying 58 yards of bridge, are at the disposal of army headquarters, and a light bridge train carrying the same length of bridge would usually be allotted to each army corps. In Russia half a pontoon battalion, carrying about 140 yards of bridge, is detailed to each army corps, and in addition the divisional sapper company has a light bridge train carrying 22 yards of bridge on six waggons. In Italy the pontoon companies provide eight army bridge trains (219 yards of bridge each), and the sapper company attached to each division carries 43 yards of bridge on six waggons.

See VON RIPPER, *Europäischen Kriegsbrücken-Systeme*, Vienna, 1896; and *Instruction in Military Engineering*, part iii., Bridging, 1894. (J. E. C.)

Pontremoli, a town and bishop's see of the province of Massa and Carrara, Tuscany, Italy, in the upper valley of the Magra, 20 miles north by east of Spezia. It has a 17th-century cathedral, a citadel, and an episcopal library. There are also mineral springs; and the people quarry marble and polish it, as well as make lime and bricks. The town was an independent republic in the 12th and 13th centuries, and in 1495 was sacked by the troops of Charles VIII. of France. Population (1899), 11,000.

Pontypool, a town in the northern parliamentary division of Monmouthshire, England, 8 miles north of Newport by rail. An electric lighting power company was formed in 1893 to supply the district with electric light. The market-house was opened in 1894, after a reconstruction which cost £22,280, and a new cattle market was formed in 1899. A new recreation ground was opened in 1893. Population (1901), 6126.

Pontypridd, market-town, urban district, and parish in the eastern parliamentary division of Glamorganshire, Wales, on the Taff river, 12 miles south of Merthyr Tydfil by rail. A new town hall has been built over the market, and a free library erected. New gas works have been established, and a water reservoir to store 200,000,000 gallons was completed in 1900. Population (1891), 24,763; (1901), 32,319.

Poole, a municipal borough, county in itself, seaport, and market-town in the Eastern parliamentary division of Dorsetshire, England, 20 miles east of Dorchester on the South-Western Railway. Modern erections are the free library and school of art; and the Cornelia Hospital. Poole Park, containing 40 acres of land and 62 acres of water, was acquired in 1887 and 1889, and Brankstone Park of 40 acres in 1895. Since 1885 the Poole corporation has had power to regulate the oyster fisheries in the harbour, and 200 acres in the Wareham Channel have been granted to a local company, under whose management the oyster beds are again productive. The harbour, which has a depth of only 8½ feet, is beset by shifting sand-banks, through which there are only narrow channels. In 1888 the registered shipping totalled 42 vessels of 2257 tons; in 1900, 45 vessels of 2834 tons. In 1888, 1002 vessels of 87,299 tons entered and 984 of 83,567 tons cleared; in 1900, 1353 vessels of 156,399 tons entered and 1366 of 158,414 tons cleared. The total trade is valued at £130,000 annually. Area, 5333 acres. Population (1881), 12,310; (1891), 15,438; (1901), 19,461.

Poole, Reginald Stuart (1832–1895), English archæologist and orientalist, was born in London, 27th January 1832. On his mother's side he was a nephew of E. W. Lane, the Arabic scholar, with whom he lived in Cairo from 1842 to 1849, thus imbibing an early taste for Egyptian antiquities. In 1852 he became an assistant in the British Museum, and was assigned to the department of coins and medals, of which in 1870 he became keeper. His work in that capacity was of the highest value, alike as a writer, teacher, and administrator. In 1882 he was largely responsible for founding the Egypt Exploration Fund, and in 1884 for starting the Society of English Medallists. He retired in 1893, and died on 8th February 1895. Some of Poole's best work may be found in his articles for the *Ency. Brit.* (ninth ed.) on EGYPT, HIEROGLYPHICS, and NUMISMATICS; he also wrote for Smith's *Dictionary of the Bible*, and published several volumes dealing with his special subjects. He was for some time professor of archæology at University College, London, and also lecturer at the Royal Academy.

Poona, or PUNA, a city and district of British India, in the Deccan division of Bombay. The city is on the right bank of the Muta river, 1850 feet above the sea; railway station, 119 miles from Bombay. Municipal area, about four square miles; population (1881), 129,751; (1891) 161,390; (1901) 111,385, showing an increase of 24 per cent. between 1881 and 1891, but a decrease of 31 per cent. between 1891 and 1901. From its healthy situation, Poona has been chosen not only as the headquarters of the Bombay army, but also as the residence of the Governor of Bombay during the rainy season, from July to November. The native town, along the river bank, is somewhat poorly built. The European quarter extends to the north-west as far as the cantonment of Kirkee. The modern waterworks have been constructed mainly by the munificence of the late Sir Jamsetjee Jeejeebhoy. Poona was never a great centre of trade or manufacture. Two cotton mills, with 1250 looms and 33,000 spindles, employing 1000 hands; a paper mill, employing 340 hands, with an out-turn valued at Rs.3,09,000; a brewery (at Dapuri) producing 800,000 gallons of beer; two flour mills, with an out-turn valued at Rs.42,000; factories of ice and mineral waters; four dairy farms, furnish the chief industries. Educational institutions are numerous, but their statistics since 1896 have been vitiated by the prevalence of the plague. They include the Government Deccan College, with a law class; the aided Fergusson College; the unaided Maharashtra College; the Government college of science, with agricultural and forest classes; seven high schools; training schools for masters and mistresses; medical school; municipal technical school; and several schools for European boys and girls. There are altogether forty-three printing-presses, including those belonging to Government departments, which issue two English and a large number of vernacular newspapers. Since 1896 the history of Poona has been painfully associated with the plague. Down to July 1898 the total number of cases of plague reported in Poona city was 9362, and the number of deaths was 6967. During 1897 the death-rate rose to 93 per thousand in Poona city, 71 per thousand in the cantonment, and 93 per thousand in Kirkee.

The district of POONA has an area of 5369 square miles; population (1881), 901,828; (1891), 1,067,800; (1901), 995,074, showing an increase of 18 per cent. after the disastrous famine of 1876–77, but a decrease of nearly 7 per cent. between 1891 and 1901; average density, 185 persons per square mile. Land revenue and rates, Rs.19,32,443, the incidence of assessment being R.0–10–3 per acre; cultivated area (1897–98), 1,860,195 acres, of which 142,948 were irrigated, including 54,492 from Government canals; number of police, 1210; children at school (1897–98), 20,699, being 2 per cent. of the total population. The principal crops are millet, pulse, oilseeds, and wheat. The two most important irrigation works in the Deccan are the Mutha canal, with which the Poona waterworks are connected, and the Nira canal. The total capital outlay on the former has been Rs.66,00,979; in 1897–98 the gross receipts were Rs.2,34,211 and the expenditure Rs.79,818, showing a profit of 2·34 per cent. The capital outlay on the latter has been Rs.56,71,000; in 1897–98 the gross receipts were Rs.1,35,705 and the expenditure Rs.61,694, showing a profit of 1·30 per cent. There are manufactures of cotton, silk, and blankets. The district is traversed for 106 miles by the Great Indian Peninsula Railway, and also by the Southern Mahratta line, which starts from Poona city towards Satara. It is liable to drought, from which it suffered severely in 1866–67, 1876–77, and again in 1896–97. (J. S. CO.)

Poor Laws.—The chief difficulty in understanding the English poor law arises from the fact that there are three authorities, each of them able to alter its administration fundamentally. Few statutes relating to the poor law have been repealed, and the need of consolidation is very generally admitted. The poor law, however, is not only the creation of statutes passed by Parliament; it is also controlled by the subordinate jurisdiction of the Local Government Board, which in virtue of various Acts has the power to issue Orders. The Board possesses great facility for consolidating its Orders, and probably all that is here possible has been done. A third source of authority is the local board of guardians, which, within the discretion allowed to it by Statutes and Orders, can so variously administer the law that it is difficult to understand how procedure so fundamentally different can be based on one and the same law. This elasticity, admirable or mischievous, as we choose to regard it, is the most characteristic feature of the English poor-law system, and a supplementary note in illustration of its working during the closing years of the 19th century will give a better idea of the public policy in this respect than an elaborate analysis of statutes.

I. *Legislation.*—The burden of pauperism was in 1834 so heavy that England hardened its heart to perform a very drastic act of social surgery. The Poor Law Amendment Act, 1834, checked the growth of pauperism. Relatively to the wealth and population of the country, pauperism has never since that date been an overwhelming burden. Apprehension was allayed, and a certain humanitarian reaction against the strict theory which underlies the Act of 1834 set in almost at once. Up to 1869 the local administrative bodies, with few exceptions, although in self-defence they applied the provisions of the Act, never embraced its principles with enthusiasm. About 1869, owing to a variety of causes (*e.g.*, the influence and example of men like Edward Denison, followed as a result by Mr Goschen's circular of 20th November 1869 and Mr Fawcett's book on Pauperism, published in 1871), a deeper theoretical interest was aroused, and several boards of guardians adopted (as recommended in these and other treatises) a stricter administration of outdoor relief. The burden, it was argued, might no longer be intolerable to the ratepayer, but the dependence of the pauper was a cruelty to himself, and a firm policy, tending to infuse a spirit of independence into the pauper population, was the truest philanthropy. Thoroughgoing support to this policy has been confined to a few unions, but some advance in this direction has been well-nigh universal. A reduction of pauperism from 47·1 per 1000 of population in 1871 to 21·9 in 1900 (see *Monthly Statement of Pauperism*, March 1900) is a solid achievement. The improvement, however (so at least advocates of the principles of 1834 argue), is much less marked than it might have been had the policy of 1834 been frankly adopted. This belief in the emancipating effect of a stricter policy has not had much weight with the legislature, and effort has chiefly been directed to secure the comfort rather than the emancipation of the pauper. Legislative changes, indeed, with regard to the actual administration of the law, have not during the period under review been numerous or important.

The first Act to be noticed in this connexion is the Medical Relief Disqualification Removal Act, 1885, passed by Lord Salisbury's Government. This Act relieves voters from disqualification which would otherwise attach in consequence of the receipt by them or their families of medical or surgical assistance, or of medicine, at the expense of the poor rate. This does not apply to guardian elections, and it does not include persons who, in addition to medical relief, receive nourishment or other relief from the poor rate. The provisions which require the removal of the names of paupers from the electoral roll are, it is understood, very perfunctorily carried out. The Outdoor Relief Friendly Societies Act, 1894, authorizes guardians, in calculating the proper allowance to be made, to disregard an income derived from a friendly society, and to give relief as if the applicant in receipt of such an allowance was wholly destitute. This Act is a curious illustration of the English poor-law system. In earlier years, notably in what is known as Paget's letter (22 Rep. Poor Law Board, p. 108), the Central Board had, in answer to inquiry, pointed out that such preferential treatment given to men receiving benefit, insufficient to maintain them, from a friendly society, could not in equity be withheld from persons in receipt of an adequate benefit, or from those whose savings took the form of a deposit in a bank, of a share in a co-operative society, or of cottage property; and further, that an engagement on the part of guardians to supplement insufficient allowance from a friendly society was a bounty on inadequate and insolvent friendly society finance. The Central Board went so far as to say that relief given in such disregard of the pauper's income was illegal. They had, however, issued no peremptory order on the subject, nor had guardians been surcharged for neglect of the rule. The local authorities followed their own discretion, and a very general practice was to reckon friendly society allowances at half their value. The above Act sets aside the Central Board's earlier interpretation of the law. It makes, however, no attempt to enforce its procedure on the numerous boards of guardians who regard the course thereby authorized as contrary to public policy.

The period under review has also seen the passage of several Acts designed to secure a more effective treatment of lunatics and children. The Lunacy Act of 1890 is a consolidation of the Acts affecting lunatics. It is further amended by the Lunacy Act, 1891. An explanatory letter issued by the Local Government Board will be found in the 20th Annual Report, p. 33. The tendency of this and of all recent legislation for an afflicted class is to increase the care and the safeguards for their proper treatment. The same desire to improve administrative methods for the rescue of the helpless is shown in the Poor Law Act, 1889, and in the Custody of Children Act, 1891, sect. 3. The evil of allowing children who have been reputably brought up in poor-law schools to relapse into vicious habits on return to the custody of unworthy parents, has been the subject of frequent remark. By the Act of 1889, guardians are authorized to detain children who are under their charge, as having been deserted by their parents, up to the age of 16 if boys and of 18 if girls. By the Poor Law Act, 1899, the principle is extended to orphans and the children of bad parents chargeable to the rates. The Act of 1891 goes farther, and enacts that where a parent has (*a*) abandoned or deserted his child, or (*b*) allowed his child to be brought up by another person at that person's expense, or by the guardians of a poor-law union for such a length of time and in such circumstances as to satisfy the Court that the parent was unmindful of his parental duties, the Court shall not make an order for the delivery of the child to the parent unless the parent has satisfied the Court that, having regard to the welfare of the child, he is a fit person to have the custody of the child.

Some important readjustments of the burden of local expenditure have next to be noticed. The system of making grants from the national taxes in aid of local rates has proceeded to considerable lengths. The article in the ninth edition of the *Ency. Brit.* notices the institution of the Metropolitan Common Poor Fund, a device for giving metropolitan grants assessed on the whole of London in aid of the London local poor-law authorities. The same principle, *mutatis mutandis*, is also followed in the relations which now obtain between the national and the local exchequers.

At the time of the repeal of the Corn Laws, Sir R. Peel expressed an opinion that this fiscal change necessitated some readjustment of local rates. In that year, 1846, a beginning of grants from the national exchequer in aid of local expenditure was made. The salaries of poor-law teachers, medical officers, and auditors were provided from the larger area of taxation, and in 1867 the salaries of public vaccinators were added to the list. In 1874 a grant of 4s. per head per week was made for each pauper lunatic passed by the guardians to the care of a lunatic asylum. By the Local Government Act, 1888, supplemented by the Local Taxation (Customs and Excise) Act, 1890, this principle was more widely extended. The various grants in aid were abolished, and in substitution the proceeds of certain specified taxes (*i.e.*, additional beer and spirit duties, (*a*) customs and (*b*) excise; excise licences, share of the probate, now termed the estate duty) were set aside for local purposes. From this source, the gross amount of which of course varies, there are now distributed to local poor-law authorities 4s. a week for lunatics in asylums, and allowances based on their average expenditure in previous years in salaries of officials and other specified charges. In London, in order not to conflict with the operation of the Common Poor Fund, which had already spread these charges over a wide area, the grant takes the form of a sum equivalent to 4d. per diem for each indoor pauper. The number on which this calculation is based is not, however, to be the actual number, but the average of the last five years previous to the passing of the Act. By this legislation something like one-quarter of the total expenditure on poor-law relief is obtained from national taxes as opposed to local rates. By the Agricultural Rates Act, 1896, enacted for a period of five years, the occupier of agricultural land is excused one-half of certain rates, including the poor rate. The deficiency is supplied by a contribution from the National Exchequer. Meanwhile, the spending authority continues to be elected by the local ratepayers. In this connexion two further anomalies deserve notice. By the Poor Rate Assessment and Collection Act, 1869, owners who compound to pay the rates in respect of tenement property are entitled to certain deductions by way of commission. Such payments by the owner are constructively payments by the occupier, who thereby is to be deemed duly rated for any qualification or franchise. Under these arrangements a large number of electors do not contribute directly to the rate. A converse process is also going on, whereby the ownership of an important and increasing body of property is practically unrepresented. This is due to the great growth of property in the hands of railway companies, docks, and limited liability companies generally. The railways alone are said to pay 13 per cent. of the local taxation of the country, and they have no local representation. There is, in fact, in local administration a divorce between representation and taxation to a greater extent than is generally supposed, and it is impossible not to connect the fact with the rapid growth of local expenditure and indebtedness.

The Local Government Act, 1894, did away with *ex officio* and nominated guardians. The plural vote (which gave to the votes of the larger ratepayers a higher value) was also abolished; and in place of the old property qualification for the office of guardian, a ratepaying or residential qualification was substituted. In urban districts the Act in other respects left the board of guardians untouched, but in rural districts it inaugurated a policy of consolidating local authorities which is capable of further extension. In the rural districts the district council is practically amalgamated with the guardians, for, though each body retains a separate corporate existence, the district councillors are the guardians, and guardians as such are no longer elected. These electoral changes, extremely democratic in their character, have not brought about any marked general change in poor-law administration. Here and there abrupt changes of policy have been made, but the difficulty of bringing general principles to bear on the administration of the law remains much as before. Two statutes important to the official staff of the guardians may be mentioned—the Poor Law Officers' Superannuation Act, 1896, and the Poor Law Officers' Superannuation Act Amendment Act, 1897. The Poor Law Act, 1897, is a consolidating and amending Act on the important question of the repayment of loans. This Act, together with the Poor Law Act, 1889, which it partially repeals, are the principal statutes governing the question. With the sanction of the Local Government Board, guardians may borrow, and repay in a period not to exceed sixty years; such loans are not to exceed one-fourth of the total annual rateable value of the union.

II. Passing to the *subordinate jurisdiction* of the Local Government Board, we may notice that in the year ending 31st March 1899 over eighteen hundred Orders were issued by the Board, over one thousand of them having special reference to the poor law. It is not possible, therefore, even to summarize this mass of subordinate legislation. The Orders and circulars (these last are hardly less important) quoted below are mentioned merely as illustrations.

Several circulars and Orders with reference to the detention of casual paupers have been issued since 1885. These are summed up in the General Order, 11th June 1892. Its general purpose is to mitigate the severity which might seem authorized by the provisions of the Pauper Inmate Discharge Act of 1871 and the Casual Poor Act, 1882. By this order the guardians are called on to use a reasonable latitude in allowing the departure of the casual pauper who professes to be in search of work. Against this we have to set a circular letter of 25th February 1896, calling attention to the increase of vagrancy, and stating that "there appeared to be reason for considering that this increase was to a considerable extent not unconnected with a failure on the part of boards of guardians to enforce the provisions of the Pauper Inmate Discharge and Regulation Act, 1871, as amended by the Casual Poor Act, 1882; and of the regulations of the Board." On inquiry, the Board found that "in a large proportion of unions" the deterrent regulations authorized by these Acts had been neglected.

The earlier years of the period were years of commercial depression, and the boards of guardians throughout England were much exercised as to the best means of dealing with the "unemployed." On the 15th March 1886 an important circular was issued from the Local Government Board. It states that while "the Board have no doubt that the powers which the guardians possess are fully sufficient to enable them to deal with ordinary pauperism, and to meet the demand for relief from the classes who usually seek it," yet "these provisions do not in all cases meet the emergency. What is required to relieve artisans and others who have hitherto avoided poor-law assistance, and who are temporarily deprived of employment, is—(1) Work which will not involve the stigma of pauperism; (2) work which all can perform, whatever may have been their previous occupations; (3) work which does not compete with that of other labourers at present in employment; and lastly, work which is not likely to interfere with the resumption of regular employment in their own trades by those who seek it."

The circular goes on to recommend that guardians should confer with the local authorities, "and endeavour to arrange with the latter for the execution of works on which unskilled labour may be immediately employed." The conditions of such work were (1) the men to be employed must be recommended by the guardians; (2) the wages must be less than the wages ordinarily paid for such work.

The circular was widely distributed. Many boards that were inclined in that direction regarded it as an encouragement to open or to promote the opening of relief works. Others, again, looked closely at the conditions, and declared roundly that it was impossible to fulfil them. A poor-law authority, they said, cannot give relief which will not subject the recipients to the legal (if any) and economic disabilities attaching to the receipt of poor-law relief. Work which all can perform can only be found in the shape of task-work under adequate supervision. If the work is of a useful and necessary character, it must compete with the labour of others belonging to the trades affected. If the relief works are opened by authorities other than the poor-law guardians, the conditions that the men were only to be employed when recommended by the guardians, and then paid less than the current rate of wages, were calculated, it was urged, to secure bad work, discontent, and all the "stigma of pauperism." The ambiguity of the circular indeed is such, that both action and inaction, as presently to be described, seem amply justified by it.

Two important Orders on the subject of the boarding out of poor-law children were issued in 1889. By the *Boarding of Children in Unions Order*, orphan and deserted children can be boarded out with suitable foster-parents in the union by all boards of guardians except those in the metropolis. This can be done either through a voluntary committee or directly. By the *Boarding Out Order*, orphan and deserted children may be boarded out by all boards of guardians without the limits of their own unions, but in all cases this must be done through the offices of properly constituted local Boarding-Out Committees. The sum payable to the foster-parents is not to exceed 4s. per week for each child. The local committee require to be approved by the Local Government Board.

The question of the education of poor-law children has been much discussed of late years. During the early years of the Central Authority, it was the object of the Commissioners to induce boards of guardians to unite in *Districts* for educational purposes. This was advocated on grounds of efficiency and economy. It was very unpopular with the local authorities, and the number of such districts has never exceeded a dozen. In London, where this aggregation was certainly less desirable than in rural unions, several districts were formed and large district schools were built. Adverse criticism, by Mrs Nassau Senior in 1874, and by a departmental committee appointed twenty years later, has been directed against these large, or, as they are invidiously called, barrack schools. The justice of this condemnation has been disputed, but it seems probable that some of these schools had grown too large. One of the districts was dissolved by order of the Local Government Board on the application of the unions concerned, and others were in 1900 in course of dissolution. This condemnation of some schools has in certain quarters been extended to all schools, and is construed by others as an unqualified recommendation of boarding out, a method of bringing up poor-law children obviously requiring even more careful supervision than is needed in the publicity of a school.

The classification of children apart from adult paupers is peremptory. Even in those unions where what is called a *Workhouse School* is maintained, the children are kept in detached parts of the building, and do not associate with the adult paupers. The *Separate School* is built on a separate and often distant site. Sometimes the separate school is one building, sometimes *Detached "Blocks,"* and sometimes a group of *Cottage Homes.* There still remain ten *District Schools.* In Sheffield and other places an experiment which is called the *Scattered Homes* system has been adopted. This consists in lodging-homes for the children placed in different parts of the town, from which the children attend the local public elementary schools. In the rural districts and in less populous unions the children generally attend the local public elementary school. To these expedients *Boarding-out* must be added. The above refers of course only to those children who as inmates are under the charge of the guardians. Outdoor paupers are responsible for the education of their children, but guardians cannot legally continue outdoor relief if the children are not sent regularly to school.

Summary, for year ending Lady Day 1898, of the number of unions in which the children attend the different classes of schools :—

Class of School.	Attended by the Children belonging to	Average daily Number of Children.
Poor-law schools—		
District schools . .	28 unions	6,811
Separate schools . .	38 ,,	10,230
Workhouse schools .	63 ,,	3,531
Schools of other unions .	26 ,,	...
	155 ,,	20,572
Public elementary schools .	493 ,,	...
TOTAL . .	648 ,,	...

A later return with regard to boarding out gives the number boarded out *within the Union* on 1st January 1899 as 5191, the number boarded out *beyond the Union* as 1896.

III. *Local Administration.*—The above recorded variations of the educational policy must to a certain extent be regarded as the result of differences of local administration, but as each system is supervised in considerable detail by the Local Government Board, they have been noticed in connexion with the Orders issued by the Central Authority. The administration of relief to the adult population affords a better instance of the strangely divergent methods in which the poor law is *normally* carried out in contiguous and similar areas. These differences of policy largely turn on the attitude taken by guardians towards outdoor relief. Both in town and country, since 1875, a few boards have practically discontinued to give outdoor relief—that is, relief to paupers at their own homes. Other boards have continued to give it lavishly. Between the two extremes almost every variety is to be found. The following table will illustrate the position. The figures are taken from the summer returns (a period less affected by weather conditions), at a date previous to the change of policy which arose from the above-mentioned discussions of 1869, and from returns for 1899.

For this comparison unions in proximity have been chosen. More striking contrast could be obtained by a wider selection (see *Guardians' Guide*, by an Official, p. 27). The motives which underlie these two entirely divergent methods of administration require careful consideration, if the current operation of the law is to be understood. The strict or indoor policy is based on the belief that the more eligible the endowment of pauperism, the easier will

Two Town Unions.

Name of Union.	Date.	Number of Indoor Paupers, less Vagrants and Lunatics.	Number of Outdoor Paupers, less Vagrants and Lunatics.	Total.	Proportion of Paupers to Population at last Census.
					One Pauper to every
Whitechapel (East London)	July 1, 1870	974	3236	4210	18
	July 1, 1899	1162	26	1188	62
St Olave's (South London)	July 1, 1870	1320	3548	4868	20
	July 1, 1899	2278	4120	6398	21

Two Country Unions.

Name of Union.	Date.	Number of Indoor Paupers, less Vagrants and Lunatics.	Number of Outdoor Paupers, less Vagrants and Lunatics.	Total.	Proportion of Paupers to Population at last Census.
					One Pauper to every
Bradfield (Berks) .	July 1, 1870	152	807	959	16
Do. .	July 1, 1899	104	17	121	140
Hungerford (Berks)	July 1, 1870	109	1049	1158	17
Hungerford and Ramsbury (Berks)	July 1, 1899	61	395	456	39

be the descent into pauperism and the greater the reluctance to undergo the effort necessary for emancipation. The supporters of this policy also point with confidence to the expansive nature of the English industrial system, and they complain that the progress of the poorer population from the servile conditions of feudalism and pauperism (influences both historically and essentially closely related) is retarded and arrested by a lavish poor-law administration. The offer of indoor maintenance, if strict and repressive, is also, they contend, adequate and humane. If hard cases arise, they should not be strained to make bad law, but should be dealt with by private charity or by voluntary agencies, a method of relief which has a less disturbing effect on the calculation and conduct of the poor. The opponents of this stricter system have had the great advantage of being the party in possession. They appear to believe less firmly in the possibility of a complete emancipation of the poorer class. Their principal desire is to relieve the sufferer in the manner most agreeable to him. They persuade themselves that the general effect of this policy will not be detrimental to the general welfare. Or, if they admit a danger, they argue that progress is too dearly purchased by curtailment of a system of relief to which the poorer population has become habituated.

Two instances may be added to show how on *abnormal* occasions the widest variety of policy can be introduced, with the sanction apparently of one and the same set of statutes and orders. During the decade beginning in 1885 there was much complaint made on behalf of the unemployed. A large number of unions passed through the crisis without any relaxation of their procedure. Whitechapel, which may be again taken as typical, offered "the house" to the able-bodied, as directed by the law. They obtained, but we believe made no use of, a special Order from the Local Government Board authorizing them to receive the able-bodied male head of a family into their workhouse and to relieve the family at their home; after a short detention they were authorized to let the man go out to look for work during the day, and to continue for a limited period the outdoor relief to the family.

They opened no labour-yard, and the crisis passed without any apparent pressure on the relief authorities. No large additional class found it necessary to become dependent, and no exceptional hardship, it is alleged, was imposed on the class which undoubtedly would have availed itself of relief offered under more eligible conditions. Separated only by the Thames is the union of St Olave's, containing a population industrially superior rather than inferior to the Whitechapel population. London, it should be premissed, is administered under the Outdoor Relief Regulation Order, 1852, which permits the local board to open a labour-yard. Unions under the Prohibition Order, 1844, require the sanction of the Local Government Board. The St Olave's board availed itself of this privilege, and, accepting with more enthusiasm than discrimination the recommendations of the circular of 15th March 1886, opened a labour-yard, gave relief at trade union wages, and speedily attracted an enormous and unmanageable crowd. This policy reached a climax in the winter of 1894–95. The labour-yard was opened 7th January 1895, and remained open till the end of March. The guardians spent £18,000 in employing all applicants at stone-breaking, paying trade union wages. Each ton cost £7, as against 4s., which was said to be the market price. The labour-yard was largely monopolized by the worst characters, and the conditions of relief were thus rendered extremely distasteful to any respectable workman who was obliged to apply. Supervision was so lax, that the men absented themselves till the hour of payment arrived. On the day before the yard was closed, presumably because the guardians thought it was no longer necessary, there were over 1000 men in attendance. No evil consequences are said to have followed the closing of this source of relief. The facts as above stated are derived from the evidence of the chairman of the board, given to the Committee on Distress from Want of Employment.

One other instance of the large discretion placed in the hands of the local administrator may be cited. In April of the year 1898 a strike affecting some 100,000 colliers took place in South Wales. The union of Merthyr found its workhouse full, and opened a labour-yard. The representatives of the employers, who were the principal ratepayers, objected to relief being given to workmen on strike; being in a minority, they appear to have withdrawn from attendance at the board. The stone-yards were failures in two respects—they did not serve as tests of destitution, and each ton of stone broken involved a dead loss and seriously added to the cost of relief. The guardians accordingly closed the labour-yards, and gave relief on the plea of "sudden and urgent necessity," without calling on the able-bodied head of the family to enter the workhouse, and without subjecting him to the task of work. (See *L. G. B.*, 28*th Annual Report*, p. 174.) One of the leading colliery companies took the matter into court, asking for an injunction to stop further relief to the colliers, and for a declaration as to the legality of relief given in such circumstances. On appeal, it was affirmed by the Master of the Rolls "that the payment by the defendants out of the poor rates of any money for setting to work or for the relief of able-bodied men, who were at the time able to obtain and perform work at wages sufficient to support themselves and their wives and families (if any), was unlawful. . . . But this declaration does not include relief given to or for the wives and children of such men." This judgment may be of less importance than at first sight appears. It leaves an enormous discretion in the hands of the local authority. A board of guardians favourably disposed to the employers, or determined to be neutral, would, as has frequently been done in similar cases, have exerted themselves to provide temporary workhouse accommodation, a course of procedure which, all previous experience seems to show, would have enabled them to surmount the difficulty. Very few would have accepted the condition. On the other hand, even with the declaration of law as above quoted, a board of guardians determined to favour a strike can still do so by relieving the wives and families on terms which it is known will be readily accepted. Happily, such questions do not often arise, but the incident and the declaration of the law which it called forth are both very characteristic of the elastic, not to say arbitrary, nature of local administration.

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Pope, John (1822–1892), American soldier, was born at Louisville, Ky., 16th March 1822, and graduated at the United States Military Academy in 1842. Brevetted for gallantry at Monterey and Buena Vista, he next made surveys over the Mexican frontier, and was commissioned a captain of engineers, 1st July 1856. In the political campaign of 1860 he earnestly espoused Lincoln's candidacy, and was nearly court-martialled for his remarks. As brigadier-general of volunteers, 17th May 1861, he was placed in command of the Missouri military districts. He co-operated in 1862 with Admiral Foote's flotilla in the capture of New Madrid and Island No. 10, taking over 6000 prisoners. Promoted major-general of volunteers, March 1862, he next united with General Halleck's combined armies in the capture of Corinth, 30th May. He was now summoned to the east and assigned to command of the army of Virginia, while McClellan was at the Peninsula. Upon the latter's want of success the army of the Potomac was recalled to aid Pope's operations close to Washington; but the new campaign was unfortunate, and culminated in the disastrous second battle of Bull Run, 29th and 30th August; and a few days later Pope resigned his command, and never again actively engaged at the seat of war. Controversy arose over the failure of these operations, which Pope himself imputed to the personal hostility of Generals McClellan and Fitz-John Porter, though not himself free from blame. He subsequently commanded departments at the North-West and the Pacific; was made major-general United States army, 26th October 1882; retired, 16th March 1886; and died at Sandusky, Ohio, 23rd September 1892.

Poperinghe, a town of Belgium, in the province of West Flanders, 40 miles south-west of Bruges, with a station on the line from Ypres to Hazebrouck (France). The district around is covered with hop-gardens. Among the industries are the manufacture of woollen goods, tobacco, and tanning. Population (communal) (1880), 11,007; (1900), 11,124.

Population.—The total population of the world continues to be very largely a matter of rough approximation, though every decade brings a certain diminution of the field of conjecture, as some form of civilized administration is extended over the more backward tracts. In the following table the results of the most recent census and estimates are compared with those given in 1882, the proportion of guesswork being indicated against both population and area.

TABLE I.

	Population, in Thousands.			Square Miles, in Thousands.			People per Square Mile in 1900.
	1882.	1900.	Percentage Unenumerated.	1882.	1900.	Percentage Unsurveyed.	
Europe . .	327,743	393,622	1·6	3,755	3,788	3·8	104
Asia . . .	795,591	874,282	63·0	17,208	15,806	44·4	55
Africa . .	205,823	164,319	87·9	11,513	11,306	93·4	14
America . .	100,415	145,661	7·2	14,851	15,477	20·1	9
Oceania . .	4,232	5,652	15·5	3,456	3,446	9·9	1·6
Total[1] .	1,433,804	1,583,536	45·0	50,783	49,823	42·4	32

[1] Excluding the Polar regions.

Next to Africa, China and its neighbourhood, with Turkey, Persia, the large islands of the south-eastern oceans and the wilder tracts of Central and South America, furnish the greater part of the field still open to inquiry (see CENSUS).

Sex.—Investigations into the subject of the normal distribution of the sexes have added comparatively little directly to our knowledge of the question, though much valuable information in this respect has been obtained from the wider study of factors which tend to disturb that proportion. Among the undeveloped communities brought under observation, the relatively low value set upon female life results possibly in a real, certainly in a recorded, paucity of that sex. Again, in a far more advanced stage of civilization, convention entails a similar inaccuracy of the record. In most Oriental and orientalized countries, for instance, the strict seclusion of the women of the household and consequent reticence regarding them, is habitual among the upper classes, and naturally tends to spread downwards throughout the community. Even in the higher and more progressive civilization of Western Europe and its offshoots in other continents, where neither of the above-mentioned disturbing considerations are operative, other causes, such as the greater dangers to which men are exposed in war and industry, together with the wider prevalence of migration among that sex, tend to counteract what appears to be the better vitality of women and a possibly growing proportion of female births. All that can be said on the subject with certainty, therefore, is that in long-settled and prospering communities, where accuracy of data may be fairly assumed, there will be found a greater or less excess of females, whilst in their colonies the influence of immigration throws the weight into the opposite scale. Elsewhere, on the other hand, the general preponderance in the returns of males may be attributed both to neglect of female life and to the concealment of those in existence, according to circumstances. In illustration of these general propositions, the following table, giving the number of females per 1000 males, is subdivided into groups showing Western European countries, Oriental countries, and European colonies respectively, with, in some cases, the variation in the proportion that has been returned at different periods.

TABLE II.

Country.	Year.	Females per 1000 Males.	Country.	Year.	Females per 1000 Males.
England and Wales	1851	1042	Portugal	1878	1091
	1871	1054		1900	1090
	1901	1069	Spain	1877	1029
Scotland	1851	1100		1897	1062
	1871	1096	Italy	1871	989
	1901	1058		1881	995
Ireland	1841	1034	Greece	1879	934
	1871	1050		1896	921
	1901	1028			
Sweden	1870	1067	Hungary	1869	1002
	1900	1049		1890	1015
Norway	1865	1036	Russia (Europe)	1897	986
	1890	1090	Servia	1895	949
Finland	1886	1038	Bulgaria	1900	959
	1897	1022	Bosnia (and Herzegovina)	1895	893
Denmark	1870	1026			
	1900	1053	Egypt	1897	967
Germany	1875	1036	Ceylon	1861	941
	1900	1032		1891	887
Austria	1869	1041	India	1901	963
	1890	1044	Russia (Asia)	1897	893
Holland	1849	1040			
	1899	1025	United States	1860	955
Belgium	1866	995		1900	953
	1900	1005	Canada	1871	939
Switzerland	1870	1046		1891	967
	1900	1035	Cape Colony	1891	990
France	1851	1010	Australasia	1861	715
	1876	1008		1901	864
	1896	1024	Argentina	1895	893

Age.—The general distribution of the population by age is ascertained in the first instance at the census, but the return, when based upon the untested statement of the individual, is apt to err, owing to the ignorance or deliberate intent of those furnishing the information. Of the latter class of error examples are given in the census reports for England and Wales. The possibilities of the former may be judged by the preference shown by the enumerated for the even multiples of ten in the following selected figures.

TABLE III.

Age.	Number at each Age per 10,000 of Population.			
	Germany, 1890.	United States, 1890.		India, 1891. Females.
		White.	Coloured.	
19	160	195	196	64
20	183	202	225	505
21	177	200	187	54
29	138	148	101	42
30	149	214	238	624
31	143	123	69	30
49	86	70	50	12
50	101	119	156	386
51	87	56	35	12
59	59	41	20	10
60	69	77	103	281
61	56	35	17	11

In order to neutralize such irregularity, the return is subdivided into aggregates of five to ten years, from which the annual detail can be obtained by graduation. Shown in some such form, it will be found that the distribution by age varies not only in the different countries, but also from decade to decade in the same country. To facilitate comparison in this respect, the table given below contains

TABLE IV.

Country.	Year.	Proportion in 1000 Persons.			
		Under 15.	15–40.	40–60.	60 and over.
Sweden	Normal	336	389	192	83
	1890	333	360	192	115
Denmark	1890	348	368	182	102
Holland	1889	352	372	184	92
Belgium	1890	328	389	186	97
Germany	1871	345	389	190	76
	1890	351	387	182	80
Austria	1890	342	388	191	79
Hungary	1890	387	379	178	56
Bulgaria	1888	414	322	172	92
France	1851	273	399	227	101
	1896	260	392	223	125
Italy	1881	322	388	201	89
England and Wales	1841	360	408	161	71
	1891	351	405	170	74
Scotland	1891	356	398	167	79
Ireland	1841	382	396	157	65
	1891	325	387	183	105
United States	1860	405	418	134	43
	1890	356	423	159	62
United States (coloured)	1890	421	404	129	46
Canada	1891	365	411	153	71
Cape Colony	1891	432	390	130	48
Australia	1891	374	427	149	50
India	1891	392	399	157	52

the number per thousand of the population of each of the selected countries, returned at the different periods corresponding with early youth, prime, middle age, and decline of life. Most of the more recent figures are borrowed from the report on the German census of 1890, whilst the earlier are compiled from the original returns. At the head of the list stands the distribution of a standard West Eu opean population established by Dr Sundbärg, of Stockholm, from the unrivalled series of data available in Sweden, with which the figures for countries more subject to abnormal disturbance may be compared. Amongst the prominent features of the return may be mentioned the high proportion of those under forty in the British Colonies, England, and Germany; the low proportion of the young in France, Ireland, and Italy, with a corresponding weight of the aged; and the generally close approach of Austria to the standard.

General Rate of Increase.—The variation in the total population of a country and in its distribution by sex and age at different times, as reflected in the preceding table, is mainly due, apart from the effects of war, pestilence, or famine, to the ordinary relation between births and deaths on the one hand, and the interchange of population with other countries on the other. The former, or natural, variation usually manifests itself in a greater or less excess of births over deaths, while the tide of migration sets, on the whole, steadily from the old world to the new, and from the north of Europe to the north of Asia. The resultant of these two factors is shown in Table V. below, which gives the annual rate of increase per cent. during the 19th century of some of the principal countries of the civilized world. It should be noted, however, that the returns for the earlier years dealt with are by no means as accurate as those for the years since 1840 (see the *Bevölkerungslehre und Bevölkerungspolitik* of A. F. von Fircks, p. 197). The rate, again, is in geometrical, not arithmetical, progression; and is lower, accordingly, than that shown in some current publications. The total for Europe includes the figures for Ireland, the population of which has been decreasing since about 1845, as well as those for countries in the east of Europe, of which the population is at present, or was until recently, a matter of conjecture. Taking only the western countries, the returns for which are more trustworthy, the percentage for the century is something over ·68 instead of ·76. France, Spain, and Italy fall far below this average, while England and Scandinavia considerably surpass it. The rate in "new" countries is given by way of contrast.

TABLE V.

Country.	Annual Rate of Increase per Cent.			
	1800–99.*	1800–50.	1850–99.*	By latest Census.
England and Wales	1·35	1·41	1·21	1·15
Sweden	0·78	0·79	0·78	0·71
Norway	0·93	0·94	0·92	1·10
Denmark	0·98	0·84	1·11	1·09
Finland	0·91	0·91	0·92	1·01
Germany	0·98	0·96	0·99	1·50
Austria	0·67	0·58	0·79	0·89
Hungary	0·65	0·57	0·75	0·95
Holland	0·87	0·73	1·01	1·24
Belgium	0·81	0·76	0·88	1·06
France	0·36	0 52	0·20	0·13
Spain	0·49	0·48	0·51	0·54
Italy	0·57	0·56	0·58	0·69
All Europe	0·76	0·67	0·79	0·86
United States	2·69	3·00	2·39	1·90
Australia	...	...	3·05	1·87
Argentina	...	...	...	3·22
Canada	...	...	2·15	1·00
Brazil	...	...	...	2·06
British India	...	...	...	0·93†

* Or later. † 1891.

Migration.—The want of full information as to emigration from the different countries precludes any accurate demarcation by statistics of the respective influence upon the rates of increase given above of migration and natural growth. It has been calculated by the author quoted just now, Dr Fircks, that during the period 1825–1900 over 23 millions of people left western Europe in excess of those received from abroad. To this sum Ireland contributed 8·7 millions; Germany, 5·5; Great Britain, 2·3; Italy, chiefly during recent years, 1·6; and Scandinavia, about a million. The loss to Germany during the twenty-four years ending with 1895 is stated to have amounted to about 18 per cent. of the natural increase. In the United States the census of 1890 gives nearly 15 per cent. of the population as foreign-born, as compared with 9·68 per cent. in 1850. The census of Canada, too, in 1891 gave a proportion of about 14 per cent. In Australia in 1891 the corresponding figure was nearly one-third, and the census of Argentina in 1895 showed over one-fourth to be of foreign birth.

Natural Increase.—The general rate of increase given above may be compared with the average annual excess per cent. of births over deaths shown in Table VI. The only general tendency to be noted in the figures is that while both birth- and death-rates appear to diminish, the former does so far more slowly than the latter. There are important exceptions, however, amongst which are France, England, and Ireland.

TABLE VI.—*Annual Rates of Birth, Death, and Natural Increase per 100 of Population.*

Country.	Birth-Rate.			Death-Rate.			Excess of Births.		
	1841–50.	1861–70.	1891–95.*	1841–50.	1861–70.	1891–95.*	1841–50.	1861–70.	1891–95.*
England and Wales	3·46	3·76	3·05	2·37	2·40	1·92	1·09	1·36	1·24
Ireland	...	2·62	2·29	...	1·66	1·85	...	0·96	0·74
Sweden	3·11	3·14	2·74	2·06	2·02	1·62	1·05	1·12	1·12
Norway	3·07	3·09	3·04	1·82	1·80	1·63	1·25	1·29	1·41
Denmark	3·05	3·10	3·06	2·05	1·99	1·74	1·00	1·11	1·32
Finland	3·55	3·47	3·15	2·35	3·26	2·16	1·20	0·21	0·99
Germany	3·61	3·72	3·59	2·68	2·69	2·15	0·93	1·03	1·40
Austria	3·87	3·85	3·71	3·33	3·06	2·72	0·54	0·79	0·99
Hungary	...	4·35	4·16	...	3·40	3·18	...	0·95	1·03
Holland	3·30	3·53	3·28	2·62	2·54	1·84	0·68	0·99	1·44
Belgium	3·05	3·16	2·92	2·44	2·38	2·02	0·61	0·78	0·90
France	2·73	2·63	2·23	2·32	2·36	2·16	0·41	0·27	0·07
Italy	...	3·75	3·43	...	3·10	2·31	...	0·65	1·12

* Or later.

In comparing the conditions of different countries as judged by their vital statistics, the question arises: What standard should be applied? By some authorities civilization is judged by the death-rate. Others, however, regard as of equal importance the gradual extension of that rate over a wider field, and take the birth-rate also into account. In order to avoid giving the latter undue preponderance in the equation, Herr Rubin, Director of Statistics for Denmark, has suggested as the most representative measure of civilization the quotient of the birth-rate into the square of the death-rate (*Journal of Royal Statist. Soc., London, 1897*, p. 154). The serial order of the twelve principal countries of Europe for which figures are available is shown in Table VII. according to all three methods. In the two first sections the order is that of the death- and birth-rates respectively, beginning in each case with the lowest, that is, Norway as to the former and France in respect to births. The last section of the table combines in like order these two factors in the ratio proposed by Herr Rubin. In two of the three divisions Scandinavia and England occupy the first place, but the high birth-rate of England places it below France and Belgium. The decreasing natality of France takes that country far down the list in the combined figure; but Austria and Hungary, with high rates of both natality and mortality, occupy the lowest places. The position of Finland is obviously due to the abnormal death-rate in the decade 1861–70, otherwise its place would fall between Holland and Belgium.

TABLE VII.—*Countries in Serial Order according to the Birth and Death-Rate.*

Country.	(d) Death-Rate.			(b) Birth-Rate.			$d^2:b$.		
	1861-70.	1881-90.	1891-99.	1861-70.	1881-90.	1891-99.	1861-70.	1881-90.	1891-99.
Norway . .	1	2	2	2	4	4	1	1	1
Sweden . .	3	1	1	4	2	2	3	2	2
Denmark . .	2	3	3	3	5	5	2	3	3
Finland . .	11	7	8	6	8	6	12	5	8
England and Wales	4	4	5	7	6	7	4	4	5
Germany . .	8	9	7	9	10	10	7	8	6
Holland . .	7	6	4	8	7	8	6	6	4
Belgium . .	6	5	6	5	3	3	5	7	7
France . . .	5	8	9	1	1	1	8	10	11
Italy . . .	10	10	10	10	11	9	10	9	9
Austria . .	9	11	11	11	9	11	9	11	10
Hungary . .	12	12	12	12	12	12	11	12	12

Nuptiality and Fecundity.—In connexion with the subject of natural increase may be mentioned the tendency of a people towards marriage, and the average fertility of each union, so far as these facts can be tested statistically. In Table VIII., based on German authority of some years ago, the yearly rate of marriages per 1000 of population is shown for three periods, together with the average number of children per marriage and the births per thousand married women of between fifteen and forty-five years old.

TABLE VIII.—*Marriage Rates, &c.*

Country.	Annual Marriages per 1000 of Population.			Average Number of Children per Marriage.	Average Number of Births per 1000 Wives, aged 15–45.
	1841-50.	1861-70.	1891-95.	1871-80.	1871-80.
Sweden . .	14·54	13·08	11·45	4·0	302
Norway . .	15·56	13·28	12·92	3·9	322
Denmark .	15·74	14·90	13·84	4·3	286
Finland . .	16·30	15·50	12·98	4·1	309
England and Wales . .	16·10	16 69	15·16	4·2	302
Ireland . .	...	10·50	9·48	5·5	...
France . .	15·88	15·62	14·90	2·9	201
Germany . .	16·10	17·04	15·88	4·2	332
Holland . .	14·82	16·44	14·48	4·3	367
Belgium . .	13·58	15·04	15·24	4·1	342
Italy . .	...	15·20	14·96	4·5	291
Austria . .	17·25	17·36	15·76	4·0	...
Hungary . .	...	18·60	17·92	4·4	...

The general tendency shown in this table is for the marriage rate to decline. It is apparently the same with the number of births compared with that of married women of the productive ages, for in England that rate, which was in 1871, 292 per thousand wives, fell in 1891 to 264. In Prussia the corresponding figures were 409 and 383. The Swedish returns, which go back to 1811, show considerable fluctuations, but seem to indicate a decline dating from the middle of the 19th century.

The average age at marriage is another factor not without its importance in connexion with this subject. Without entering into details, it may be said that in Switzerland and Austria the husband's age tends to a little above 31, and in Scandinavia and Belgium to a little below that figure. It is about a year less in France, Italy, and Holland. England, with 28·4, stands lowest. As to the average age of the wife at marriage, there seems a considerable tendency towards 27 years, Scandinavia, Holland, and Belgium exceeding, and England and France falling short of it. Italy returns the lowest figure, namely, 24¼. Most of Europe, excluding Russia and the east, shows a difference in age between husband and wife of from two to three years. In Italy the interval is nearly 5 years, in Ireland and Austria, about 4, in France, 3½, and in England and Holland, 2¼ years.

Mortality.—The influence on the constitution of a population of the distribution by age and sex of the annual death-rate can only be given in outline here. The most prominent feature in the returns of mortality is the heavy proportion borne to the total by the deaths of children of under five years old. This ratio varies according to the birth-rate, from a little over a quarter, in France, to over 40 per cent. in the greater part of central Europe, and even higher in Russia and the east. The predominant factor is the rate during the first year of life, which tends to be twice, thrice, and even four times that which prevails in the succeeding year. The two first columns of Table IX. give the rate of this infantile mortality at two decennial intervals computed by Dr Bodio. In the rest of the table the sexes are distinguished, as the rates of the two differ materially. Thus the predominating numerical superiority of women in most civilized countries is shown by the third column to be not attributable to the fact that more of them come into the world, since boys are born in far greater numbers than girls, though the disproportion seems, from the English returns, to tend to diminish. But, except between the ages of 10 and 20, the vitality of the female sex exceeds that of males throughout life, the advantage in the first year, according to the theoretical constitution of a life-table, being as great as is shown below:—

TABLE IX.—*Infantile Mortality, &c.*

Country.	From Returns.			From Life-Tables.					
	In 1000 Births, Deaths in First Year.		Boys born Alive per 1000 Girls.	Annual Deaths per 1000 at each Age.				Mean After-life-time, in Years.	
				Under 1 Year.		Under 5 Years.			
	1874-83.	1884-93.	1894.	Boys.	Girls.	Boys.	Girls.	M.	F.
Sweden .	128	107	1050	141	119	50	44	45·3	48·6
Norway .	104	96	1058	113	96	43	39	47·4	49·9
Denmark .	141	136	1048	147	124	47	42	45·6	47·4
England .	144	146	1039	161	131	55	48	43·7	47·2
Holland .	204	174	1055	197	165	64	56	42·5	45·0
France .	165	168	1046	198	167	64	57	40·8	43·4
Italy . .	208	190	1058	213	193	89	85	35·1	35·4
Prussia .	216	207	1052	221	189	73	65	39·0	42·2
Saxony .	284	282	1050	303	258	96	84	34·6	38·5

A considerable difference will be noted between Scandinavia and England and the rest of the countries mentioned. In the former not only is infantile mortality lower, but the difference between the sexes in this respect is less. It is true that Italy precedes them in regard to this last point; but there the conformity of the two rates is apparently the result of a high female rather than of a low male mortality. The general results tend to confirm the indications afforded in the last portion of Table VII.

Comparison between the countries is carried a little farther by the addition of the mean after-lifetime from birth, calculated from the life-tables. It must be understood that where, as in England, there is a large natural increase, the mean age at death is necessarily much lower than the figures here given, which are those derived solely from a stationary community.

The normal course of a generation in the different countries is as follows:—

Table X.—*Survivals at Various Ages of* 100,000 *Births of each Sex.* (*Herr Fircks.*)

Country.	Males.				Females.			
	5 Years.	15 Years.	45 Years.	70 Years.	5 Years.	15 Years.	45 Years.	70 Years.
Sweden . .	775	727	574	294	798	749	610	356
Norway . .	803	754	590	325	820	769	616	372
Denmark .	785	737	587	285	808	753	588	334
England and Wales . .	751	726	564	239	783	759	604	299
Holland .	717	684	543	269	748	712	560	314
France . .	716	680	512	245	744	703	539	291
Italy . .	629	579	442	198	643	588	438	200
Prussia . .	684	651	505	210	715	677	542	263
Saxony . .	602	573	443	169	645	614	483	239

(J. A. B.)

Porbandar, a native state of India, in the Gujarat division of Bombay, extending along the south-west coast of the peninsula of Kathiawar. Area, 636 square miles; population (1881), 71,072; (1891) 85,785; estimated gross revenue, Rs.6,50,000, of which Rs.2,62,560 was expended on public works in 1897–98; tribute, Rs.48,504. The chief, whose title is Rana, is a Jethwa Rajput. At present the state is under British administration. Limestone is largely exported to Bombay. The town of Porbandar is on the seacoast, and the maritime terminus of the Kathiawar railway system. Population (1881), 14,569; (1891), 18,805. A large trade is conducted in native boats as far as the west coast of Africa. There are an oil mill and a state printing-press, issuing a gazette.

Pordenone, a town of the province of Udine, Venetia, Italy, 30 miles west by south of Udine on the railway to Treviso. It was the birthplace of the painter Il Pordenone (1483–1539). Paintings from his brush adorn the Renaissance cathedral, and others are preserved in the gallery of the town hall. Cotton industries are active, and silk and pottery are manufactured. There is an industrial school (1872). Population (1881), 6996; (1899), 7500.

Portadown, an inland town and urban sanitary district in the county of Armagh, Ireland, on the river Bann and the Great Northern Railway, 25 miles west-south-west of Belfast. There are frequent markets for the sale of agricultural produce, and a large number of persons are engaged in the manufacture of linen and cotton goods. The town, which belongs to the Duke of Manchester, has been much improved. Population (1881), 7850; (1891), 8430; (1901), 10,046.

Portaels, Jean François (1818–1895), was born at Vilvorde (Brabant), in Belgium, 30th April 1818. His father, a rich brewer, sent him to study in the Brussels Academy, and the director, François Navez, ere long received him as a pupil in his own studio. About the year 1841, Portaels, wishing to make further progress, went to Paris, where he was kindly received by Paul Delaroche. Having returned to Belgium, he carried off the Grand Prix de Rome in 1842. He then travelled through Italy, Greece, Morocco, Algeria, Egypt, the Lebanon, Judæa, Spain, Hungary, and Norway. On his return to Belgium in 1847, Portaels succeeded H. Vanderhaert as director of the Academy at Ghent. In 1849 he married the daughter of his first master, Navez, and in 1850 settled at Brussels; but as he failed in obtaining the post of director of the Academy there, and wished, nevertheless, to carry on the educational work begun by his father-in-law, he opened a private studio-school, which became of great importance in the development of Belgian art. He again made several journeys, spending some time in Morocco; he came back to Brussels in 1874, and in 1878 at last obtained the directorship of the Academy which had so long been the object of his ambition. Portaels executed a vast number of works. Decorative paintings in the church of St Jacques-sur-Caudenberg; Biblical scenes, such as "The Daughter of Sion reviled" (in the Brussels Gallery, see Plate), "The Death of Judas," "The Magi travelling to Bethlehem," "Judith's Prayer," and "The Drought in Judæa"; genre pictures, amongst which are "A Box in the Theatre at Budapest" (Brussels Gallery), portraits of officials and of the fashionable world, Oriental scenes, and, above all, pictures of fancy female figures and of exotic life. "His works are in general full of a facile grace, of which he is perhaps too lavish," wrote Théophile Gautier. Yet his pleasing and abundant productions as a painter do not constitute Portaels's crowning merit. The high place his name will fill in the history of contemporary Belgian art is due to his influence as a learned and clear-sighted instructor, who formed, among many others, the painters E. Wauters and E. Agneesens, the sculptor Ch. van der Stappen, and the architect Licot. He died at Brussels on 8th February 1895.

See E. L. de Taeye, *Peintres Belges contemporains;* J. du Jardin, *L'Art Flamand.* (F. K*.)

Portage, a city of Wisconsin, U.S.A., capital of Columbia county, on the Wisconsin river and the Chicago, Milwaukee, and St Paul and the Wisconsin Central railways, south of the centre of the state, at an altitude of 813 feet. It is in a farming and lumber region, has considerable trade and important manufactures of lumber. Population (1880), 4346; (1890), 5143; (1900), 5459, of whom 1184 were foreign-born.

Portage la Prairie, a port of entry and the chief town of Macdonald county, Manitoba, Canada, situated 50 miles west of Winnipeg, on the Canadian Pacific and Canadian Northern railways, at an altitude of 854 feet above the sea. It is in the midst of a fine agricultural district, and a large export trade in grain and other farm produce is carried on. Population (1891), 3363; (1901), 3901. (J. W.)

Portalegre, a city and episcopal see of Portugal, capital of district of Portalegre, 103 miles north-east of Lisbon. Population (1890), 10,354. The district of Portalegre, with an area of 2482 square miles, and population (1890), 112,834, and (1900), 124,697, giving 50 inhabitants to the square mile, produces corn, olive oil (annual average, 325,400 gallons, valued at £40,000), and wine (246,578 gallons in 1892); but the chief occupation is the breeding of pigs. Woollens and corks are manufactured.

Port Arthur, or, as it is called by the Chinese, Lu-shun-kou, a fortress situated at the extreme south of the peninsula of Liaotung, which stretches down between the Gulf of Pechili and the Yellow Sea in the Chinese province of Manchuria. It was formerly a Chinese naval arsenal and fortress, but was captured by the Japanese in 1894, who destroyed most of the defensive works. In 1898 it

"THE DAUGHTER OF SION REVILED." BY F. PORTAELS.

(*In the Brussels Gallery.*)

was leased to Russia along with the neighbouring port of Talienwan, and was gradually converted into a Russian stronghold. The port or harbour is a natural one, entirely landlocked except to the south, where the entrance is very narrow, being less than a quarter of a mile wide. The basin inside is of limited extent, but is being improved by dredging. Barren and rocky hills rise from the water's edge all round. Extensive barracks have been constructed for the accommodation of troops. A railway connects the port with the Russian lines in Manchuria. The harbour is ice-free all the year round, a feature in which it contrasts favourably with Vladivostok.

The Liao-tung peninsula, separated from Korea by the Bay of Korea, from the Chinese mainland by the Gulf of Liao-tung, runs in a south-westerly direction from the mainland of Manchuria, and is continued by a group of small islands which reach another peninsula projecting from the mainland of China in a north-easterly direction, and having at its north-eastern extremity the port of Wei-hai-wei. The Liao-tung peninsula is indented by several bays, two of which nearly meet, making an isthmus less than 2 miles wide, beyond which the peninsula slightly widens again, this part of it having the name of Kan-tun (Regent's Sword). Two wide bays open on the eastern shore of the latter: Lu-shun-kou (now Port Arthur) and Talienwan. Both have been leased to Russia. The bay is nearly 4 miles long and 1¼ mile wide, the entrance being only 350 yards wide. The Chinese deepened the bay artificially and erected quays, and the population of the village at its extremity reached 6000, Chinese and Japanese. The roadstead is exposed to south-easterly winds, and in this respect the wider bay of Talienwan is better. Port Arthur is well connected by roads with Peking, Korea, and Manchuria, and lies 270 miles from Mukden, 500 miles from Kirin, and 800 miles from the Nikolsk station of the South Usuri railway. Coal is found near to the port. The climate is very mild, and similar to that of south Crimea, only with more moisture. The small peninsula above mentioned has received in Russia the official name of Kwang-tung province. Since its occupation by the Russians, Port Arthur has become Europeanized. The Russian military port, Dalny, is a few miles to the north.

Port Augusta, a town of South Australia, in the county of Frome, the northernmost port of the colony, on the east shore of Spencer Gulf, 259 miles by rail northwest of Adelaide. There is a fine natural harbour. The Government wharf has berthing for large vessels. The town is the starting-point of a railway, which joins the main line from Adelaide to the north. Valuable gold reefs were discovered in 1900 at Tarcoola. A water reservoir (200,000,000 gallons) has been formed at Nectar Brook, 22 miles distant. The town hall is the finest in the colony, that of Adelaide excepted. Population (including Port Augusta West, 369), 1370.

Port-au-Prince. See HAYTI.

Port Chester, a village of Westchester county, New York, U.S.A., on the shore of Long Island Sound, and the New York, New Haven, and Hartford Railroad, 26 miles north-east of New York. Its site is hilly and its plan irregular. It has varied manufactures, consisting in part of woollen goods, carriages, and iron and steel goods. Population (1880), 3254; (1890), 5274; (1900), 7440, of whom 2110 were foreign-born and 97 negroes.

Port Darwin, or PALMERSTON, the chief town of the Northern Territory of South Australia, on the eastern shore of Port Darwin inlet, in the county of Palmerston, about 2000 miles north-north-west of Adelaide. It possesses a magnificent harbour, and a jetty connecting it with the railway, which runs for a distance of 146 miles to Pine Creek. There are a Government House, town hall, and other public buildings, and a Government experimental nursery garden has been laid out in the vicinity. The mean yearly rainfall (13 years) is 63·21 inches. Population, about 2600.

Port Elizabeth, a town and seaport of Cape Colony. The population increased from 13,000 in 1875 to 23,266 in 1891, while the foreign exchanges have in some years exceeded £10,000,000. The imports, chiefly textile fabrics, machinery, and hardware of all kinds, apparel and haberdashery, spirits and provisions, rose from £2,800,000 in 1891 to £8,670,000 in 1896, £7,877,000 in 1897, and £6,246,000 in 1898; for the same years the exports (gold, diamonds, wool, ostrich feathers, hides) were £2,000,000, £1,921,000, £1,950,000, and £2,103,000. The commercial importance of Port Elizabeth is largely due to its position nearly midway between Cape Town and Durban, about 800 miles from both places, and a little over half that distance from Kimberley. The opening of several important railways, by which it communicates with Port Alfred, Graaff Reinet, the Orange River Colony, and Rhodesia, has also helped to make it the most convenient outlet for the whole of South Africa. Lying on the west side of Algoa Bay, under the sheltering headland of Cape Recife, it is protected from the west winds, but is still exposed to the more violent easterly gales pending the completion of extensive harbour works.

Porter, David Dixon (1813–1891), American admiral, was born in Chester, Pennsylvania, 8th June 1813. Three generations of his family before him had commanded vessels upon the high seas. It was under his father, Admiral David Porter of the war of 1812, that he took his first lessons in naval service, when at the age of eleven he accompanied an expedition to the West Indies. He studied for a time at Columbian College, Washington; but the sea soon claimed him, and at the age of fourteen he was a midshipman in the Mexican navy (of which his father was then commander-in-chief). In 1829 he entered the U.S. navy as midshipman, in 1841 was made lieutenant, and in the war with Mexico was in command of the naval rendezvous at New Orleans. At the outbreak of the Civil War he was given command of the steam-frigate *Powhatan*, and joined the expedition for the relief of Fort Pickens. On 22nd April 1861 he was appointed to the rank of commander. In the battle of New Orleans he was in charge of the auxiliary fleet of mortar-boats which made the preliminary five days' bombardment upon Forts Jackson and St Philip. It was he, also, to whom the forts surrendered after the capitulation of New Orleans to Farragut. In October 1862 he took command of the Mississippi Squadron, and the following January had an important part in the capture of Arkansas Post. He next formed the original and daring plan of cutting the levee of the Mississippi at the old Yazoo Pass, and sending a fleet of vessels through the gap into the Cold Water, and thus down the Tallahatchie and the Yazoo rivers to the rear of Yazoo city; but the almost insuperable physical difficulties involved gave the Confederates time to block the advance. In March 1863 another expedition no less daring, and, as it proved, still more perilous, attempted under Porter's personal command to penetrate through connecting streams and bayous to the Yazoo river, and thus reach the rear of Vicksburg; but even greater obstacles thwarted its success. These two expeditions illustrate how difficult and dangerous were the enterprises undertaken by Porter and other naval commanders in their river operations far inland, largely with miscellaneous and improvised vessels, often under conditions hitherto unknown in the history of naval warfare, and yet not infrequently with brilliant success. When Grant decided to approach the rear of Vicksburg from the south, Porter ran his fleet successfully down past the Vicksburg batteries and co-operated with him in the undertaking, and also with General Banks in an expedition up the Red river against Alexandria. On 4th July 1863 he was appointed rear-admiral. In September 1864 he was transferred to the command of the North Atlantic

Blockading Squadron, and in December, with the largest fleet that was assembled at one point during the war, bombarded Fort Fisher, N.C., and silenced the enemy's guns. After a second bombardment (15th January 1865) a land force stormed the fort, and with the aid of the guns of the fleet captured it. After the war he was superintendent of the U.S. Naval Academy (1865–69), and was then assigned to departmental duty at Washington. He was made vice-admiral 25th July 1866, and admiral 15th August 1870, being the only person except his predecessor, Admiral Farragut, who had ever reached that rank. He died at Washington, 13th February 1891. Among his writings are *The Life of Commodore David Porter*, *Incidents and Anecdotes of the Civil War*, and *The Naval History of the Civil War*. His reputation, although somewhat overshadowed by that of his foster-brother, Farragut, was deservedly great. Marked ability and skill as an officer, readiness to take hazardous risks when needed, and an order of originality and resourcefulness quite invaluable in the work that he had to do, were his characteristic qualities as a naval commander. (G. B. L.)

Porter, Fitz-John (1822–1901), American soldier, was born at Portsmouth, N.H., 31st August 1822, the son of Captain John Porter, U.S.N., and graduated at the United States Military Academy in 1845. He served with honour in the Mexican War, was instructor at West Point, 1849–55, and in 1856 became assistant adjutant-general, with the rank of captain, serving in the Utah expedition of 1857–60. In 1860 he was assistant inspector-general, with headquarters in New York City; and he superintended, in 1861, the protection of the railway between Baltimore and Harrisburg during the Baltimore riot, and also organized volunteers in Pennsylvania. He became colonel of a new regiment of regulars, 14th May 1861, and, 17th May, was made brigadier-general of volunteers. In 1862 he took part in the Virginia Peninsular campaign; he was at the siege of Yorktown; and upon the evacuation of that place took command of the 5th Corps, and fought splendidly in June in the battles of Mechanicsville and Gaines's Mill; taking a leading part, besides, at Malvern Hill, 1st July, when McClellan changed his base to the James river. Promoted major-general of volunteers 4th July 1862, and temporarily attached to the army of Virginia, he fought under Pope in the second battle of Bull Run, 29th and 30th August 1862; his corps was unable to move forward the first day, when ordered to advance, but in the afternoon of the second day fought well to save the army from utter rout. Porter, as a warm friend of McClellan, had shown dislike of Pope, and charges were preferred against him; he was tried by court-martial, November 1862, and sentenced to be cashiered, 21st January 1863, "and for ever disqualified from holding any office or trust under the Government of the United States." The justice of this sentence was much discussed after the Civil War, and upon a re-examination made in 1882 Porter was acquitted of the main charge, and President Hayes remitted the disqualifying penalty. General Grant had now taken Porter's part. Against much opposition, partly political, 1879–86, and a veto from President Arthur, a relief Bill finally passed Congress, and Porter was, 7th August 1886, restored to the United States army as colonel, and placed on the retired list. He was commissioner of public works, New York City, 1875–76; police commissioner, 1884–88; and fire commissioner, 1888–89. He died 21st May 1901, at Morristown, New Jersey. (J. SCH.)

Porter, Noah (1811–1892), American educationist and philosophical writer, was born in Farmington, Connecticut, 14th December 1811. He graduated at Yale College, 1831, and laboured as a Congregational minister in Connecticut and Massachusetts, 1836–46. He was elected professor of moral philosophy and metaphysics at Yale in 1846. From 1871 to 1886, when he resigned, he was president of the same college. He edited several editions of Noah Webster's English dictionary, and wrote on education, books and reading, moral science, and the ethics of Kant; but his best-known work is *The Human Intellect, with an Introduction upon Psychology and the Human Soul* (1868), comprehending a general history of philosophy, and following in part the "common-sense" philosophy of the Scottish school, while accepting the Kantian doctrine of intuition, and declaring the notion of design to be *a priori*. He died in New Haven, 4th March 1892.

Port-Glasgow, a seaport, burgh of barony, and parliamentary burgh (Kilmarnock group) of Renfrewshire, Scotland, on the Clyde about 20 miles below Glasgow by rail. The output from the shipbuilding yards, 71,325 tons in 1889, was only 48,123 tons in 1899. There are two graving docks, and a considerable amount of repair work is done. The manufacture of tents and trawling gear has been introduced. The port has an area of 16 acres and nearly 6000 feet of quayage. In 1900, 23 vessels of 15,494 tons were on the register of the port. Modern erections are a library, orphan homes, and public baths. The Birkmyre Park was opened in 1894. Population (1881), 13,294; (1891), 14,685; (1901), 16,840.

Port Hope, the chief town of Durham county, Ontario, Canada, situated 58 miles east-north-east of Toronto, on the north shore of Lake Ontario and on the Grand Trunk Railway. File and machine shops, tanneries, breweries, canneries, carpet and carriage factories, are the principal industries. Population (1901), 4188.

Port Huron, a city of Michigan, U.S.A., capital of St Clair county, on the St Clair river, at the foot of Lake Huron, and the Grand Trunk and the Pere Marquette railways, in the eastern part of the state, at an altitude of 586 feet. The site is level, the street plan regular, and it is divided into ten wards. It has the Holly system of waterworks, the supply being pumped from Lake Huron, and the city is well paved. It is an important railway centre, and has a large trade in grain and lumber. It has the works of the Grand Trunk Railway, many grain elevators, and manufactures of varied character. It is connected with Sarnia, Canada, on the opposite side of the river, by ferries and by a railway tunnel. Population (1890), 13,543; (1900), 19,158, of whom 7142 were foreign-born and 69 negroes.

Port Jervis, a village of Orange county, New York, U.S.A., on the Delaware river, at the mouth of the Neversink, near the junction of the three states of New York, New Jersey, and Pennsylvania. It is on the Erie Railway, and at an altitude of 442 feet. It contains works of the Erie Railway, and has varied manufactures. Population (1890), 9327; (1900), 9385, of whom 895 were foreign-born and 119 negroes.

Portland, a town of Middlesex county, Connecticut, U.S.A., on the east side of the Connecticut river, 40 miles from Long Island Sound and the New York, New Haven, and Hartford Railroad. It comprises an area of 26 square miles of hilly country, containing rural population, and a village of the same name as the town. It contains quarries of brown sandstone. Population of the town (1890), 4687; (1900), 3856, of whom 1316 were foreign-born.

Portland, a city and seaport of Maine, U.S.A., capital of Cumberland county, in the south-western part of the state, the largest and most important city in the state. It has an uneven, hilly site, broad, well-shaded streets, is divided into nine wards, and derives an excellent water-supply from Sebago Lake to the north by gravity, the works being owned privately. It is well sewered, and the business streets are paved. It is situated on a neck or promontory, rising, in Munjoy Hill, to an altitude of 161 feet, and lying between the harbour and Back Bay. The deep and capacious harbour has made Portland mainly a commercial city. Its exports for the year ending 30th June 1901 amounted to $12,416,793, and its imports to $633,114. The Grand Trunk, the Maine Central, and the Boston and Maine railways meet here. The manufactures are large and varied; in 1900 it contained 639 establishments, with a total capital of $6,991,251, employing 5699 hands, and with a product valued at $11,440,201. One of the largest industries was carpentering, the products of which were valued at $1,094,788. Other items of importance were foundry and machine-shop products, lumber, and clothing. The assessed valuation in 1900 was $45,128,305, the net debt was $1,287,533, and the rate of taxation was $21 per $1000. Population (1890), 36,425; (1900), 50,145, of whom 10,435 were foreign-born and 291 negroes. There were 12,645 persons of school age (5 to 20 years). Of 15,433 males 21 years of age and over, 597 were illiterate (unable to write). In 1899 the city of Deering was included within the charter limits of Portland.

Portland, a city of Oregon, U.S.A., capital of Multnomah county, on both banks of the Willamette river, 12 miles above its junction with the Columbia, in the north-western part of the state. The city is built mainly on the west side of the river, the portion on the east side consisting of recent inclusions within the charter limits, which were formerly known as East Portland and Albina, and which were annexed in 1891. The business portion lies mainly on low ground near the river on the west side, whence the residential quarter extends up the slope to the hills, now being dotted with villas. The water supply is drawn from streams and lakes in the Cascade range by gravity, the sewer system is excellent, and the city is divided into eleven wards. It derives its power for manufactures, for trolley cars, and for lighting, from the falls of the Willamette at Oregon city by electric cable. Portland is the chief city and seaport of the state. Although situated more than 100 miles from the mouth of the Columbia, the largest vessels can reach its wharves, and its foreign commerce is considerable. For the year ending 30th June 1901, its exports, consisting almost entirely of wheat and wheat flour, had a value of $10,381,884. It is the meeting-point of four railways, the Southern Pacific from California, the Northern Pacific from Seattle and the north, the Astoria and Columbia River from the west, and the Oregon Railroad and Navigation Company from east Washington and Oregon. The latter line brings to Portland for shipment the enormous wheat crop of southern Washington and north-eastern Oregon. It has regular steamship lines to San Francisco, to Puget Sound, Alaska, China, and Japan. The volume of business may be summarized by the statement that in 1898 the exchanges at its clearing-house aggregated $94,572,454. The number of manufacturing establishments in 1900 was 1064, with a total capital of $13,331,500. They employed 8572 hands, and the product was valued at $23,451,132. The chief industries, with the value of their products, were lumber and timber, $3,539,268; flouring and grist mill products, $1,759,262; and slaughtering and meat-packing (wholesale), $1,306,996. Among the many fine buildings may be mentioned the magnificent new Union depôt, the Portland Hotel, the Oregonian Building, the Chamber of Commerce, and the City Hall. Among the institutions of the city is the *Portland Oregonian*, one of the best-known newspapers of the West. The assessed valuation of real and personal property in 1900, on a basis of about one-fourth of the full value, was $29,554,209. The net debt was $5,631,548, and the rate of taxation $36 per $1000. Population (1890), including that of Albina and East Portland, since annexed, 62,046; (1900), 90,426, of whom 25,876 were foreign-born and 9812 coloured, including 775 negroes. There were 23,211 persons of school age (5 to 20 years). Of 38,353 males 21 years of age and over, 3251 were illiterate (could not write).

Portland Canal, a typical fjord on the north-west coast of America, leading from Dixon's Entrance in 54° 40′ N. north-eastwards and northwards for a distance of some 80 miles, with an average width of a mile and a half north of lat. 55°. The lower portion, commonly known as Portland Inlet, is divided by islands on the northern side, receives from the eastward the estuary of the Nasse river, and sends out an arm called Observatory Inlet, 40 miles long, to the north-east, which is divided from Portland Canal by a peninsula terminating at Point Ramsden. These inlets were discovered and named by Vancouver in 1793, and surveyed again by Staff Commander Pender in 1868. The water is deep, and the shores are for the most part precipitous and bordered by mountains from 3000 to 6000 feet in height. There are no settlements on the canal except those of the Nasse river Indians. The canal derives its interest from the fact that its mid-channel line, according to the treaty of 1825 between Great Britain and Russia, forms the boundary between Alaska and British Columbia.

Portland, Isle of, a peninsula and town of England, projects from the south coast of Dorsetshire, 4 miles south of Weymouth and 50 miles by rail south-west from Southampton. The harbour of refuge, and the gigantic moles by which it is enclosed, are described under Dockyards. Population (1891), 9443; (1901), 15,262.

Port Louis. See Mauritius.

Port Mahon, or Mahon, a seaport and the capital of the island of Minorca. Its population in 1897 was 17,790. Mahon is still the principal quarantine station of Spain, with a large lazaret. The bay and splendid roadstead cause it to be frequently visited by Spanish and foreign fleets. The modern buildings are a town hall, military and civil hospitals, the Coliseum Theatre, the institute and primary schools, the public library, the museum, a few parish churches that have been restored, and the Government House. The trade is important. The imports in 1898 amounted to £133,596, and were mainly cement, coal (chiefly from England), flour, iron, raw cotton, hides, and machinery. The exports, principally live stock, bread-stuffs, agricultural products, shoes, and cotton stuffs, were valued at £127,772. The shipping returns showed that 165 vessels entered and 136 cleared, mostly Spanish.

Porto Alegre, a city of Brazil and capital of the state of Rio Grande do Sul, at the head of the Bay of Patos and the mouth of the Pardo river. Owing to the shallowness of the bar at the mouth of the lagoon and the temporary closing of the custom-house (reopened in 1900), the trade of the port is not in a flourishing condition. The bar, too, is rapidly increasing in height, for whereas in 1898 the average depth of water was $16\frac{1}{2}$ feet, in 1900 it was only $15\frac{1}{6}$ feet. Important works are contemplated to improve the port. The exports, chiefly lard, jerked beef, salt pork, hides and leather, and manioc flour, vary between £560,000 and £630,000 annually. The greater part of the trade is with other Brazilian ports, and with Hamburg, New York, and Great Britain. Amongst its public institutions counts a school of engineering and an efficient fire brigade. A successful exhibition of industrial and other products was held here in 1901. Population (1890), 52,421; (1900, estimate, probably too high) 100,000, including 10,000 Germans.

Porto Empedocle, formerly MOLO DI GIRGENTI, a seaport town of the province of Girgenti, Sicily, Italy, 6 miles by rail south-west of Girgenti. It exports large quantities of sulphur, the total export increasing from £371,800 in 1888 to £792,400 in 1898. The other exports are chiefly almonds (£50,000 in 1897 and £42,000 in 1898). The total exports rose from £387,000 in 1888 to £774,600 in 1898. The imports increased in the aggregate from £10,350 in 1888 to £60,000 in 1898. The port is protected by two breakwaters, and affords a depth of 17½ to 22½ feet. Vessels load and unload from and into lighters. It was cleared by 1322 vessels of 323,120 tons in 1898. The inhabitants carry on fishing and fish-curing, especially of anchovies and sardines, and there are quarries of calcareous tufa. Population, about 7500.

Port of Spain. See TRINIDAD.

Porto Maurizio, capital of the province of the same name, Liguria, Italy, on the north shore of the Gulf of Genoa, 71 miles by rail south-west of Genoa. It is visited for sea-bathing, and possesses a school of navigation and a meteorological observatory. It has trade in olive oil. In 1897 the port was cleared by 198 vessels of 68,096 tons. Population (1881), 6591; (1901), 7207.

Porto Rico, or PUERTO RICO ("Rich Harbour"), the most easterly and fourth in size of the Antilles, situated between 17° 50′ and 18° 30′ N. and 65° 35′ and 67° 10′ W., roughly rectangular in shape, being 108 miles long and 37 broad, and with an area of 3550 square miles.

Population.—In 1900, the people, almost entirely natives, numbered 953,243. They are divided into a better class of whites of Spanish descent, which constitutes the commercial, professional, and planter element, and a lower class of peasants, known as *gibaros*, which includes whites, people of mixed blood (coloured), and blacks, and constitutes the labouring and agricultural element. Among the *gibaros* there were many traces of the aboriginal Borinquens or Boricuans, who were absorbed into the Spanish cult by the application of the Encomienda in 1512. Of the total population, 589,426 are white and 363,817 black and coloured. Nearly all the people are Roman Catholic in religion and Spanish in language, customs, and dress. The density of population is about 225 to the square mile, and the island presents a continuous series of farms and small villages. The lower classes generally are indolent and thriftless. The question of education was neglected under the Spanish dominion, and the proportion of persons unable to read or write (75 per cent. of these over 10 years of age) is unusually large. The scattered character of the population accounts to some extent for the absence in the past of any effective educational system for the lower classes. The clergy have from time to time attempted to cope with these difficulties, but without any marked degree of success. The United States Government since its occupation has initiated a comprehensive and thorough system of public schools directed by duly qualified teachers, and attendance is compulsory. The cost of these schools is defrayed by the State.

Industries.—One of the principal industries is the production of *coffee*. There are approximately some 110,000 acres under cultivation, and the area is increasing. It is of high quality, and the prices realized are much greater than for the Brazilian article. The coffee plantations are as a rule situated on the higher lands in the interior of the island, where the climate is temperate and healthy. The amount available for export in average years is 26,000 to 27,000 tons. Excessive rain or unusually dry weather seriously affects the yield. Little attention is paid to scientific methods of cultivation. The preparation of the bean for the market is also carried out in a slovenly manner. Labourers on the plantations earn an average wage of 50 cents a day in Porto Rican money, equal to a little less than two shillings. Some foreign capital is invested in the industry besides that belonging to Spaniards, who own, however, most of the larger estates not in the hands of natives. A few plantations are owned by British subjects.

The *sugar* industry showed fairly good prospects in 1902, chiefly owing to the small intrinsic value of the wage rate and the advantage the producer gains from the removal of the American duties. The majority of the plantations are on the lower lands near the seaboard, where the ground allows of easy ploughing. The great central factories common in Cuba are nowhere found. The sugar available for export amounts to some 60,000 tons annually, the greater part being sent to the United States. Rum of excellent quality is largely manufactured, and finds a ready sale in European markets. A considerable amount of foreign capital, some of it British, is invested in the sugar industry. Several properties changed hands after the island became a colony of the United States, the buyers being Americans.

Cacao is also cultivated to some extent. The bean is exported in its natural state, and also as manufactured chocolate. There is room for a great extension of this industry, lands suitable for plantation being abundant and reasonable in price, and the demand for the product showing a steady increase in the United States. The principal plantations are situated in the valleys, at no great height above sea-level, where the climate is moist and warm, and the trees are sheltered from the prevailing winds.

Tobacco is largely grown, both for local consumption and for export. The quality is, however, inferior, although seed is annually brought from Cuba. Cigar and cigarette manufactories are established in all the larger towns. It has been stated by experts that with more attention to the curing of the leaf the quality could be much improved.

Cattle-farming is an important source of wealth, the number of animals in the island being estimated to exceed 400,000. Cuba was a purchaser of the surplus stock, and a market was also found in Barbados and other West Indian islands. In 1896 the value of the live cattle exported was $139,000, and this has since increased considerably. Hides are shipped to the United States and Spain, and have constituted a regular article of trade with these countries for many years. Little attempt has been made to improve the breed of cattle.

Communications.—Porto Rico requires both railways and roads for the proper development of its resources. In all there were 137 miles of railway open to traffic in 1902, and other lines were under construction. San Juan is connected with Arecibo by rail, and Ponce with Mayaguez. The railway system was built by a French company under a concession from the Spanish Government, by which interest on the capital invested was guaranteed. An excellent road with easy gradients runs from San Juan across the island to Ponce, passing through the towns of Caguar, Cayey, Aybonito, and Coamo. The distance from San Juan to Ponce is 90 miles, the journey in a carriage usually occupying 12 hours. This road was built by the Spanish authorities for military purposes, and similar works in other sections of the island were in progress when the war broke out. In 1898 there were 470 miles of telegraph open to public service. A submarine cable connects San Juan with St Thomas and Jamaica, and thence with the outside world.

Finance and Commerce.—There is no public debt, the revenue obtained under Spanish administration having been sufficient to balance expenditure. In the year from 1st July 1894 to 30th June 1895 the receipts and expenses were returned as:—

Revenue.		Expenditure.	
Property taxed	$1,045,417	General expenses	$715,297
Customs duties	2,904,138	Justice and worship	368,953
Stamps	318,747	War	1,142,906
National properties	17,887	Marine	255,555
Miscellaneous	168,771	Finance	160,479
		Interior	702,014
		Public works	558,667
Total	$4,454,960	Total	$3,903,871

The currency was the silver dollar coined specially for use in Porto Rico, and exchange in 1898 averaged $11 to one sovereign. The United States authorities have brought the currency to a gold basis. The foreign trade in 1895 amounted to $33,245,000, the value of the imports being $17,446,000, and of the exports $15,799,000. In 1896 the amount was $37,953,000, distributed as follows:—

Countries.	Imports.	Exports.
Spain	$6,188,000	$5,480,000
Great Britain	2,350,000	144,000
France	299,000	2,701,000
Germany	1,344,000	1,954,000
United States	4,118,000	2,645,000
Cuba	718,000	4,014,000
British Colonies	2,734,000	298,000
Other countries	1,195,000	1,771,000
	$18,946,000	$19,007,000

The principal articles exported in 1896 were coffee to the value of $13,864,000, sugar to the amount of $4,242,000, and tobacco worth $423,000. The principal imports are textiles, rice, flour, provisions, oils, hardware, machinery, and wines. In 1896 the number of vessels calling at Porto Rico was 1142, with a tonnage of 1,407,240. The number sailing from the island was 1116. Oranges, bananas, pine-apples, and many other tropical fruits grow to perfection, and can be delivered in the United States in four days, the distance from San Juan to New York being only 1420 miles. The demand for fruit in that market, especially during the winter months, is practically unlimited.

Towns and Cities.—The Americans found seventy-one municipalities in Porto Rico, including many cities and villages. These were all either agricultural centres or shipping places, which had little commerce with one another, owing to the difficulties of inland communication. All were built upon the Spanish plan, with public edifices massively constructed of mamposteria, and had paved streets, central plazas, and gardens. Some of them dated back to 1511. San Juan (27,000), on the north side, was the political capital; Ponce (42,389), on the south side, the largest commercial city; and Mayaguez, on the west side, the abode of wealthy planters and an important seaport. Arecibo (26,000), Aguadilla, Guayama (the seaport of which is Arroyo), and Humacao (12,000) were capitals of departments which bear their names, and Naguabo and Fajardo, in Humacao, smaller maritime cities of the second class, of from 6000 to 15,000 population. Each transacted considerable foreign commerce by means of steamers and sailing ships. Sabana Grande, Yauco, Juana-Dias, and Salinas, on the south side, are small commercial towns of less than 10,000 people each, situated near the foot of the mountains a few miles from the south coast. Adjuntas, Aguas Buenas, Aybonito, Caguas, Cidra, Cayey, Juncos, Las Marias, Lares, Moca, San Sebastian, and Utuado are neat country towns of 5000 people each, more or less, situated in the coffee districts of the central mountains. They are essentially agricultural towns, Cayey and Caguas being chiefly dependent upon the surrounding tobacco farms. Many of the villages, like Lares, were handsome and well improved. Each had an imposing church and ayuntamiento. With the exception of Caguas, Aybonito, and Cayey, which are situated upon the macadamized highways, they were almost inaccessible except by pack trains.

History.—During the great Spanish-American uprising at the beginning of the 19th century, and the various Cuban insurrections, Porto Rico exhibited slight sympathetic signs of unrest; but Spain was always kinder to this island than to Cuba, and met these disturbances by enacting conciliatory legislation. Between 1815 and 1820 a Junta was formed of Republicans, who later declared independence. Governor de la Torre took prompt action, and restored tranquillity in 1823. Many of the leaders were executed. During the ten years' war in Cuba the Porto Rico Republicans again attempted an uprising. In 1868 there were insurrections at Ponce, Bayamon, and Arecibo, but these were quickly suppressed. A result of the last outbreak was the passage of a measure by the Spanish Cortes, in 1860, which took away the colonial character of the island and made it a political province and organic part of Spain. The province was divided into seven departments for convenience of central administration, while the old municipalities continued to constitute the units of local government. The island was given representation in the Spanish Cortes by five regular Deputies and two Senators, elected upon the same suffrage as those in Spain. With the outbreak of the last Cuban revolution in 1895 the insurrectionary spirit again became noticeable. The Spanish garrisons were increased and the island volunteers strengthened. Many arrests were made, and suspects fled to the United States and Mexico. An insurrectionary Junta was maintained in New York. In 1897 the Spanish Prime Minister, Canovas, instituted a system of reform called provincial autonomy, which was, however, merely a matter of form, the island being governed, as of old, by the representatives of the Crown at San Juan. When, in April 1898, war was declared between Spain and the United States, the Spanish naturally expected that Porto Rico would be assaulted, and the island was strongly garrisoned. In July 1898 the American army reached the island, and was received with a patriotic outburst of welcome by the Porto Ricans that surprised Americans and Spaniards alike. The people, it seems, like those of all other Spanish-American countries, looked upon the American flag as the symbol of democracy and Republican government, and expected that it would bring to them, as General Miles at the time told them it would, all the privileges of other citizens of the United States. When war broke out, General Macias was the Spanish captain-general. He was without adequate means of defending the colony in the event of any serious attack on the part of the United States. In the harbour of San Juan were a few antiquated cruisers and one first-class torpedo boat, the *Terror*. The latter properly belonged to the squadron under Admiral Cervera. The fortifications, especially at San Juan, were of old-fashioned massive stone construction, and most of the artillery was of an obsolete type. A few earthworks were thrown up for the defence of the capital, and orders were given to the troops in the various coast

The Spanish-American war.

towns to report immediately any indication of the appearance of the enemy. General Macias then waited quietly for developments. On 12th May an American squadron, under the command of Admiral Sampson, appeared off San Juan and bombarded the forts. Having satisfied himself that the squadron under Admiral Cervera was not in the harbour, the American commander withdrew. No great damage was effected by the shells from the American ships, but the fire of the Spanish guns was silenced and a panic was created in the city. On 22nd June the United States converted cruiser *St Paul* appeared off San Juan, having been detailed to watch the seas in that direction. The Spanish gunboat *Isabella II.* and the torpedo boat *Terror* were ordered by General Macias to put to sea and attack the American vessel. The *St Paul* was armed with ten 6-inch quick-firing guns, and a secondary battery of three- and six-pounder Hotchkiss and Gatling guns. The *Isabella II.* soon retired, but the *Terror* approached within 1500 yards of the *St Paul.* The American vessel had been holding her fire while the Spaniard was attempting to reach her, but suddenly opened with a broadside, and continued firing rapidly. The *Terror* was struck by a shell, which exploded on board; but she managed to steam back into the harbour, the *St Paul* not attempting to pursue. The residents of San Juan fled in large numbers from the town, and did not return until after the protocol of peace was signed in August. All communication was cut off between Porto Rico and the outer world; but the food supplies were fairly abundant, and little real distress prevailed. No change occurred in the situation until 25th July, when a United States fleet appeared off the southern coast, San Juan being also threatened by a small squadron. A bombardment of the Playa, the port of Ponce, then took place. While this was in progress, an expedition of United States troops was landed at Guanica, fifteen miles to the eastward, the small Spanish garrison of which surrendered. A movement of the American troops was then made towards Ponce, which capitulated without resistance on 28th July. General Miles, the commander-in-chief of the United States army, was in command of the forces, and was assisted by Generals Brooke, Ernst, Schwan, Henry, and Wilson. The first expedition disembarked consisted of 3415 officers and men, but reinforcements arrived immediately after the first landing and brought the number up to 10,000 in round figures.

The Spanish forces in the southern section of the country were ordered to fall back towards the ridge of mountains intersecting the island from east to west, and a little to the north of the town of Coamo. This was a strong position, and here General Macias determined to endeavour to check the American advance. Reinforcements were brought up from San Juan, and all preparations made to resist an attack. General Miles advanced towards the Spanish position, and occupied Coamo after a sharp skirmish. Other movements were in progress, when the peace protocol was signed on 12th August, and orders were at once issued to suspend hostilities. The section of the island occupied by the Americans remained under the jurisdiction of the United States military authorities, while to the north the Spaniards remained in possession. This condition of affairs continued during the arrangements for the evacuation of the island by Spain. The total loss on the American side in the campaign was three killed and forty wounded. The Spanish casualties were somewhat greater, but were not heavy.

The commissioners appointed to arrange the evacuation of the island were Admiral Schley, General Brooke, and General W. Gordon for the United States; and Admiral Villarino, General Ortega, and Señor Dellagiulia for Spain. The meetings of the Commission began early in September, and continued regularly for six weeks. It was arranged that the Spanish troops should be concentrated at San Juan for embarkation. As the Spaniards withdrew from the positions occupied, American troops were detailed to garrison the different towns. While the evacuation was taking place, disturbances occurred at various points, owing to certain natives having instigated their neighbours to revenge themselves on Spanish civilians. The United States military authorities were prompt in quelling these outbreaks; and when it was understood that the first person found implicated in these attacks would be shot or hanged, the trouble practically ceased. By the beginning of October the greater portion of the island had been evacuated by the Spaniards; and on 15th October 1898 Captain-General Macias embarked for Spain, leaving General Ortega to make the final delivery of the island to the American authorities. On 1st January 1899 the sovereignty of Spain, which had dominated the island for four hundred years, was formally transferred to the United States.

Porto Rico—an American dependency.

Pending the action of Congress, the island was temporarily placed under a military government, presided over by the commanding officer of the military department of Porto Rico, General Guy V. Henry, to whom any one treated unjustly had the right of appeal. The four Spanish insular bureaus of administration—State, Justice, Treasury, and Interior, each under a prominent citizen—were continued. The old municipal local governments and Spanish laws remained as before and were not interfered with, except in cases of notorious corruption or injustice. In August 1899 a tropical hurricane of unusual severity devastated the island. Towns, estates, and habitations were destroyed in a day, and thousands of people were reduced to dependence. In Arecibo alone 540 persons were killed by falling houses or masonry thrown down by the wind. The total loss of life was reported to be nearly 5000 persons. The administration of General George B. Davis, who succeeded General Henry shortly after this event, was largely devoted to alleviating the suffering. Over $5,000,000 was expended by the Government of the United States.

Reconstruction and civil government.

Meanwhile the people of Porto Rico awaited patiently the action of the American Congress, which alone had power under the Constitution to devise for them a territorial form of government. The old Spanish tariff laws were still in force, and the island suffered a heavy loss of trade, due to the fact that the customs laws of both Spain and the United States were operative against it. The commercial conditions during this interval were well described by the President in his annual Message of 1899, in which he said: "Since the cession, Porto Rico has been denied the principal markets she had long enjoyed, and our tariffs have been continued against her products, as when she was under Spanish sovereignty. The markets of Spain are closed to her products except upon terms to which the commerce of all nations is subjected. She has therefore lost her free intercourse with Spain and Cuba, without any compensating benefit in this market. The markets of the United States should be opened up to her products. Our plain duty is to abolish all customs tariffs between the United States and Porto Rico, and give her products free access to our markets." When the American Congress assembled in December 1899, the problem of a government for the Porto Ricans quickly came to the front, and unexpectedly resulted in legislation divergent from all traditions and precedents of the American people. A revenue Bill, reported to the House of Representatives by the Ways and Means Committee, provided for a continuance of a tariff between Porto Rico and the United States. This measure was considered unconstitutional by many, and was so directly in opposition to the President's recommendation, that "it was our plain duty" to give the island free trade, that it resulted in a violent storm of opposing public opinion, which bade fair to wreck the organization of the dominant political party. But in spite of the great sentiment against this proviso, the discipline of the party leaders was so perfect that the measure was forced through the House by a small majority. The Bill made no provision for the government of the island. In President McKinley's Message of 5th December 1899 to the fifty-sixth Congress, first session, he stated that it was desirable that the military government should be superseded by an administration entirely civil in its nature, and recommended that Congress pass a law for the organization of a temporary government, which should provide for the appointment by the President (subject to confirmation by the Senate) of a governor and such other officers as the general administration of the island might require; and that for legislative purposes upon subjects of a local nature a legislative council, composed partly of Porto Ricans and partly of citizens of the United States, should be nominated. In the municipalities and other local subdivisions he recommended that the principle of local self-government be applied at once, so as to enable "the intelligent citizens of the island to participate in their own government, and to learn by practical experience the duties and requirements of a self-contained and self-governing people." When the House Bill, providing revenues for Porto Rico, reached the Senate, an amendment providing for a government of Porto Rico was appended thereto. The Bill as amended then passed and became a law. Under this Act the government of Porto Rico is vested in the hands of a governor, to be appointed by the President of the United States. The governor has absolute power to veto all Acts of the legislature. A legislative assembly, also provided, consists of an Executive Council and a House of Delegates. The Executive Council comprises the Island Secretary, Attorney-General, Treasurer, Auditor, and Commissioners of the Interior and Education, none of whom need be citizens of the island, and five other persons to be appointed by the President, who shall be native inhabitants. The House of Delegates is to consist of five members from each of the seven districts of the island. This legislature is given no authority which the governor has not the power to veto; and all power whatsoever over the local questions of franchises, rights, provisions, or concessions is left solely in the hands of the non-resident Executive Council and governor. The ultimate judicial power is vested in the Supreme Court, to be composed of a Chief Justice, Associate Justices, and a Marshal, to be appointed by the President, who need not be residents of the island. Minor judicial matters remain vested in the courts and tribunals already established. The island is elevated into a judicial district, to be called the District of Porto Rico. The pleadings of the court must be conducted in the English language, and appeals may be taken to the Supreme Court of the United States. A Commission was also constituted to revise the laws of Porto Rico, to consist of three members, one of whom shall be a native citizen. Each commissioner is to receive $5000 per annum, to be paid out of the treasury of Porto Rico, together with an allowance for necessary clerks and other assistance. The Act did not give Porto Rico a territorial delegate to Congress, as has heretofore been provided in the case of new territorial organizations; but the island is allowed a resident commissioner at Washington, who is to receive $5000 per annum. The Act leaves no substantive authority whatever in the hands of the people of the island, and does not give them American citizenship. Under the law, furthermore, all administration officials may be Americans, with the exception of the five native members of the Council and the thirty-five members of the House of Delegates. The form of government greatly resembles that of the British Crown Colony of Jamaica.

On 1st May 1900, Mr Charles A. Allen, who had been appointed the first American civil governor of Porto Rico, was installed in office at San Juan. Under his administration the island became peaceful, and prosperity was attained through the removal of duties by executive proclamation of President McKinley.

AUTHORITIES.—(1) **Popular and Descriptive**: Over three hundred titles are given of articles on Porto Rico in the *Cumulative Index* of 1898 and 1899. Of this character the following books are the best: ROBINSON, A. G. *The Porto Rico of To-day.* Scribners, New York, 1899.—HAMM, M. A. *Porto Rico and the West Indies.* New York, 1899.—OBER, F. A. *Puerto Rico and its Resources.* Appleton, New York, 1899.—DIDWIDDIE, W. *Puerto Rico.* Harpers, New York, 1899.—HILL, ROBT. T. *Cuba and Porto Rico, with the other Islands of the West Indies.* 2nd edition. Century Company, New York, 1899. (2) **Scientific Books**: **Fishes**: See Reports of the U.S. Fish Commission, 1899, 1900.—WILSON, H. M. "Water Supply and Irrigation," U.S. Geological Survey Bulletin, 1900.—HILL, ROBT. T., and NITZE, H. B. C. "Mineral Resources," Twentieth Annual Report U.S. Geological Survey.—HILL, ROBT. T. "The Forest Conditions of Porto Rico," U.S. Department of Agriculture, 1899. **Climatology**: Reports and Bulletins U.S. Weather Bureau. **Topography**: HILL, ROBT. T. *National Geographic Magazine*, March 1899, and *Scottish Geographical Magazine*, 1899. **Economic and Statistical Papers**: Reports of U.S. War, Treasury, and Agricultural Departments, 1899.—HILL, ROBT. T. "Value of Porto Rico," *The Forum*, June 1899.—Report of Porto Rican Census, U.S. War Department, 1900. **Government**: See debates in *Congressional Record*, December 1899, January–May 1900.—Reports of Insular Department, Washington, 1901–1902. (R. T. H.; C. E. A.)

Portovenere, a town and summer resort of the province of Genoa, Liguria, Italy, at the southern extremity of the peninsula which protects the Gulf of Spezia on the west, 7 miles south of Spezia. It still retains portions of the fortress and walls with which it was provided by the Genoese in 1113; also of the church of St Peter (1118, destroyed by the Aragonese in 1494), which is reputed to occupy the site of a temple of Venus (whence *Portus Veneris*). The parish church dates from 1139. Here is the cave in which Lord Byron was inspired to write *The Corsair.* To the north of the towns is the Varignano lazaretto, where Garibaldi was imprisoned in 1860 and 1867. Marble and building-stone are quarried, and oysters are caught. Population, about 4000.

Portraiture.—The earliest attempts at individual portraiture are found in the eidolon and mummy-cases of the ancient Egyptians; but their painting never went beyond conventional representation—mere outlines filled in with a flat tint of colour. In Greece portraiture probably had its origin in skiagraphy or shadow-painting. The story of the Greek maiden tracing the shadow of her departing lover on the wall points to this. The art developed rapidly. In 463 B.C., Polygnotus, one of the first Greek painters of distinction, introduced individual portraiture in the decoration of public buildings, and Apelles nearly a century later showed so much genius in rendering character and expression, that Alexander the Great appointed him "portrait painter in ordinary," and issued an edict forbidding any one else to produce pictorial representations of his majesty. Similar edicts were issued in favour of the sculptor Lysippus and Pyrgoteles the gem engraver. No works of the Greek painters survive, but the fate of two portraits by Apelles, which were in the possession of the Emperor Claudius (A.D. 41–54), is known, the heads having been painted out to make room for the features of the divine Augustus!

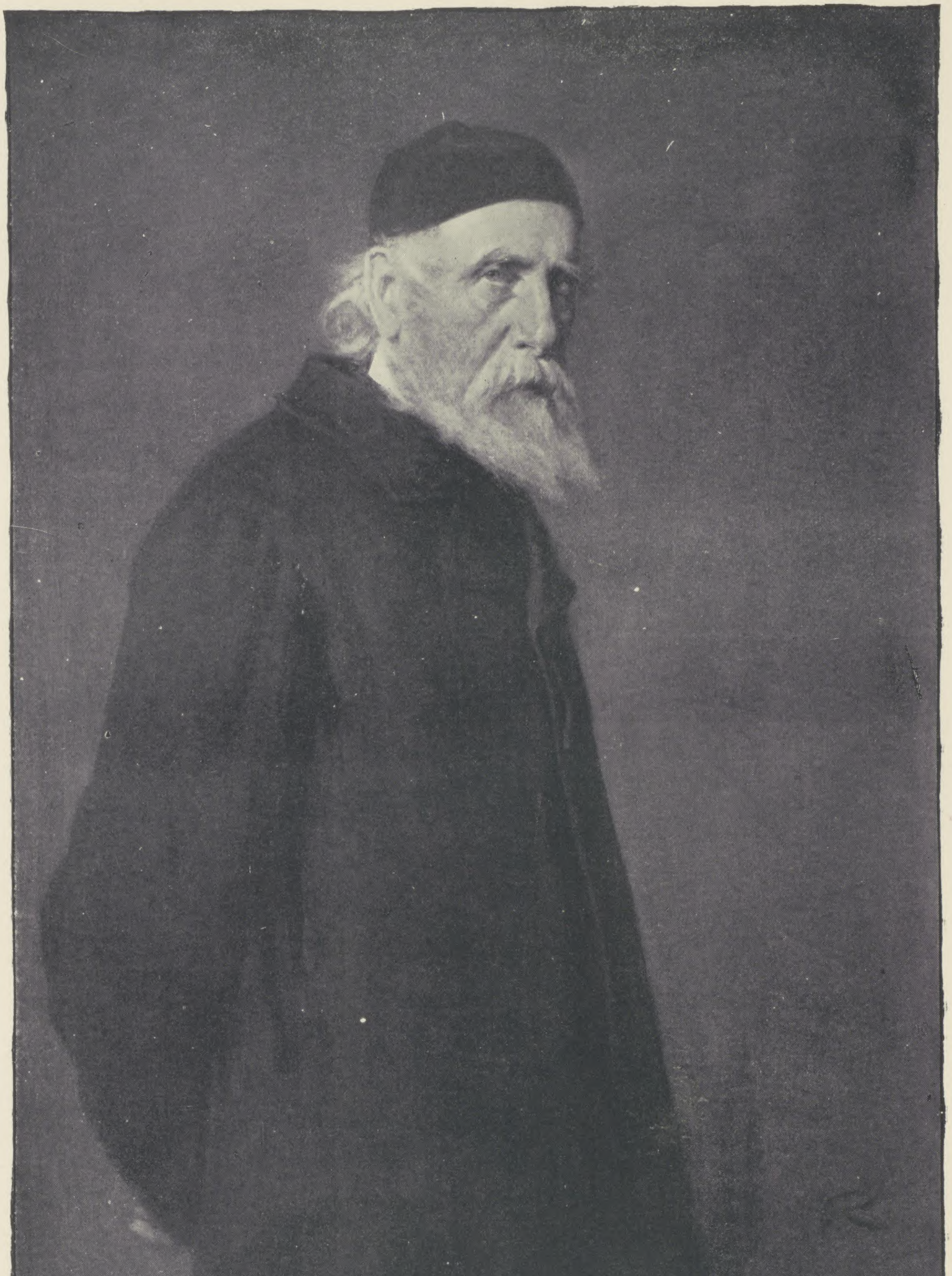
After the time of Alexander (300 B.C.) Greek art rapidly deteriorated. There is, perhaps, nothing in the history of human intelligence to compare with the dazzling swiftness of its development or the rapidity of its decline. War was followed by pillage and devastation, and victorious Roman generals, mere depredators and plunderers, crowded Rome with the stolen treasures of Greece, with the result that Greek art and Greek influence soon made themselves felt in the imperial city, and for generations its artists were almost exclusively Greeks, chiefly portrait-painters and decorators. The Romans possessed no innate aptitude for art, and rather despised it as a pursuit little becoming the dignity of a citizen. Although lacking in appreciation of the higher conditions of art, they had from early times decorated their atria with effigies—originally wax moulds—of the countenances of their ancestors. These primitive "wax-works" ultimately developed into portrait busts, often vivid and faithful, the only branch of art in which Rome achieved excellence.

With the invasion of the Northern barbarians and the fall of the empire Græco-Roman art ended. In the following centuries Christianity gradually became the dominant religion, but its ascetic temper could not find expression in the old artistic forms. Instead of joy in the ideals of bodily perfection, came a loathing of the body and its beauty, and artists were classed among "persons of iniquitous occupations." Before the 5th century these prejudices had relaxed, and images and pictures again came into general favour for religious uses. In the 8th and 9th centuries the iconoclasts commenced their systematic destruction, and it was not till the Renaissance in the 13th century that art began again to live. The great revival brought with it a closer observation of the facts of nature and a growing sense of beauty, and the works of Cimabue and Giotto prepared the way for those of Benozzo Gozzoli, Ghirlandaio, and the long line of masters who raised Italian art to such a height in the 15th and 16th centuries. Although the works of the early painters of the Renaissance were mostly devoted to the expression of the dogmas of the Church, the growing love and study of nature led them, as opportunity afforded, to introduce portraits of living contemporaries into their sacred pictures. Gozzoli (1420–1498) and Ghirlandaio (1449–1494) began the practice, followed by nearly all the old and great painters, of introducing portraiture into their works; Ghirlandaio especially filling some of his great fresco compositions with the forms and features of the living men and women of Florence, members of the Tornabuoni, Medici, and other great families. Acuteness of observation was innate in the race. By degrees it manifested itself in a marvellous subtlety in the rendering of individual character, in the portrayal of individual men and women, and a school of portraiture was developed of which Titian became the crowning glory. This great Venetian painter, by universal consent reckoned one of the masters of portraiture, has handed down to us the features of many of the greatest historical and literary personages of his time—Emperor, Pope, King, Doge—all sat by turn to him and loaded him with honours. The names of Bellini, Raffaelle, Tintoret, Veronese, and Moroni of Bergamo occur among those of the great Italian portrait painters of the 15th and 16th centuries. The last named, some of whose finest works are now in England, was highly praised by Titian.

A love of ugliness characterizes the artists of the early German and Flemish schools, and most of the portraits produced by them previous to Holbein's time suffer from this cause. Schöngauer, Dürer, and Lucas Cranach are never agreeable or pleasant, however interesting in other respects. Dürer, the typical German artist, the dreamer of dreams, the theorist, the thinker, the writer, was less fitted by nature for a portrait painter than Holbein, who, with a keen sense of nature's subtle beauty, was a far greater painter although a less powerful personality. He produced many fine works in other branches, but it is as a portrait painter that Holbein is chiefly known, and his highest claims to fame will rest on his marvellous achievements in that branch of art. He first came to England in 1526, bringing with him letters of introduction from Erasmus. Sir Thomas More received him as his guest, and during his stay he painted More's and Archbishop Warham's portraits. In 1532 he was again in London, where till his death in 1543 he spent much of his time. He was largely employed by the German merchants of the Steelyard and many Englishmen of note, and afterwards by Henry VIII., by whom he was taken into permanent service with a pension. As a portrait painter Holbein is remarkable not only for his keen insight into the character of his sitters, but for the beauty and delicacy of his drawing. As colourist he may be judged by an admirable example of his work, "The Ambassadors," in the National Gallery in London. Many of his drawings appear to have been made as preliminary studies for his portraits.

In Flanders, Jan van Eyck (1390–1440), his brother Hubert, Quintin Matsys, Memlinc, and other artists of the 15th century, occasionally practised portraiture. The picture of Jean Arnolfini and his wife, in the National Gallery, London, is a remarkable sample of the first-named artist, and the small half-length of young Martin van Nieumenhoven, in the Hospital of St John at Bruges, of the last-named. Nearly a century later the names of Antony Mor (or Moro), Rubens, and van Dyck appear. Rubens, although not primarily a painter of portraits, achieved no small distinction in that way, being much employed by royalty (Maria de Medici, Philip IV., and the English Charles I. among the number). His services were also in request as ambassador or diplomatist, and thrice at least he was sent on missions of that nature. His personal energy and industry were enormous, but a large proportion of the work attributed to him was painted by pupils, of whom van Dyck was one of the most celebrated. Van Dyck (1599–1641) early acquired a high reputation as a portrait painter. In 1632 he was invited to England by Charles I., and settled there for the remainder of his life. He was knighted by Charles, and granted a pension of £200 a year, with the title of painter to his majesty. Many of van Dyck's portraits, especially those of his early and middle periods, are unsurpassed in their freshness, force, and vigour of handling. He is a master among masters. England possesses many of his works, especially of his later period. To van Dyck we owe much of our knowledge of what Charles I. and those about him were like. A routine practice, luxurious living, failing health, and the employment of assistants, told upon his work, which latterly lost much of its early charm.

In Holland, in the 17th century, portraiture reached a high standard. A reaction had set in against Italian influence, and extreme faithfulness and literal resemblance became the prevailing fashion. The large portrait pictures of the members of guilds and corporations, so frequently met with in Holland, are characteristically Dutch. The earliest works of the kind are generally rows of portraits ranged in double or single lines, without much attempt at grouping or composition. Later, in the hands of painters like Rembrandt, Frans Hals, and van der Helst, these pictures of civic guards, hospital regents, and masters of guilds assumed a very different character, and



Professor Mitchell, D.D., St Andrews. By Sir George Reid, P.R.S.A.

are among the very finest works produced by the Dutch portrait painters of the 17th century. They may be termed "subscription portraits,"—each member of the guild who desired a place on the canvas agreeing, before the commission was given, to pay, according to a graduated scale, his share of the cost. Among the most famous examples of this class of portraits are "The Anatomy Lesson," "The March-out of Captain Banning Kock and his Company" (erroneously called "The Night Watch"), and "The Five Syndics of the Cloth-Workers' Guild," by Rembrandt. The magnificent portrait groups at Haarlem by Hals—the next greatest portrait painter of Holland after Rembrandt—and the "Schuttersmaaltyd" by van der Helst, in the Amsterdam Museum, which Reynolds considered "perhaps the first picture of portraits in the world," must also be mentioned.

Of the pictorial art of Spain previous to the 15th century, little, if any, survives. Flemish example was long paramount, and Flemish painters were patronized in high places. In the 16th century the names of native Spanish artists begin to appear—Morales, Ribera, Zurbaran, a great though not a professed portrait painter; and in the last year of the century Velazquez was born, the greatest of Spain's artists, and one of the great portrait painters of the world. None, perhaps, has ever equalled him in keen insight into character, or in the swift magic of his brush. Philip IV., Olivarez, and Innocent X. live for us on his canvases. His constantly varying, though generally extremely simple, methods, explain to some extent the interest and charm his works possess for artists. Depth of feeling and poetic imagination were, however, lacking, as may be seen in his prosaic treatment of such subjects as the "Coronation of the Virgin," the "Mars," and other kindred works in the Madrid Gallery. Velazquez must be classed with those whose career has been prematurely cut short. His works often show signs of haste and of the scanty leisure which the duties of his office of "Aposentador Mayor" left him—duties which ended in the fatal journey to the Isle of Rhé.

In France the most distinguished portrait painters of the 16th and 17th centuries were the Clouets, Cousin, Vouet, Philippe de Champaigne, Rigaud, and Vanloo. French portraiture, long inflated and artificial, reached the height of pomposity in the reigns of Louis XIV. and XV., the epoch of which the towering wig is the symbol. In the 18th and early part of the 19th centuries occur the names of Boucher, Greuze, David, Gérard, and Ingres; but somehow the portraits of the French masters seldom attract and captivate in the same way as those of the Dutch and Italian painters.

Foreign artists were engaged for almost every important work in painting in England down to the days of Sir Joshua Reynolds and Gainsborough. Henry VIII. employed Holbein; Queen Mary, Sir Antonio Moro; Elizabeth, Zucchero and Lucas de Heere; James I., van Somer, Cornelius Janssens, and Daniel Mytens; Charles I., Rubens, van Dyck, Mytens, Petitot, Honthorst, and others; and Charles II., Lely and Kneller, although there were native artists of merit, among them Dobson, Walker, and Jamesone, a Scottish painter. Puritan England and Presbyterian Scotland did little to encourage the portrait painter. The attitude of the latter towards it may be inferred from an entry in the diary of Sir Thomas Hope, the Scottish Lord Advocate in 1638. "This day, Friday, William Jamesone, painter (at the earnest desyr of my sone Mr Alexander) was sufferit to draw my pictur." He does not even give the painter's name correctly, although Jamesone at the time was a man of some note in Scotland. At the commencement of the reign of George I., art in England had sunk to about the lowest ebb. With the appearance of William Hogarth (1697–1764) the English school of painting may be said to have commenced, and in Reynolds and Gainsborough it produced two portrait painters whose works hold their own with those of the masters of the 16th and 17th centuries. Both Sir Joshua and Gainsborough are seen at their best in portraits of women and children.

George Romney (1734–1802) shared with Reynolds and Gainsborough the patronage of the wealthy and fashionable of his day. Many of his female portraits are of great beauty. For some unknown reason he never exhibited his works in the Royal Academy.

Sir Henry Raeburn (1756–1823) was a native of Edinburgh, and spent most of his life there. His portraits are broad and effective in treatment, masterly and swift in execution, and often fine in colour. He painted nearly all the distinguished Scotsmen of his time — Walter Scott, Adam Smith, Braxfield, Robertson the historian, Dugald Stewart, Boswell, Jeffrey, Professor Wilson, and many of the leading noblemen, lairds, clergy, and their wives and daughters. For a considerable period his portraits were little known out of Scotland, but they are now much sought after, and fine examples appearing in London salerooms bring remarkable prices. Raeburn's immediate successor in Scotland, J. Watson Gordon (1788–1864), also painted many excellent portraits, chiefly of men. A very characteristic example of his art at its best may be seen in his "Provost of Peterhead" in the Scottish National Gallery.

Sir Thomas Lawrence (1769–1830) was the favourite English portrait painter of his time, and had an almost unrivalled career. He had an immense practice, and between the years 1787 and 1830 exhibited upwards of three hundred portraits in the Royal Academy alone. The Waterloo Gallery at Windsor contains some of his best work, chiefly painted in 1818–19, including his portraits of the Emperor Francis, Pope Pius VII., and Cardinal Gonsalvi. He was loaded with honours, and died President of the Royal Academy.

Sir J. E. Millais (1829–1896), although most widely known as a painter of figure subjects, achieved some of his greatest successes in portraiture, and no artist in recent times has approached him as a painter of children. His portraits of Mr Gladstone, Sir James Paget, Sir Gilbert Greenall, Simon Fraser, J. C. Hook, and Mrs Bischoffsheim, to name only a few, are alone sufficient to give him a high place among British portrait painters.

Frank Holl (1845–1888) first came into note as a portrait painter in 1878, and during the subsequent nine years of his life he painted upwards of one hundred and ninety-eight portraits, an average of over twenty-two a year. The strain, however, proved too great for a naturally delicate constitution, and he died at the age of forty-three—another instance of a brilliant career prematurely cut short.

It is always a matter of considerable difficulty to estimate the work of contemporary artists, for, owing to its nearness, it is apt to assume an importance which with the lapse of time it loses, but the names of a few of the best portrait painters living in 1902 may be mentioned, including those of G. F. Watts (*b.* 1820), to whom we are indebted for admirable portraits of many of the leading men of the Victorian era in politics, science, literature, theology, and art; Orchardson (*b.* 1835), like Millais more widely known as a painter of figure subjects, but also admirable as a portrait painter; Sargent (*b.* 1856), whose brilliant and vigorous characterization of his sitters leaves him without a rival; as well as Ouless, Shannon, Fildes, Herkomer, and others, who have worthily carried on the best traditions of the art.

In France contemporary portraiture is ably represented in the works of Carolus-Duran, Bonnat, and Benjamin-Constant, and in Germany by Lenbach, who has handed down to posterity with uncompromising faithfulness the form and features of Prince Bismarck.

Of portraiture in its other developments little need be said. Miniature painting, which grew out of the work of the illuminator, appears to have been always successfully practised in England. The works of Hilliard, Isaac and Peter Oliver, Samuel Cooper, Hoskins, Engleheart, Plimer, and Cosway hold their own with the best of the kind; but this beautiful art, like that of the engraver, has been largely superseded by photography and the "processes" now in use. It is unnecessary to refer to the many uses of portraiture, but one of its chiefest has been to transmit to posterity the form and features of those who have played a part, worthy or otherwise, in the past history of our race. Of its value to the biographer and historian, Carlyle, in a letter written in 1854, says, "In all my poor historical investigations it is one of the most primary wants to procure a bodily likeness of the personage inquired after; a good *portrait*, if such exists; failing that, even an indifferent, if sincere one; in short, *any* representation, made by a faithful human creature, of that face and figure which *he* saw with his eyes and which I can never see with mine. Often I have found the portrait superior in real instruction to half-a-dozen written biographies, or rather, I have found the portrait was as a small lighted *candle*, by which the biographies could for the first time be *read*, and some human interpretation be made of them." (G. RE.)

Port Richmond, formerly a village of Richmond county, New York, U.S.A., and since 1st January 1898 a part of Richmond borough, one of the five boroughs constituting New York city. It is situated on the northern shore of Staten Island, in the south-east part of the state. Population (1890), 6290.

Portrush, a seaport town in the extreme north of Co. Antrim, Ireland. It is very picturesquely situated, and is on the Belfast and Northern Counties Railway. A fine new hotel and an excellent golf-course are the chief new features, and the place is much frequented both for golf and sea-bathing. It is also the centre for visitors to the Giant's Causeway, with which it is connected by an electric railway (see ELECTRICITY SUPPLY, III., vol. xxviii.). There is a thriving trade in salmon. Population, about 2500.

Port Said, a seaport town of Egypt, at the Mediterranean end of the Suez Canal. Its prosperity is bound up with the traffic going through the Canal; for statistics, &c., see EGYPT. In 1893 it was connected with Ismailia by railway. Population, 37,000.

Portsea. See PORTSMOUTH.

Portsmouth, a municipal, county (1888), and parliamentary borough, seaport, naval station, and arsenal of England, an aggregate of four towns, namely, Portsmouth, Portsea, Landport, and Southsea, in the south-west of the island of Portsea, Hampshire, opposite the Isle of Wight, from which it is separated by Spithead, 75 miles by rail south-west of London. It is a terminal station of the London and South-Western and of the London, Brighton, and South Coast railways. There are about 20 churches. The new church of St Mary's, or Kingston Church, with a tower 165 feet high, was erected in 1889, at a cost of nearly £50,000. Twenty-six board schools include 2 of higher grade, one of them (1896) equipped with chemical and physical laboratories. There are also schools for engineering students and dockyard apprentices. Public buildings of modern erection are the town hall (1890), costing £140,000, and the Royal Hospital (1899). Close to the town hall is Victoria Park (15 acres), with a monument to Admiral Napier; on the north side of it is the still unfinished Roman Catholic cathedral. Whale Island, in Portsmouth harbour, has, by the continuous accretion of excavated mud, grown to nearly 90 acres in area, and is now covered with naval and military buildings. It is proposed to connect the island by a causeway with the mainland. Between Portsmouth and Portsea is the gunwharf of 14 acres reclaimed from the harbour; the grand depôt for ordnance and ammunition, both for land and sea service, with an aggregate of about 40,000 stand of arms. A floating bridge (1892), 100 feet in length of hull by 62 feet wide, with capacity for 1400 passengers, connects Portsmouth with Gosport. There are now only seven barracks, including the Marine Artillery Infantry barracks at Eastney, beyond Southsea, the Anglesea barracks having been absorbed by the extending dockyard. On the Gosport side of the harbour (see GOSPORT) are two barracks—making in all nine barracks. An extension of 62 acres beyond the Royal Dockyard was determined on by the Admiralty in 1897 for the erection of naval barracks to accommodate about 3000 men. Portsmouth Dockyard covered an area of 294 acres—the total area planned out when the extension works were commenced in 1864—by 1890. Since then it has been further enlarged, and is now said to be the greatest dockyard in the world. Down to August 1900 the extension works cost about 2¼ millions sterling. Altogether the dockyard comprises 15 dry docks, 2 building slips, 60 acres of enclosed basins, 18,400 feet of wharfage, and about 10 miles of railway, with iron foundry, gun-mounting and boiler-making stores, joinery, mast-house, pump-house, block-making machines, naval college, observatory, Admiralty house, official residences; sheer, boat-house, south, and troopship jetties, &c. The men employed in the dockyard number about 9800. (See also DOCKYARDS.)

On the north defensive works stretch nearly 7 miles along Portsdown Hill, with a total barrack accommodation for 3000 men. On the south there are various forts. On the sea face of Gosport, again, the line of defence is continued for two miles westwards along Stokes Bay to Browndown. Thence a line of 5 forts stretches across the marshy ground between the Solent and Portsmouth harbour. On the east side of the harbour other forts take up the defence works of Portsdown Hill and continue the defence southwards to Hilsea lines, 2800 yards long. The south face of Portsea island is defended by 4 works. There are also forts on the Isle of Wight and a line of forts on shoals between St Helens (Isle of Wight) and Portsmouth. The shipping registered at the port in 1888 amounted to 262 vessels, of 15,520 tons; in 1900, to 253 vessels, of 13,539 tons. 14,601 vessels, of 1,524,939 tons, entered in 1888; in 1900, 16,743, of 1,851,593 tons. In 1888, 14,130 vessels, of 1,490,163 tons, cleared; in 1900, 16,552, of 1,800,507 tons. The total foreign and colonial imports in 1888 were valued at £221,797; in 1900, £222,174. The total exports amounted to £121,022 in 1900. Two daily newspapers are issued. Area of the municipal and parliamentary boroughs, which are coextensive, 4320 acres. Population (1881), 127,989; (1891), 159,251; (1901), 189,122.

Portsmouth, a city of New Hampshire, U.S.A., capital of Rockingham county, on a peninsula at the mouth of the Piscataqua river, in the south-eastern part of the state. The city is irregularly laid out, divided into five wards, and supplied with water from springs by gravity. Though a seaport and the only one in the state, Portsmouth has practically no foreign commerce. It has manufactures, largely of cotton goods and boots and shoes. In 1900 there were 176 manufacturing establishments, having a capital of $4,167,545, employing 1809 wage-earners, and turning out products valued at $4,813,138. Population (1890), 9827; (1900), 10,637, of whom 2033 were foreign-born and 101 negroes.

Portsmouth, a city of Ohio, U.S.A., capital of Scioto county, on the Ohio river, at the mouth of the Scioto, in the southern part of the state, at an altitude of 525 feet. It has a level site on the flood plain of the river, partly enclosed by terraces, is divided into seven wards, and derives its water supply from the river by pumping. It has three railways, the Norfolk and Western, the Cincinnati, Portsmouth, and Virginia, and the Baltimore and Ohio South-Western, which, with boats on the river, give the city a large trade. It has also extensive manufactures, consisting in great part of iron and steel goods, boots and shoes, lumber, and flour. In 1900 its 284 manufacturing establishments had a total capital of $4,113,700, and employed 4586 hands. Their products were valued at $7,532,976. Population (1890), 12,394; (1900), 17,870, of whom 1064 were foreign-born and 947 negroes.

Portsmouth, a city and seaport of Virginia, U.S.A. Though within the limits of Norfolk county, it is not subject to county government. It is situated at the mouth of the Elizabeth river, opposite Norfolk, in the south-eastern part of the state. It is irregularly laid out on a level site, and is divided into five wards. It shares Norfolk harbour with the city of Norfolk, and has some commerce by sea. It is traversed by five railways, the Atlantic and Danville, the Atlantic Coast Line, the Chesapeake and Ohio, the New York, Philadelphia, and Norfolk, and the Seaboard Air Line. It contains the works of the last-named line. In 1900 there were 103 manufacturing establishments, employing 1154 hands. Population (1890), 13,268; (1900), 17,427, of whom 710 were foreign-born and 5625 negroes.

Port Townsend, a city and seaport of Washington, U.S.A., capital of Jefferson county, at the north-eastern point of the Olympic peninsula, in the north-western part of the state. It is at the entrance to Puget Sound, and, as a commanding point, has been fortified by the United States, which has also established there a quarantine station and a marine hospital. The city is well laid out, with a water supply by gravity from Little Quilcene river. It has regular lines of steamers to Sound ports and to Victoria, and is the terminus of the Port Townsend Southern Railroad. It is in a lumber region, and its industries consist largely in the sawing and manufacture of lumber. Population (1880) 917; (1890), 4558; (1900), 3443, of whom 1042 were foreign-born and 218 coloured.

PORTUGAL

I. Geography and Statistics.

PORTUGAL, one of the two constituent kingdoms of the Iberian Peninsula, lies to the west of Spain, and is washed by the Atlantic for a distance of 473 miles out of a total frontier line of 1075 miles. It is the most westerly country of the continent of Europe.

Orography.—Portugal embraces three mountain systems: (1) the Transmontane, embracing the ranges which lie north of the Douro and stretch through the provinces of Minho, Traz-os-Montes, and a small part of Douro; (2) the Beirene, comprising the ranges of the two provinces Beira and the province of Douro, lying between the rivers Douro and Tagus; (3) the Trans-Tagine, or the ranges which lie south of the Tagus. To the Transmontane system belong the following ranges: Peneda (4728 feet), forming the watershed between the rivers Minho and Lima; Gerez (4817 feet), which rises like a gigantic wall between the Lima and the Homem, and sends off a spur known as the Amarella, Oural, and Nora, parting the Homem from the Cavado; and Cabreira (4196 feet), which gives birth to the Ave, and separates the basin of the Cavado from that of the Tamega. These three main ranges belong to the province of Minho. In the province of Traz-os-Montes these ranges occur: Larouco (5184 feet), which continues the Serra do Gerez, and gives birth to the river Cavado; Padrélla (3776 feet), Villarelho (3668 feet), and Marão (4666 feet), forming an enormous *massif* between the rivers Tamega, Tua, and Douro; and Nogueira (4331 feet) and Bornes (3944 feet), separating the basins of the Tua and the Sabor. To the Beirene system belong the following chains: Montemuro (4557 feet), between the Douro and its left-hand tributary the Paiva; Gralheira (3681 feet), separating the Paiva from the Vouga, and continued south by the Serra do Caramullo (3511 feet), parting the basins of the Vouga and Dão; and Lapa (3330 feet), lying to the north-east of the last-named, and giving rise to the Tavora and Paiva (tributaries of the Douro), the Vouga, and the Dão. All these lie north of the Mondego; south of this river come the loftiest ranges in the kingdom, still belonging to the same system, namely, the Serra da Estrella (6539 feet), and Louzã (3944 feet), between the Mondego and the Zezere; Mesas (3465 feet), the watershed between the Coa and the Zezere; and Guardunha (4016 feet) and Moradal (3547 feet), separating the Zezere from the Ponsul and Ocreza, right-hand tributaries of the Tagus. The constituent ranges of the Trans-Tagine system are the Serra da Arrabida (1637 feet), between Cape Espichel and Setubal; São Mamede (3363 feet), in Portalegre; Ossa (2129 feet), Monfurado (1378 feet), and Mendro (1332 feet), forming the high ground between the Sorraia, Sado, and Guadiana. Finally, in the province of Algarve, in the south, a series of low ranges—Alcaria do Cume (1716 feet), Malhão (1887 feet), Mesquita, Monchique (with the summit of Foya, 2963 feet), and Espinhaço de Cão—stretch from east to west, and terminate in Cape St Vincent. Plains and level expanses are comparatively few, the most notable being the *veigas* of Chaves and Valença, in the north, the *campos* of the valley of the Tagus, the *baixas* of the coast in Alemtejo, the *campos* of Beja, the *baixas* of the Sorraia, and the *campos* of Aviz. To these may be added the high plains known as the *cimas* of Mogadouro, in Traz-os-Montes, and the *cimas* of Ourem, east of the Tagus.

Geology.—Nearly every geological formation is represented in the structure of Portugal. The district of Minho, in the extreme north, is almost entirely built up of granites, amongst them being granite with white mica and granite with black mica in the valley of the Cavado, and porphyritic granite extending from the Minho to the Serra do Marão, and thence passing over into the district of Traz-os-Montes. Between the granites, on the north and south, lie embedded strata of crystalline and Silurian schists, in the middle. The Serra de Padrélla is formed of ramifications of the Transmontane granites. In Beira Baixa (province) granites, irregularly intermingled with schists, compose the great mass of the Serra da Estrella. Jurassic formations predominate in the province of Estremadura, constituting the bulk of the Serra do Bouro, the Serra de Penella, the Serra de Sicó, and the south face of the Serra de Cintra, as well as the peninsula of Peniche. South of Torres Vedras, between the Tagus and the coast, Cretaceous rocks prevail, and along a line drawn from Leiria to Aveiro they are overlain by a Tertiary deposit. In Alemtejo, although the granite reappears, the greater part of the province consists of schists accompanied by crystalline limestones. In the southernmost province of Algarve, Cretaceous, Jurassic, and Triassic rocks are all represented. Basalt is encountered near Lisbon, and between that city and Alhandra, Tertiary formations.

Climate.—Meteorological observations are taken at eleven stations. Those with the lowest mean temperature are on the Serra da Estrella (44·7° F.), at Montalegre (48·3°), and at Guarda (50·3°); those with the highest mean are Lagos (63·5°), Campo Maior (60·9°), Evora (61·9°), and Lisbon (60·5°). The greatest daily variations have been registered at Campo Maior (22·8°) and Evora (18·5°); and the least at Lisbon (12·5°) and on the Serra da Estrella (11·3°). The greatest humidity is at Guarda, the smallest at Campo Maior; and the heaviest rainfall occurs on the Serra da Estrella, and at Vizeu, Oporto, and Montalegre; and the smallest at Lagos, Campo Maior, and Moncorvo.

Area and Population.—Particulars of the area and population in 1890 and 1900, together with the density in the latter year, are given in the following table:—

District.	Area in Square Miles.	Population, 1890.	Population, 1900.			Density per Square Mile, 1900.
			Males.	Females.	Total.	
Aveiro	1213	287,437	137,257	164,924	302,181	249
Beja	4196	157,571	81,233	80,369	161,602	38
Braga	1057	338,308	161,727	195,092	356,819	338
Bragança	2574	179,678	91,924	93,662	185,586	73
Castello Branco	2556	205,211	105,752	110,877	216,629	85
Coimbra	1499	316,624	153,545	179,960	333,505	222
Evora	2736	118,408	64,779	62,453	127,232	45
Faro	1872	228,635	127,221	127,630	254,851	136
Guarda	2145	250,154	126,618	136,674	263,292	122
Leiria	1343	217,278	117,169	122,998	240,167	178
Lisbon	2718	611,168	360,806	347,944	708,750	260
Oporto	885	546,262	280,370	321,318	601,688	680
Portalegre	2482	112,834	63,052	61,645	124,697	50
Santarem	2649	254,844	139,661	144,015	283,676	107
Vianna do Castillo	866	207,366	93,766	120,833	214,599	248
Villa Real	1717	237,302	116,949	126,635	243,584	142
Vizeu	1920	391,015	186,149	216,650	402,799	209
Portugal	34,428	4,660,095	2,407,978	2,613,679	5,021,657	146
Angra do Heroismo	281	72,151	33,361	40,091	73,452	264
Horta	304	58,685	24,461	30,995	55,456	182
Ponta Delgada	337	124,758	59,208	68,358	127,566	378
Azores	922	255,594	117,030	139,444	256,474	278
Madeira (Funchal)	315	134,040	72,262	78,266	150,528	477
Grand Total	35,665	5,049,729	2,597,270	2,831,389	5,428,659	152

During the period 1878 to 1890 the increase per cent. was ·85, and between 1890 and 1900, 7·5 per cent. In 1890 there were 41,339 subjects of foreign countries in Portugal; and at the same date 3,067,408 of the population (1,507,269 males and 1,560,139 females) were unmarried and 1,669,874 were married, and there were 94,198 widowers and 218,249 widows. The following table shows the movement of the population in continental Portugal and the Azores and Madeira in 1890 and 1896:—

	1890.		1896.			
	Total.	Per Thousand.	Continent.	Islands.	Total.	Per Thousand.
Births	164,627	32·60	144,530	13,335	157,865	31·24
Deaths	127,237	25·19	110,970	8,761	119,731	23·71
Marriages	35,769	7·08	30,585	2,433	33,018	6·54

Thus the natural increase in 1896 was 38,134, or at the rate of 7·53 per thousand of the 1890 population. Emigration is still relatively heavy. In 1890 there were 29,421 emigrants; in 1895 (an exceptional year), 44,746; in 1898, 23,510. Of the last number, 21,422, or more than 91 per cent., went to America, Brazil being the destination of practically all; 1854, or nearly 8 per cent., were bound for Africa. From 15 to 20 per cent. of the emigrants are from the Azores and Madeira. Only about one-fifth are females.

Government.—Various modifications have been made in the constitution of the two Houses of Parliament since 1885. Until that year certain members sat in the House of Peers by hereditary right. It was then decided, however, that such rights should cease, except in the case of princes of the royal blood, with those of the members who then held them, and that when all the hereditary peerages had thus lapsed, the House should be composed of the princes of the royal blood, the twelve bishops of the continental dioceses, a hundred legislative peers appointed by the king for life, and fifty elected every new Parliament by the deputies of the Lower House. A further modification was decided on in 1895, when the number of life peers was reduced to ninety and the elective branch was abolished. The House of Deputies was reconstituted in 1899, when all citizens 21 years of age who could read and write, or who paid taxes to the value of 500 reis (except non-commissioned soldiers, Government workmen, domestic servants, &c.), were declared qualified electors. The House is composed of 145 deputies—six from Lisbon, three from Oporto, one from each of 129 other electoral districts into which the mainland, the Azores, and Madeira are divided, and seven from the colonies. Both life peers and deputies must possess certain qualifications. Besides the courts of appeal at Lisbon and Oporto, there is a third at Ponta Delgada (Azores). About 17,500 persons, of whom some 20 per cent. are women, are, on an average, annually convicted of crime, the proportion of convictions thus being about 1 in 300 inhabitants.

Religion.—Not only is Roman Catholicism the State religion of Portugal, but it is professed by nearly all the inhabitants; Protestants do not number more than 500. The total income of the upper hierarchy of the Church is estimated to be about £70,000.[1]

Education.—The law making primary education compulsory, provided there be a school within a mile, is not stringently enforced, and in 1890, nearly 50 years after the passing of the Act, 79·2 per cent. of the total population could not read. In the same year the children attending primary schools formed less than 1 in 20 of the population; there were 5339 primary schools (3864 public), with 237,783 scholars (152,707 boys and 85,076 girls). In 1357 communes there were no primary schools. By 1899, however, 619 additional public primary schools had been established. The system of secondary education was improved and set upon a sound basis in 1894. New state lyceums have been established since 1885 at Amarante, Guimarães, and Lamego, and these, with the district lyceums, were attended in 1898 by 3976 pupils. Private secondary schools affording a general education are numerous, and there are 18 theological seminaries, with (1897) 2262 pupils. Technical and commercial schools number about 30 and educate over 4000 scholars, while special mention may be made of a college for those who intend to go into the army. Under the head of secondary education, also, notice may be taken of the increase in the number of training colleges for primary school teachers, and of the pilot schools established at Lisbon, Oporto, Faro, and Ponta Delgada (Azores). In addition to the institutions for higher education mentioned in the ninth edition of this work, there are military and naval colleges, a high school of letters, a second school of fine arts (at Oporto), and a conservatorio at Lisbon for music and dramatic art. At the University of Coimbra there were 1429 students in 1900. According to the Budget of 1898–99, the total Government expenditure on education in that year was over £282,200, of which about £20,260 was expended through the War and Marine ministries.

Finance.

In 1891 the financial condition of the kingdom had become so serious that the public debt had to be reorganized. A marked improvement was subsequently observed. While the revenue increased very considerably, the expenditure had not up to 1901 grown to any appreciable extent, and though it always exceeded the revenue, the deficits were much smaller than was formerly the case. In 1891–92 the revenue was £8,587,380 and the expenditure £12,210,460. Between then and 1901 the worst financial year was 1896–97, when the revenue had increased to £11,287,955 and the expenditure stood at £12,946,820. The Budget estimates for 1900–01 were as follows:—

Revenue.		Expenditure.	
Direct taxes	£2,722,080	Consolidated debt	£4,434,243
Indirect taxes	5,398,680	Loss on exchange	111,111
Additional taxes	244,155	Sums voted for the several ministries	4,986,296
Registration and stamps	1,223,555	Civil list, Cortes and various	2,172,212
Receipts *d'ordre*	974,015	Deposit and Consignment Office	15,408
National property and sundries	779,320		
Total ordinary	£11,341,805	Total ordinary	£11,719,270
Extraordinary	255,555	Extraordinary	469,384
Total	£11,597,360	Total	£12,188,654

[1] Throughout this article $4\frac{1}{2}$ milreis (thousand reis) has been taken as the equivalent of one pound sterling.

Thus the deficit on the Budget of 1900–01 was only a little over half a million sterling, compared with more than 3½ millions in 1891–92 and more than 1½ million in 1896–97. The outstanding debt in 1899 was estimated to be—

Total external	£62,901,275
Internal, 3 per cent. (quoted in London) .	58,951,812
Total . .	£121,853,087
Also outstanding—	
Internal, at 4 and 4½ per cent. . .	£6,143,426

£2,318,819 of the external debt and £27,579,446 of the internal debt—total, £29,898,265—was stated to be in the hands of Government. The floating debt in 1899 amounted to £9,738,350.

Defence. The Portuguese army is maintained at its normal strength partly by conscription, the chief law regulating it being that of 1887 as variously modified in subsequent years. The Cortes fixes the number of conscripts to be enrolled in each year (in 1899, 16,500 for the army, 200 for the navy), and with certain exceptions all men over 21 years of age are liable for service —3 years in the regular army, 5 years in the first reserve, and 7 years in the second reserve. In time of peace the effective force of the regular army is 1723 officers, 29,703 men, 5404 horses and mules, and 144 guns; that of the reserve troops is 81 officers and 297 men, making the total number of officers 1804 and of men 30,000. In time of war the regular army has an effective force of 2029 officers, 82,843 men, 10,736 horses and mules, and 216 guns; while the reserve forces can muster 1447 officers, 62,796 men, 5113 horses and mules, and 96 guns, making a total effective force of 3476 officers, 145,639 men, 15,849 horses and mules, and 312 guns. In time of war, also, the municipal guards, numbering 80 officers and 2176 men, and the fiscal guards, numbering 136 officers and 5619 men, may be incorporated in the army. The Portuguese navy is being gradually increased, and in 1901 consisted of 1 armoured vessel, 5 protected cruisers, 3 third-class cruisers, 21 gunboats, 2 destroyers, 4 torpedo boats, 21 river gunboats, 5 steamers, and 4 training ships. The whole fleet was manned by about 5000 men.

Production and industry. *Minerals.*—Coal is scarce, and, owing to that fact and to the lack of cheap transport, the mines still remain to a large extent unworked. In 1899 the principal products were copper ore (366,680 tons, value £212,698); anthracite and lignite (10,942 tons, value £10,178); lead ore (1866 tons, value £8411); and iron ore (11,169 tons, value £7066). The market value of the total output was £285,887.

Agriculture.—In spite of the great improvement in roads and in agricultural training and agricultural machinery during the last quarter of the 19th century, it is estimated that from 5 millions to 10 millions of acres of land are still uncultivated, notably large tracts in Alemtejo and Traz-os-Montes, and in the higher parts of the mountains. Owing to this fact, the very large proportion of 45·8 per cent. of the country is classed as "waste" in the returns. Notwithstanding this, more than 65 per cent. of the population are agricultural, and agricultural products constitute more than 60 per cent. of the exports. But Portuguese agriculture is not in a flourishing condition. Wages have nominally increased, but the effects, so far as the workers are concerned, have been neutralized by the high protective duties. Other retarding influences are the lack of education, ignorance of modern methods of agriculture, and a slowness to adopt modern machinery; these are all in addition to the hampering conditions of heavy landed mortgages and scarce and dear capital. The branches of agriculture in which there is the greatest amount of energy and enterprise are wine-growing, the production of fruit and vegetables (especially in the south), and cattle-breeding. Olive trees abound, and large quantities of oil are manufactured, though in an unscientific way. The country may be divided into four agricultural divisions: (i.) the north, producing millet and other cereals and cattle; (ii.) the centre, producing millet, wheat, and rice; (iii.) the south, producing wheat and pigs; and (iv.) the mountainous regions, in which rye is the chief crop and the breeding of live stock the chief occupation. In divisions (i.) and (iii.) large estates are the rule; small estates in divisions (ii.) and (iv.). Of the whole area of the country, 26·7 per cent. is pasture and fallow; 12·5 per cent. under cereals; 7·2 per cent. under fruit trees; 2·9 per cent. under forests; 2·7 per cent. under pulse and other crops; and 2·2 per cent. under vineyards, all these areas forming the 54·2 per cent. of the country not returned as waste. The average annual yield of cereals is estimated as follows: wheat, 5,670,900 bushels; millet, 11,729,550 bushels; rye, 4,678,850 bushels; barley, 2,693,800 bushels; and oats, 797,500 bushels. The yield of potatoes averages 120,108 tons annually, and of beans, 18,103 tons. Wine, however, though vineyards cover a relatively small area, is still the most important product. Attempts have been made to find foreign markets for the great quantity of light cheap wine which has always been made in Portugal, for since 1886 greater care has been given to the manufacture, so as to produce good sound wine of the nature of claret and hock. In 1900, while 6,057,000 gallons of port wine and 576,450 gallons of Madeira were exported, the export of the lighter Portuguese wines amounted to 11,597,200 gallons. In 1892 the produce amounted to 79,336,360 gallons, valued at £3,495,150; by 1898 the figures had increased to 93,399,537 gallons and the value to £4,169,692. All live stock numbered 5,786,610 in 1898, and was valued at £9,456,100.

Fisheries.—In 1898 the fisheries yielded fish estimated to be worth £826,250, the most important being the sardine fishery, valued at £386,650; the tunny fishery, the next most important, was far below, being of the estimated value of £62,650. Both these fisheries have developed greatly along the south coast of Portugal. About 4000 vessels of all kinds are engaged in the fisheries.

Manufactures.—Since the institution of protective duties in 1892, Portuguese industries, stimulated also by the growing demands of the Portuguese colonies on the south-west coast of Africa, have made considerable progress. The most advanced are the manufactures of cottons and woollens, the chief centres of which are Lisbon, Oporto, and Covilhã. Other branches which have been thus artificially fostered are the manufacture of linen fabrics, china, earthenware, and metal goods.

Commerce. The following table shows the value of the imports and of the exports (including coin and bullion) in four several years since 1880:—

	1885.	1890.	1895.	1900.
Imports .	£8,261,177	£12,385,161	£9,107,555	£13,272,088
Exports .	6,017,639	7,255,317	6,504,245	10,451,333

These figures fairly illustrate the fluctuations in the respective values, but special reference should be made to the exports in 1891, when they reached the quite exceptional value of £11,373,944. The figures for 1900 show the highest point reached by the imports and exports in the years quoted. Of the imports in 1898 (£11,293,946) the most valuable were wheat, £812,925; cotton, £784,905; and cottons and yarn, £636,900; while sugar, cod-fish, coal, iron, cattle, leather and hides, wool, and woollens and yarn, ranged in value from £453,900 for the first to £227,900 for the last. The only exports higher in value than this last item of the imports were wine, £2,551,327, which it will thus be seen provided more than one-third of the total value of all exports (£7,379,370); cork, £734,000; cottons, £521,770; and sardines, £338,600. Of the imports, 32 per cent. came from Great Britain, 14 per cent. each from Germany and the United States, 10 per cent. from France, and 9 per cent. from Spain. Great Britain received 28 per cent. of the exports (with Brazil, Great Britain received most of the wine export, Portuguese vintages being valued at more than one-fifth of the total wine import of the United Kingdom), Brazil received 20 per cent., the Portuguese colonies 16 per cent., and Spain 13 per cent.

Shipping. In 1890, 6110 foreign vessels (including those merely calling at different ports), of 5,288,000 tons, entered, and 6381, of 5,276,000 tons, cleared; in 1900, 5744, of 9,464,386 tons, entered, and 5733, of 9,425,758 tons, cleared. In the coasting trade, 5438 vessels, of 1,006,000 tons, entered in 1890, and 5244, of 977,000 tons, cleared; in 1900, 4294 vessels, of 1,452,335 tons, entered, and 4219, of 1,416,017 tons, cleared.

Internal communications. There are 8700 miles of public roads. In 1898, 1464 miles of railway were open for traffic, the State owning 507 miles. There were 1304 post offices, and the total number of pieces of all kinds carried during the year was: internal, 55,201,810; international and colonial, 10,202,493. The number of telegraph offices was 425, controlling 4584 miles of line and 9475 miles of wire, and dealing with 1,272,042 internal and 1,065,309 international telegrams, including those in transit.

Banking and credit. In 1896 there were in all 35 banks (including savings banks). Only the Bank of Portugal can circulate notes in the country, though the Ultramarine Bank may issue them in the colonies. No gold has been coined since 1891, and in the present condition of the monetary system paper and silver are the chief media of circulation. The amount of the State Bank notes in circulation in February 1900 was £14,404,400. At the beginning of 1899 the deposits in savings banks amounted to £3,084,000, of which rather less than £700,000 was in the State Savings Bank.

Colonies. The table on next page shows the area and population of the several Portuguese colonies as nearly as possible; in the case of the African continental possessions and the Indian Archipelago, only estimates are possible. The figures in parentheses indicate the year of the last census.

Colonial Possessions.	Area in Sq. Mls.	Population.	Colonial Possessions.	Area in Sq. Mls.	Population.
In Africa:			*In Asia:*		
Cape Verde Islands (1896)	1,480	114,130	India: Goa (1887)	1,390	494,836
Guinea	4,440	820,000	India: Damâo Diu (1887)	168	77,454
Prince's and St Thomas's Islands	360	24,660	Indian Archipelago (Timor, &c.)	7,458	300,000
Angola	484,800	4,119,000	China: Macao, &c. (1896)	4	78,627
East Africa	301,000	3,120,000	Total Asia	9,020	950,917
Total Africa	792,080	8,197,790	Total Colonies	801,100	9,148,707

Few of the colonies are self-supporting, and between 1870 and 1899 Portugal expended about 15 millions sterling on them. Between 1897 and 1900 there was a noteworthy increase in the trade between Portugal and her colonies, especially her African colonies. During the six years ending 1897 the aggregate of this commerce was under 2 millions sterling; but only two years later it had jumped up to over 12½ millions sterling. The total inclusive commerce (imports and exports) of the several colonies in the year 1899 amounted to the following sums:—Cape Verde, £392,830; Guinea, £223,190; St Thomas, £1,188,220; Angola, £3,346,830; Mozambique, £1,890,510; India, £572,400; Macao, £4,992,100; and Timor, £86,600,—total, £12,692,680. The total trade between Portugal and her colonies in 1900 was £4,194,950, as follows:—Cape Verde, £224,040; Guinea, £51,650; St Thomas, £1,281,710; Angola, £2,223,500; Mozambique, £403,000; India, £7670; Macao and Timor, £3380.

AUTHORITIES.—BAEDEKER. *Spain and Portugal.* London, 1898.—*Annuario Estatistico de Portugal, Anno 1892.* Lisbon, 1899.—*Censo da Populaçao do Reino de Portugal, 1890 y 1900.* Lisbon, 1896, 1900, and 1902.—*Movimento da Populaçao, Anno 1883.* Lisbon, 1899.—*Estatistica de Portugal: Commercio . . . Extraneiro e Ultramar,* 1883 onwards. Lisbon.—*Relatorio do Ministro da Fazenda, 1899.* Lisbon, 1899.—VASCONCELLOS. *As Colonias Portuguezas.* Lisbon, 1897. (E. DE V.)

II. HISTORY.

The closing years of the reign of King Luis of Portugal (b. 1838, succeeded 1861, died 1889) were comparatively uneventful. The policy of reform begun by his first Ministers was steadily continued, and in many cases received his active co-operation. Progress and material prosperity had advanced, the army and navy had been reorganized on a modern basis, the system of railway communications largely developed, new ports made at Lisbon and Oporto, the constitutional charters modified in a liberal sense, and compulsory education more stringently enforced. On the whole there had been a great increase in commerce and a marked improvement in the national credit. The de Mello Ministry, which came into office in October 1883 and resigned in February 1886, was succeeded by that of José de Castro, the leader of the Progressives. The marriage of the king's son and heir, Dom Carlos, to the daughter of the Comte de Paris in 1886, attracted considerable attention, and the attitude of the French Government raised it even to international importance. Then colonial affairs almost exclusively occupied public attention. The Congo Convention of 1885, by which a considerable portion of the Lower Congo territory was ceded to the king of the Belgians, had produced in Portugal a feeling akin to national humiliation, and, accordingly, the first care of the new Ministry was devoted to strengthening the ties between the mother country and its other colonies. In 1886, Germany and Portugal defined by treaty their respective spheres of influence in Africa. In the following year a native military force was organized in Angola, and the country opened up by a line of railway. Macao, hitherto leased to Portugal, was formally ceded by China on the 26th of March 1887, and steps were taken to revive the trade of this island, which had long languished. A resolution was unanimously adopted in 1889 by both Chambers, calling upon the Government to assert with all energy the legal claims of Portugal to the territories in East and Central Africa. This action was due to apprehension of attempts by Great Britain to extend her sphere of influence in those regions at the expense of Portugal.

Accession of King Charles.

On the 19th of October 1889 Luis died of typhoid fever, and was succeeded by his son Carlos (*q.v.*), who expressly declared his intention of walking in his father's footsteps. Shortly after his accession, colonial affairs took a threatening turn. Major Serpa Pinto having invaded British territory on the Shiré river, the British Government had demanded satisfaction of Barros Gomes, the Portuguese Minister for Foreign Affairs. The dilatory tactics of Portugal were met by the despatch of a British fleet to Portuguese waters, and an ultimatum of the 11th of January 1890, peremptorily requiring the withdrawal of all the Portuguese forces, civilians, and agents on the Shiré, under threat of breaking off diplomatic relations. Barros Gomes, declaring that Portugal yielded to superior force, gave way under protest on the following day. Disturbances at once broke out in Lisbon and Oporto.

Crisis with Great Britain.

In the face of the popular indignation, De Castro's Ministry resigned office, and made way on 14th January following for a Coalition (Liberal–Conservative) Government under Serpa Pimental, with Hintze-Ribeiro as Foreign Minister. The Republicans, stimulated by the success of the revolution in Brazil in the previous year, fomented the spirit of disaffection, and were so far successful that in many cities demonstrations, ostensibly directed against Great Britain, assumed an anti-dynastic character. The king, yielding to public opinion, openly espoused the patriotic attitude of the demonstrants, and in a letter to Queen Victoria declined for the time being the Order of the Garter which had just been offered him. On the 6th of February the Government addressed a circular to the Great Powers proposing to submit the Anglo-Portuguese differences to the arbitrament of a European Conference, and suspended its naval and military preparations. Meanwhile an attempted Republican pronunciamiento in Lisbon was suppressed, sixty-three arrests were made, and many officers who were under suspicion degraded. The elections resulted in an overwhelming majority for the Government, only three Republicans being returned. On the 20th of August an Anglo-Portuguese agreement respecting Africa was settled in London; but its terms were regarded in Portugal as greatly to that country's disadvantage, and their publication was a signal for a fresh outburst of disturbances in the larger cities, and even in the Cortes itself, which refused to ratify the treaty. The Ministry resigned, making way on the 14th of October for Abreu e Sousa, who formed an administration of a decidedly constitutional character. The new Cabinet approached the British Government with proposals for a revision of the agreement of 20th August; and, pending the result of the negotiations, a *modus vivendi* for six months was agreed to.

Great Britain showed herself conciliatory and ready to make concessions, with a view to relieving the tension in Portugal. Yet, in spite of the utmost vigilance, more than one collision took place between the Portuguese and the forces of the British South Africa Company in Manica, on territory which by the Convention of August was acknowledged to be under the influence of Portugal. The Portuguese forces were defeated, and the repetition of occurrences of this kind for a time threatened the very existence of the monarchy. But the Government proceeded warily, and was successful in suppressing a military revolt which broke out in Lisbon on 30th January 1891. It followed up this action by repressive measures against the Republican press. The enhanced prestige of the Cabinet prevailed with the Chambers, which forthwith by an increased majority approved the convention with Great

Britain in its original form; and the ratification of the treaty followed on 28th May following. The next step of the Government in colonial matters was the granting of a charter to a limited company to exploit and administer the African colony of Mozambique, saving the paramount sovereignty of the Crown and the surveillance of the State.

A new crisis was brought about by the unfortunate financial position of the country. The careless and extravagant management of the railways guaranteed by the State had entailed such heavy deficits that the payment of the coupon of the Railway State Loan, due on 2nd January 1892, had to be suspended. Consequently the Minister of Finance, Marianino de Carvalho, resigned; and his example was followed on the 15th of January by the other members of Abreu e Sousa's Cabinet, which a few days later was replaced by a Ministry with Diaz Ferreira as Premier and Oliveira Martins as Minister of Finance. The new financial Minister reported a great deficiency in the revenue and a heavy increase of debt, and as a remedy proposed largely to curtail the expenditure and to increase taxation. Unable, however, to obtain the sanction of the Minister to certain arrangements proposed by the Paris Syndicate of Foreign Bondholders with a view to rehabilitating the financial position, he resigned in the May following. Thereupon the Portuguese Government committed a formal act of bankruptcy by issuing a decree reducing the payments to foreign bondholders then due to one-third the amount. The committees of bondholders at once energetically protested against this illegal action, and were supported in their remonstrances by several of the official representatives of their countries. The elections to the Cortes, which took place at the end of October 1892, gave the Conservatives (Regeneradores) a substantial majority, and the Ministry was reconstructed by introducing conservative elements. But Ferreira was unable to cope with the situation; and on disagreement with the king as to the proposals for improving the financial situation, his Ministry resigned office in February 1893, and Senhor Hintze-Ribeiro undertook the formation of a Liberal Ministry. The new council promised only slightly better terms to the foreign bondholders, but on the whole it improved the position of the State finances, and by coming to an understanding with Germany in East and with Great Britain in South Africa as to the delimitation of frontiers, minimized the risks of a conflict with either country. The elections of the 15th of April 1894 resulted in a large majority for the Government, but the reform of taxation proposed by the Minister of Finance met with great opposition. Hintze-Ribeiro, however, held to his scheme and, the better to carry it, relinquished the office of Premier for that of Finance, Lobo d'Avila taking his place. But Ribeiro's proposals were nevertheless rejected by the Cortes, which were forthwith adjourned and then dissolved, the new elections again resulting in a majority for the Government. In the same year diplomatic relations with Brazil were suspended for a time, because Portugal had offered an asylum to insurgents who had fled from that country.

Financial difficulties.

Parliamentary reform had long been in the air, and the year 1895 saw the accomplishment of far-reaching reforms in the constitution of the Chambers and the qualifications of electors. By an electoral law of 28th March, the number of deputies to the Lower Chamber was reduced from 170 to 145. Every responsible male citizen of twenty-one years of age who can read and write, or pays at least 500 reis in taxes, has the right of suffrage, which is denied to domestic servants, Government servants, and soldiers. By a subsequent law of 25th September of the same year, the reform of the Upper Chamber was also effected. The elective members were abolished, and the house now consists of 90 members chosen by the king, 12 bishops, and the princes of the blood royal. Thus professional politicians, who had been the source of much mischief in Portugal, were restricted both in numbers and influence, whilst greater political influence was assured to the commercial, industrial, and agricultural classes.

Parliamentary reform.

In the autumn of 1895, the king, after undertaking a journey through France and Germany, paid a long-deferred visit to England, where he was warmly received. The Order of the Garter was now conferred upon him, and his visit did much to remove the last traces of the misunderstanding between the ancient allies.

The Hintze-Ribeiro Ministry resigned in February 1897. The chief reproach against it was its inability to remove the economic difficulties under which Portugal had suffered in consequence of bad harvests and colonial troubles. The State was forced in March of the year 1898 to come to an arrangement with its external creditors. In view of the British attitude, all attempts—notably that of the Governor of Mozambique, Major d'Albuquerque — to improve the frontier of the Portuguese colonies failed (see AFRICA, and EAST AFRICA), and this and the ensuing year closed gloomily, with a deficit in the public revenue.

Portugal observed neutrality on the outbreak of the South African war, but the permission it conceded to the British Consul at Lourenço Marques to search for contraband of war among goods imported there, and the free passage accorded to an armed force under General Carrington from Beira through Portuguese territory to Rhodesia, were vehemently attacked in the press and at public meetings. The Ministry resigned, and gave place to a Conservative Government under Hintze-Ribeiro. The award of the Swiss arbitrators in the matter of the Delagoa Bay Railway was given in 1900; it was in favour of Portugal in regard to the seizure of the railway, but the country was condemned to pay 15,314,000 francs compensation; and this sum (less than was expected) was immediately raised by loan from the Portuguese Tobacco Company. The new elections resulted in a majority for Government; and the century closed in the midst of signs that the period of gloom which had oppressed the country was passing away, and that its relations with Great Britain rested on a more friendly basis.

Boer War; Delagoa Bay award.

Posen, an eastern province of Prussia, with an area of 11,184 square miles, and population of 1,887,275 (1900). In 1900 the live stock embraced 867,795 cattle, 609,816 sheep, 772,402 pigs, and 263,284 horses. The iron foundries produced 6288 tons of iron, valued at £56,930, in 1897; and in 1899–1900 the sugar factories produced 193,243 tons of sugar; the breweries, 13,530,000 gallons of beer; and the distilleries, 13,582,360 gallons of pure alcohol. For further particulars, see under PRUSSIA.

Posen, in Polish *Poznan*, a fortified town and archiepiscopal see of Prussia, capital of the province of Posen, 103 miles by rail north from Breslau, on the river Warthe, a first-class fortress and the headquarters of the 5th German Army Corps. In 1902 the Prussian Government voted a first instalment of £200,000 for the demolition of the old fortifications, which greatly cramped the town. The modern fortifications embrace a dozen inner forts and nearly twenty outer forts. The cathedral was restored in 1898. Of the public institutions and newer buildings may be mentioned several churches, the provincial archæological museum and library (1894), the (Renaissance) town-house (1895), the Mielzynski Museum, the royal palace with state archives, the archbishop's palace, the Emperor William library, a couple of handsome fountains, zoological gardens, art and other collections of the Society (Polish) of Friends of Science, a monument to the Polish poet Mickiewicz, a monument (1870) to the soldiers who fell at Nachod in 1866, a monument of the war of 1870–71, three theatres, a theological college, a building and trades school (1892), with over 1000 pupils, a trade and domestic economy school for girls, a Jewish teachers' seminary, and a (female) normal school. The industries are of a miscellaneous character—machinery, furniture, vehicles, cigars, beer, chemicals, &c. Population (1885), 68,315; (1895), 73,239; (1900), 117,014, of whom about one-half are Germans and one-tenth Jews. The rural communes of Jersitz, Wilda, and St Lazarus were incorporated in 1900.

Pössneck, a town of Germany, duchy of Saxe-Meiningen, 21 miles by rail south of Jena, with a Gothic church (1390) and a Gothic town hall (1443), an agricultural school, and manufactures of porcelain and flannel, besides tanning, dyeing, brewing, and gardening. The town dates from the 11th century or earlier. Population (1885), 7653; (1900), 12,268.

Posters (see also ADVERTISEMENT).—The earliest examples of pictorial posters were adorned with rough woodcuts. When lithography became a common commercial process, wood-blocks ceased to be employed. The modern artistic poster made a definite beginning in France about 1836, with a design by Lalance to advertise a book entitled *Comment Meurent les Femmes.* His example was followed by C. Nanteuil, Raffet, Gavarni, Bertrand, Grandville, Tony Johannot, É. de Beaumont, T. H. Frère, Édouard Manet, and other artists of high repute. Most of these early designs were printed in black on white or tinted paper. Between 1860 and 1866 crude attempts at printing posters in colours were made in both France and England. In 1866, Jules Chéret began what was destined to be the most noticeable series of pictorial placards in existence, a series containing over a thousand items. Chéret was the first artist rightly to appreciate the possibilities of the poster and to raise it to high consideration in the opinion of the art world. Brilliant colour in acute contrast characterized his work, which rapidly achieved, and still retains, immense popularity. He may be fairly described as the father of the modern pictorial placard. Chéret was originally employed in a lithographic establishment in England before he began to work for himself, and he used his knowledge there acquired to adapt all three primary colours, economically used, to astonishingly brilliant ends. For a considerable time he remained without a rival, though he had hosts of imitators. Eugène Grasset, a decorative designer of great versatility, produced the first of a small number of placards which, though inferior as advertisements to those of Chéret, were learned and beautiful decorations. Somewhat later a sensation was caused in Paris by the mordantly grotesque posters of Henri de Toulouse-Lautrec, in which the artist reduced detail to a minimum and obtained bold effects by the employment of large masses of flat colour. Important work, similar in character to Lautrec's, was produced by Ibels, Bonnard, Steinlen, and others. A new and contrary direction was given to poster design by Mucha, a Hungarian resident in Paris, whose placards are marked by delicate colour and richness of detail. The following are amongst French artists who have designed posters of conspicuous merit: Forain, Willette, Paléologue, Sinet, Jossot, Rœdel, Mayet, Cazals, Biais, De Feure, Guillaume, Ranft, Réalier-Dumas, Valloton, and Metivet. Occasionally eminent French painters, such as Carrière, Boutet de Monvel, Aman-Jean, Schwabe, have made essays in poster-designing.

In England the first artists of repute to attempt the pictorial placard were Godfroy Durand and Walter Crane; but the first bill to attract widespread attention was one by Fred Walker to advertise a dramatized version of *The Woman in White* (1871). This was engraved on wood by W. H. Hooper. Shortly after this time pictures by Royal Academicians and others began to be reproduced as advertisements (the best known case being that of Sir John Millais's "Bubbles"), but these have nothing directly to do with poster-designing. Mr Stacy Marks, Hubert von Herkomer (the great poster for the *Magazine of Art*), Sir Edward Poynter, and Sir James Linton are among popular painters who have made special drawings for reproduction as posters.

About 1894 the English poster began to improve. Designs by Aubrey Beardsley for the Avenue Theatre, by Dudley Hardy for various plays, and by Maurice Greiffenhagen for *The Pall Mall Budget*, were widely noticed by reason of their originality, simplicity, and effectiveness. Simplicity was carried even farther by "the Beggarstaff Brothers" (James Pryde and William Nicholson), whose posters are perhaps the most original yet produced by Englishmen. Among other British designers the following have executed artistic and interesting placards: Frank Brangwyn, R. Anning Bell, John Hassall, Cecil Aldin, Phil May, Raven-Hill, Henry Harland, Robert Fowler, Wilson Steer, Charles R. Mackintosh, MacNair and MacDonald, Edgar Wilson, Charles I. Foulkes, Mabel Dearmer, Albert Morrow, and C. Wilhelm.

Poster design on the continent of Europe has been largely influenced by French work, but designs of much originality have been made in Germany, Belgium, Italy, and Spain. In Germany, among the most typical posters are those of Sattler, Otto Fischer, Gysis, T. T. Heine, Speyer, Max Klinger, Dasio, Hofmann, and L. Zumbrusch. The principal Belgian designers include Privat Livemont, Rassenfosse, Berchmans, Meunier, Duyck and Crespin, V. Mignot, Donnay, Evenepoel, Cassiers, and Toussaint. Of Italian designers those whose work is most characteristic are Mataloni and Hohenstein; while the best Spanish posters—those to advertise bull-fights and fairs—are mostly anonymous. The Spanish artists Utrillo and Casas have signed posters of more than ordinary merit. Curious if not very artistic bills are being produced in Russia; and in Austria good work is being done by Orlik, Schliessmann, Oliva, and Hynais.

In the United States of America, however, with the exception of some designs by Matt Morgan, few posters of artistic interest were produced before 1889, in which year Louis J. Rhead commenced a notable series of decorative placards. Will H. Bradley began to produce his curious decorative grotesque posters a little later. If American artists are behind Europeans in the artistic designing of large posters, they have no rivals in the production of small illustrated placards for publishers of books and magazines. Chief among those who have devoted themselves to this branch of poster design is Edward Penfield. Others who have achieved success in it include Maxfield Parrish, Ethel Reed, Will Carqueville, J. J. Gould, J. C. Leydendecker, Frank Hazenplug, Charles Dana Gibson, Will Denslore, Florence Lundbourg, and Henry Mayer.

Exhibitions of artistic posters have been held in the chief cities of Europe and America, and the illustrated placard has already a literature of its own. In England a monthly magazine (*The Poster*) was for a time specially devoted to its interests, and collectors are numerous and enthusiastic.

The following are the most important books of reference on the subject:—ERNEST MAINDRON. *Les Affiches Illustrées.* Paris, 1895. *Les Maîtres de l'Affiche.* Paris. *Les Affiches Étrangères Illustrées* (Belgium, Austria, Great Britain, United States, Germany, and Japan). Paris, 1897.—CHARLES HIATT. *Picture Posters.* London, 1895.—J. L. SPOUSEL. *Das Moderne Plakat.* Dresden, 1897.—ARSÈNE ALEXANDRE, M. H. SPIELMANN, H. C. BUNNER, and A. JACCACCI. *The Modern Poster.* Scribners, New York 1895.

(C. HI.)

POST OFFICE.

I. United Kingdom.

Since 1884 the business of the British Post Office has continued to grow at a more rapid rate than the population of the United Kingdom. Some of the causes of this development must be sought within the Post Office department, *e.g.*, improved facilities, lower charges, and the assumption of new functions; but others are to be found in the higher level of popular education, the increase of wealth, industry, and commerce, and the rapid expansion of Greater Britain.

On the death of Mr Fawcett (7th November 1884), the Right Hon. G. J. Shaw Lefevre was appointed Postmaster-General. His successors have been Lord John Manners, afterwards Duke of Rutland, who had already been Postmaster-General from 1874 to 1880, and again held the office from 1885 to 1886; Lord Wolverton, 1886; the Right Hon. H. C. Raikes, 1886 to 1891; Sir J. Fergusson, 1891 to 1892; the Right Hon. Arnold Morley, 1892 to 1895; the Duke of Norfolk, 1895 to 1900; and the Marquess of Londonderry, 1900. The Secretary to the Post Office, Sir A. Blackwood, died in 1893, and was succeeded by Mr (afterwards Sir) S. Walpole, on whose retirement in 1899 Sir G. H. Murray was appointed permanent head of the Post Office.

The following table shows the increase in the number of letters delivered:—

Letters Delivered.

Estimated number of letters delivered in the United Kingdom, and the increase per cent. per annum. Also the average number to each person. 00,000's omitted.

Financial Year ending 31st March.	Delivered in England and Wales. By Country Offices.	Inc. per Cent. per Annum.	In London District.	Inc. per Cent. per Annum.	Total in England and Wales.	Increase per Cent. per Annum.	Average Number to each Person.	Total in Scotland.	Increase per Cent. per Annum.	Average Number to each Person.	Total in Ireland.	Increase per Cent. per Annum.	Average Number to each Person.	Total in United Kingdom.	Increase per Cent. per Annum.	Average Number to each Person.
1884–85 .	757,2	2·7	391,1	4·1	1,148,3	3·2	42	122,9	2·6	32	89,1	1·6	18	1,360,3	2·9	38
1885–86 .	778,0	2·8	409,4	4·7	1,187,4	3·4	43	126,4	2·8	32	89,7	·7	18	1,403,5	3·2	39
1886–87 .	800,8	2·9	439,1	7·3	1,239,9	4·4	44	129,1	2·1	33	90,9	1·3	19	1,459,9	4·0	40
1887–88 .	838,0	4·6	448,9	2·2	1,286,9	3·8	46	132,1	2·3	33	93,2	2·5	20	1,512,2	3·6	41
1888–89 .	846,0	1·0	480,5	7·0	1,326,5	3·1	46	136,0	3·0	34	95,5	2·5	20	1,558,0	3·0	42
1889–90 .	895,0	5·8	518,1	7·8	1,413,1	6·5	48	140,3	3·2	34	96,8	1·4	21	1,650,2	5·9	43
1890–91 .	924,4	3·3	538,4	4·0	1,462,8	3·5	50	143,2	2·1	36	99,8	3·1	21	1,709,0	3·4	45
1891–92 .	965,0	4·4	551,0	2·4	1,516,0	3·7	52	146,4	2·1	36	105,0	5·2	23	1,773,4	3·6	46
1892–93 .	965,8	0·1	566,5	2·8	1,532,3	1·1	52	152,3	4·0	37	105,9	·9	23	1,790,5	1·3	47
1893–94 .	973,8	0·8	575,6	1·6	1,549,4	1·1	52	153,9	1·1	38	108,5	2·5	23	1,811,8	1·2	47
1894–95[1] .	993,3	2·0	508,8	dec. 11·6	1,502,1	dec. 3·1	50	156,0	1·4	38	112,8	4·0	24	1,770,9	dec. 2·3	46
1895–96 .	1,021,3	2·8	537,5	inc. 5·6	1,558,8	inc. 3·8	51	162,9	4·4	39	112,5	dec. 0·3	25	1,834,2	inc. 3·6	47
1896–97 .	1,049,3	2·7	557,2	3·7	1,606,5	3·1	52	168,5	3·4	40	118,0	inc. 4·9	26	1,893,0	3·2	48
1897–98[2] .	1,120,3	6·8	590,9	6·0	1,711,2	6·5	55	177,4	5·3	42	123,7	4·8	27	2,012,3	6·3	50
1898–99 .	1,242,0	10·8	617,7	4·5	1,859,7	8·7	59	190,6	7·4	45	136,5	10·3	30	2,186,8	8·6	54
1899–1900	1,276,3	2·7	632,6	2·4	1,908,9	2·6	60	196,8	3·3	46	141,1	3·4	31	2,246,8	2·7	55
1900–01 .	1,312,7	2·9	664,3	5·0	1,977,0	3·6	61	202,4	2·8	47	144,2	2·2	32	2,323,6	3·4	57

[1] It was discovered in the course of this year that the estimated figures for previous years had been swollen by an imperfect method of reckoning the London letters, &c. In 1883 as many as 2,770,000 valentines were sent through the post. The numbers gradually decreased until in 1890 only 320,000 were observed. Christmas cards have, however, considerably increased.

[2] Since 22nd June 1897, all packets over 2 oz., formerly counted as book packets, are reckoned as letters.

Inland Letter Rates.—The rates of inland letter postage have been altered as follows:—

From 5th October 1871 to 1st July 1885 the charges were:—

	s.	d.
Not exceeding 1 oz.	0	1
Over 1 oz. and not exceeding 2 oz. . . .	0	1½
,, 2 ,, ,, ,, 4 ,, . . .	0	2
,, 4 ,, ,, ,, 6 ,, . . .	0	2½
,, 6 ,, ,, ,, 8 , . . .	0	3
,, 8 ,, ,, ,, 10 ,, . . .	0	3½
,, 10 ,, ,, ,, 12 ,, . . .	0	4
,, 12 ,, ,, ,, 13 ,, . . .	1	1
,, 13 ,, ,, ,, 14 ,, . . .	1	2

and 1d. for each succeeding ounce.

On 1st July 1885 the postage on letters over 12 oz. was reduced, and the gradation of charge beyond 2 oz. was made uniform, at the rate of ½d. for each additional ounce. Thus a letter weighing over 12 and not exceeding 14 oz. was charged 4½d., 14 to 16 oz. 5d., and so on. Notwithstanding this change, it was found as late as 1895 that 95 per cent. of the letters sent through the post weighed not more than 1 oz. each.

In his Budget speech of 29th April 1897, the Chancellor of the Exchequer, Sir M. Hicks-Beach, announced that a number of postal and telegraphic concessions would be made to the public on Jubilee Day, the 22nd June 1897, the sixtieth anniversary of Queen Victoria's accession to the throne. The new rates for letters were:—

	d.
Not exceeding 4 oz.	1
Over 4 oz. and not exceeding 6 oz. . . .	1½
,, 6 ,, ,, ,, 8 ,, . . .	2

with ½d. for each succeeding 2 oz.

This change, while it saves both the Post Office and the public the trouble of testing the weight of a large number of letters, has also the advantage of simplicity of calculation—one halfpenny is charged for each 2 oz., with a minimum charge of 1d.

Arrangements were at the same time made to ensure a delivery of letters by postmen at every house in the United Kingdom. It was estimated that 16 millions of letters, whose owners had previously to fetch them from the post office or from some point on a postman's walk, would thus be added to the official delivery. The estimate proved, however, to be much under the mark. Fifty-five millions of letters are already brought annually into the official delivery under this arrangement, which still awaits completion in a few remote districts of Scotland and Ireland. In May 1892 the House of Commons, on the motion of Sir E. Birkbeck, had passed a resolution in favour of a more liberal extension of the free delivery in rural districts. Under the relaxed Treasury regulations, 155,000 letters a week were brought into the delivery in 1892, but a large number still remained outside. Financial considerations have now been entirely disregarded for the benefit of these letters, and the cost of their delivery alone, excluding sorting, carriage, cost of post office buildings, &c., greatly exceeds the whole revenue derived from them.

In studying the statistics of letters delivered, it should be remembered that the figures for any particular year are affected by circumstances like a general election or a boom in trade, as well as by changes in the rates or condition of the Post Office services. The letters from foreign countries have been stimulated by lower charges, and those from the colonies by the Imperial Penny Post, to which reference is made below.

Letter Cards.—On the 12th February 1892 letter cards bearing an imprinted penny stamp, and made to be fastened against inspection, were issued to the public at a charge of 1s. for 10 cards. The charge was reduced almost at once to 9d. for 8 cards. Similar cards have long been in use on the Continent, but they do not enjoy much popularity in Great Britain either with the Post Office, which finds them inconvenient to handle in sorting and stamping, or with the public. The number issued annually is about 10 millions, not counting those of private manufacturers.

Post Cards.—The following table gives the number of post cards:—

Estimated Number of Post Cards delivered in the United Kingdom, and the Increase per Cent. per Annum.

Year.	England and Wales.		Scotland.		Ireland.		United Kingdom.	
	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.
1884–85 .	134,100,000	4·3	18,400,000	5·5	7,900,000	3·1	160,400,000	4·4
1889–90 .	184,400,000	8·4	22,900,000	5·0	9,800,000	5·4	217,100,000	7·8
1893–94 .	209,100,000	1·4	27,400,000	2·2	12,000,000	6·2	248,500,000	1·6
1894–95[1]	271,600,000	29·9	28,700,000	4·7	12,500,000	4·2	312,800,000	25·9
1895–96 .	268,300,000	dec. 1·2	32,200,000	12·2	14,000,000	12·0	314,500,000	0·6
1900–01 .	359,400,000	inc. 4·9	41,600,000	2·0	18,000,000	6·5	419,000,000	4·7

[1] Private cards with adhesive stamps first allowed in this year.

Post cards were first introduced in Austria on the 1st October 1869, and were first issued in Great Britain on 1st October 1870. Only one kind of card was employed, and this was sold for one halfpenny; but on the complaints of the stationers, a charge of ½d. a dozen for the material of the card was made in 1872, and permission was given for private persons to have their own cards stamped at Somerset House. In 1875 a stouter card was put on sale, and the charges were raised to 7d. per dozen for thin cards and 8d. per dozen for stout cards. In 1889 the charges were reduced to 5½d. for 10 and 6d. for 10 respectively. On 1st September 1894 private post cards with an adhesive halfpenny stamp were allowed to pass by post, and the result has been greatly to diminish the number of cards purchased through the Post Office. It is estimated that 232 out of the 400 millions of cards delivered in 1899–1900 were private cards. The sizes of the official cards were again altered in January 1895 and November 1899. Reply post cards were issued on 1st October 1883. The regulations forbidding anything but the address to be written on the address side of a post card were made less stringent on 1st February 1897; and in 1898 unpaid post cards, which were previously charged as unpaid letters, were allowed to be delivered on payment of double the post card rate. These various changes, especially the use of the private card and the popularity of illustrated post cards, have contributed to the rapid increase in the number of post cards sent by post. Reply post cards were first issued on 1st October 1893. Their use has not been very extensive. Only about 1½ million are issued yearly.

Book Packets and Samples.—The following table shows the estimated number of book packets, circulars, and samples delivered in the United Kingdom, and the increase per cent. per annum:—

Year.	England and Wales.		Scotland.		Ireland.		United Kingdom.	
	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.
1884–85 .	269,400,000	8·1	34,500,000	10·0	16,500,000	18·9	320,400,000	8·8
1889–90 .	378,200,000	7·5	42,100,000	3·7	21,600,000	9·6	441,900,000	7·3
1894–95 .	522,500,000	6·7	60,800,000	8·2	31,300,000	10·2	614,600,000	7·0
1898–99[1]	590,900,000	dec. 3·6	75,100,000	dec. 2·3	35,500,000	dec. 5·3	701,500,000	dec. 3·5
1900–01 .	619,300,000	inc. 4·0	77,800,000	inc. 3·7	35,300,000	inc. 8·6	732,400,000	inc. 4·2

[1] Book packets over 2 oz. transferred to the letter post as a result of the Jubilee changes.

The rate of ½d. for 2 oz. for the book post has remained unaltered since 1st October 1870. Changes have from time to time been made in the regulations defining the articles which may be sent by book post, and prescribing the mode of packing them so as to admit of easy examination for the purpose of detecting letters, &c., sent by the halfpenny post. The book post received a great impetus in 1892 (28th May) by the permission to enclose book packets in unsealed envelopes. Complaint is, however, made that such envelopes form a dangerous trap for small letters, which are liable to slip inside the flaps of open envelopes, and so suffer delay and loss. On the other hand, as the rate of postage for articles weighing over 2 oz. is now the same for letters and for book packets, articles over that weight derive no advantage from being sent in open covers.

Sample Post.—The sample or pattern post, which was confined to *bonâ fide* trade patterns and samples on 1st October 1870, was then assimilated to the book post (½d. for 2 oz.); but the restriction was found to be both difficult to enforce and irritating to the public, and the sample post was abolished on 5th October 1871, when the rates of letter postage were lowered. It was re-established on 1st October 1887 (1d. for 4 oz. or under, and ½d. for each succeeding 2 oz.); but when the Jubilee letter rates were introduced (22nd June 1897) it lost its *raison d'être*, and ceased to exist for inland purposes.

Newspapers.—The first table on next page shows the estimated number of newspapers delivered in the United Kingdom, and the increase per cent. per annum.

The carriage of newspapers by the Post Office does not show the same elasticity as other post-office business. The Postmaster-General's Report of 1896 states that this is "due to increased energy and improved system on the part of the great newsagents." It is also, no doubt, in part due to improvements in provincial journalism, and especially to the extension of the halfpenny press. The practice of posting a newspaper after reading it, under a co-operative arrangement, has practically ceased to exist. The carriage of newspapers by post is conducted at a loss by the Post Office, which can thus regard with satisfaction the comparatively slow increase in the numbers sent.

Year.	England and Wales.		Scotland.		Ireland.		United Kingdom.	
	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.	Number.	Inc. per Cent. per Annum.
1884–85 .	110,700,000	·7	16,900,000	·9	16,100,000	·5	143,700,000	·7
1889–90 .	126,600,000	6·1	16,700,000	·6	16,000,000	...	159,300,000	4·9
1894–95[1]	117,500,000	dec. 9·5	17,300,000	dec. 2·3	17,000,000	dec. 2·3	151,800,000	dec. 7·9
1899–1900	125,000,000	inc. 5·9	19,300,000	inc. 7·8	19,100,000	inc. 4·9	163,400,000	inc. 6·0
1900–01 .	127,800,000	2·2	19,300,000	...	20,700,000	8·4	167,800,000	2·7

[1] See note to table of *Letters Delivered*.

Halfpenny Post Finance.—It has been frequently stated on behalf of the Post Office that the halfpenny post is unremunerative. Representations are, however, made from time to time in favour of lower postage for literature of all kinds. It may therefore be of interest to mention that the Postmaster-General of the United States has, in successive annual reports, deplored the effect on the Post Office service of the cheap rates for "second-class matter." The cost of carriage over so large a territory is heavier than in the United Kingdom; but the Postmaster-General states that the low rates of postage "involve a sheer wanton waste of $20,000,000 or upwards a year." Facilities like the extension of free delivery are stifled, and the efficiency of the whole service is cramped, by the loss thus sustained.

Inland Parcels.—The following table shows the number of parcels delivered in the United Kingdom:—

Year ending 31st March.	Number of Parcels.	Year ending 31st March.	Number of Parcels.
1884 . .	14,000,000	1893 . .	52,370,326
1885 . .	22,910,040	1894 . .	54,034,000
1886 . .	26,417,397	1895 . .	57,136,000
1887 . .	32,860,154	1896 . .	60,527,000
1888 . .	36,731,786	1897 . .	63,715,000
1889 . .	39,589,313	1898 . .	67,823,000
1890 . .	42,852,600	1899 . .	71,913,000
1891 . .	46,287,956	1900 . .	75,448,000
1892 . .	49,378,365	1901 . .	81,017,000

The inland parcel post commenced on 1st August 1883. No parcel might exceed 7 lb in weight, $3\frac{1}{2}$ feet in length, or 6 feet in length and girth combined. The rates were:—

	s.	d.
Not exceeding 1 lb	0	3
Exceeding 1 lb, but not exceeding 3 lb .	0	6
,, 3 ,, ,, ,, 5 ,, .	0	9
,, 5 ,, ,, ,, 7 ,, .	1	0

Arrangements were made with the railway companies, under which they receive 55 per cent. of the postage on each parcel sent by train. This arrangement, which was to hold good for 21 years, proved, however, an onerous one, and on 1st June 1887 the Post Office started a parcel coach between London and Brighton. The coach, which travels by night, arrives at Brighton in time for the first delivery, and there is thus no loss of time to the public. The experiment proving successful, other coach services were started at different dates between London and Chelmsford, Colchester and Ipswich, London to Oxford *viâ* Reading, London to Chatham, Tunbridge Wells, Bedford, Guildford, Brighton, Watford, and Windsor respectively, Birmingham and Coventry, Liverpool and Manchester, with branch coach services to Cambridge, Hitchin, &c. Motor-cars have also been employed. Nearly $11\frac{1}{2}$ millions of parcels were conveyed by the Post Office in 1900–01 without passing over a railway.

On 1st May 1896 the maximum weight was increased to 11 lb, and the postage rates were reduced:—

	s.	d.
Not exceeding 1 lb	0	3
For each succeeding pound	0	$1\frac{1}{2}$
The charge for a parcel of 11 lb was thus .	1	6

On 22nd June 1897 the present (Jubilee) rates were introduced:—

	s.	d.
Not exceeding 1 lb	0	3
For each succeeding pound up to 10 lb .	0	1
The charge for a parcel of 10 lb is thus .	1	0,

and this is also the charge for a parcel of the maximum weight (11 lb).

Registered Letters.—The number of letters registered by the public in the United Kingdom in 1884–85 amounted to 11,365,151. In the next ten years the numbers oscillated between 10,779,555 (1886–87) and 12,132,144 (1892–93); but since 1894–95, when 11,958,264 letters were registered, the number has steadily increased, until it stood at 17,729,869 for 1900–01. It has been surmised[1] that the introduction of postal orders checked the growth of registered letters for some years after 1880. In 1886 a system of insurance for registered letters was adopted. The ordinary registration fee entitled the owner, in case of loss, to recover compensation from the Post Office up to a limit of £2. For an additional insurance fee of 1d. the limit was raised to £5, and for 2d. to £10. Various changes have since been made, and the separate insurance system has been abolished. At present a registration fee of 2d. entitles to compensation up to £5, 3d. £10, and each additional penny to a further £10, up to a maximum of £120. The system of registration has also been extended to parcels.

Railway Letters.—On 1st February 1891 the railway letter service came into operation. At passenger stations on the principal railways a letter not exceeding 4 oz. in weight may be handed in at the booking office for conveyance by the next train. A fee of 2d. is payable to the railway company as well as the ordinary postage of 1d. The letter may be addressed to a railway station to be called for. If it bears any other address it is posted on arrival at its proper station. The number of packets so sent is about 200,000 a year.

Express Letters.—The express delivery service dates from 25th March 1891. A private company formed for the purpose of supplying the public on demand with an express messenger to execute errands, was found to be infringing the Postmaster-General's monopoly both as regards the conveyance of letters and the transmission of communications by electricity. The services of the company were, however, so much appreciated by the public, that the suppression of the company would have seemed both harsh to its shareholders and inconvenient to its customers, who could not obtain similar facilities from the Post Office itself. The Government accordingly authorized the Post Office to license the existing company to continue its business, on the payment of royalties, till 1903,[2] and to start an express service of its own. Messengers can be

[1] Thirty-second Report of Postmaster-General.
[2] Afterwards extended to 31st March 1922.

summoned from the post office by telephone, and arrangements can be made with the Post Office for the special delivery of all packets arriving by particular mails in advance of the ordinary postman. The sender of a packet may have it conveyed by express messenger all the way, or may direct that, after conveyance by ordinary post to the terminal post office, it shall then be delivered by special messenger. The fees, in addition to ordinary postage, were originally fixed at 2d. for the first mile, 3d. for the second mile, and 1s. a mile additional when the distance exceeded 2 miles and there was no public conveyance. Further changes of rates were made in 1892, 1893, 1895, 1897 (Jubilee revision), and 1900. Under the present regulations the fee is 3d. for each mile covered by special messenger before delivery. No charge is made for postage in respect of the special service, but if the packet is very weighty or the distance considerable, and no public conveyance is available, the sender must pay for a cab or other special conveyance.

Letters and parcels to or from a number of foreign countries and colonies may also be marked for express delivery after transmission by post; and residents in London, not having a delivery of ordinary letters on Sunday, may receive on that day express letters from home or abroad which have come to hand too late for express delivery on Saturday nights. The total number of express services in 1900–01 was 804,447. In many cases one of these services included the delivery of batches of letters, so that in London alone 819,959 articles were delivered by express messenger—307,051 being letters sent out for delivery in advance of the postman.

Returned Letters.—There are 16 depôts for dealing with "dead" or returned letters. The principal office is in London. Others are at Manchester, Liverpool, Birmingham, Leeds, Bristol, Newcastle-on-Tyne, Nottingham, Plymouth, Edinburgh, Glasgow, Aberdeen, Inverness, Dublin, Belfast, and Cork. In the year 1900–01, 7,470,288 letters were received at the various returned letter offices, of which 6,226,805 were returned to the senders, while 377,261 were returned unopened to foreign countries to be dealt with by the post offices of the country of origin, leaving only 832,421 undisposed of. Such of these as contain nothing of value are at once destroyed, and no record of them is kept. The others are recorded, and (if not previously claimed by the owners) their contents are sold by auction at intervals. If the owner applies after the sale, the proceeds are handed over to him. In addition to these 7½ millions of letters, there were 2,316,582 disposed of at head post offices, whence they were returned direct and unopened to the senders, whose names and addresses appeared on the outside of the letters. The total number of post cards received in the various offices as undelivered was 1,619,391; book packets, 11,911,614; newspapers, 627,642; and parcels, 227,252. 174,193 of these last were re-issued. Articles sent by the halfpenny post are destroyed at the head offices if they cannot be delivered; but the sender may have such articles returned if he writes a request to that effect on the outside of the packet, together with his name and address, and pays a second postage on the return of the packet.

No fewer than 85,640 articles were found loose in the post (*i.e.*, without envelopes or wrappers) in 1901–2. In 1900–1, 345,690 packets were posted unaddressed, containing £251 in cash and bank notes, and £7203 in bills, cheques, postal orders, stamps, &c. The coin found loose in the post amounted to £902. The total value of property found in undelivered letters opened in the returned letter office was £681,335.

Foreign Mails.—The following table shows the estimated weight of the mails (excluding parcels) exchanged with the British colonies and foreign countries in 1900–01. The number of letters and post cards may be roughly taken at 40 to the ℔:—

00's omitted.

Country or Colony.	Despatched from the United Kingdom.		Destined for the United Kingdom.	
	Letters and Post Cards.	Circulars, Book Packets, Patterns, Newspapers.	Letters and Post Cards.	Circulars, Book Packets, Patterns, Newspapers.
Europe.	℔	℔	℔	℔
Austria-Hungary	27,0	233,0	26,0	65,0
Belgium and Luxemburg	65,0	360,0	58,0	131,0
Denmark	17,0	73,0	16,0	32,0
France (including Algeria and Tunis)	271,0	1,715,0	243,0	719,0
Germany	259,0	1,479,0	252,0	807,0
Gibraltar (including Tangier), Malta, and Cyprus	32,0	319,0	40,0	32,0
Greece	5,0	50,0	3,5	9,0
Holland	56,0	249,0	53,0	126,0
Italy	64,0	676,0	50,0	137,0
Norway	18,0	89,0	12,0	25,0
Portugal and Azores	10,0	124,0	10,0	15,0
Rumania and Balkan States	4,5	51,0	3,5	8,0
Russia	39,5	310,0	24,0	62,0
Spain	28,0	251,0	24,0	45,0
Sweden	15,5	86,0	15,0	26,0
Switzerland	45,0	436,0	40,0	110,0
Turkey (European)	8,0	120,0	7,0	10,0
Totals	964,5	6,621,0	877,0	2,359,0
Asia.				
Asiatic Turkey and Persia	4,5	65,0	3,0	6,0
India (including Aden)	147,0	2,187,0	112,0	313,0
Ceylon, Straits Settlements, and East Indies	30,0	467,0	27,0	62,0
China and Japan	30,0	462,0	27,0	50,0
Totals	211,5	3,181,0	169,0	431,0
Africa.				
South African Colonies[1]	298,0	2,270,0	243,0	473,0
East Coast of Africa (British and Portuguese Possessions), Mauritius, &c.	8,5	119,0	6,5	11,0
West Coast of Africa, &c.	12,0	170,0	8,5	7,0
Egypt	25,0	350,0	20,0	40,0
Madeira, Canary Islands, Cape Verde, St Helena, and Ascension	5,5	56,0	5,5	3,0
Totals	349,0	2,965,0	283,5	534,0
America.				
United States	307,0	2,290,0	290,0	2,100,0
Canada and Newfoundland	83,5	1,068,0	70,0	375,0
Mexico and Central American States	7,0	96,0	5,0	11,0
Brazil, Argentine Republic, Uruguay, and Paraguay	27,0	473,0	23,0	47,0
Chile, Peru, and Bolivia	8,0	126,0	7,0	13,0
Ecuador, Colombia, and Venezuela	2,0	50,0	1,5	2,0
British West Indies (including British Guiana, British Honduras, Bahamas, and Bermuda), and Falkland Islands	21,0	350,0	20,5	35,0
Foreign West Indies	5,5	50,0	2,5	2,0
Totals	461,0	4,503,0	419,5	2,585,0

[1] Including correspondence to and from the army.

00's omitted.

Country or Colony.	Despatched from the United Kingdom.		Destined for the United Kingdom.	
	Letters and Post Cards.	Circulars, Book Packets, Patterns, News-papers.	Letters and Post Cards.	Circulars, Book Packets, Patterns, News-papers.
AUSTRALASIA.	lb	lb	lb	lb
West Australia	10,0	188,0	8,5	42,0
South Australia	8,5	145,0	6,5	45,0
Victoria	27,0	463,0	22,0	217,0
New South Wales	28,5	438,0	23,0	200,0
Queensland	12,0	270,0	8,5	78,0
Tasmania	3,5	76,0	3,0	19,0
New Zealand	26,0	567,0	18,5	183,0
Fiji, &c.	1,5	27,0	1,0	3,0
Totals	117,0	2,174,0	91,0	787,0
Grand totals	2,103,0	19,444,0	1,840,0	6,696,0

During the same year 2,005,506 parcels were despatched out of the United Kingdom, and 1,118,788 were received from the British colonies and other countries. Excluding Cape Colony, where the statistics are inflated by the parcels for the British army, Germany, with 281,145, received the largest number of any one country, and easily heads the list of countries from which parcels were imported into the United Kingdom, with 392,426, France coming next with 212,032.

It will be noticed that while the totals of letters and post cards sent abroad exceed those received by only one-ninth, the printed matter exported was nearly three times as great as that received. This is due in great measure to the large numbers of books and newspapers sent to the British colonies, and especially to the army in Egypt, India, and South Africa.

Foreign and Colonial Letter Rates.—On 1st January 1889 a weekly all-sea service to the Australasian colonies was opened. The rates were 4d. per ½ oz. for letters, and 2d. for post cards, as compared with 6d. and 3d. by the quicker route. In his Budget of April 1890, Mr Goschen provided for a lower and uniform rate of postage from the United Kingdom to India and the British colonies generally. The rates, which had hitherto varied from 2½d. to 4d., 5d., or 6d. per ½ oz., were fixed at 2½d. per ½ oz. The change took effect on 1st January 1891, and resulted at the outset in a loss of £100,000 a year. The fourth Postal Union Congress, which met at Vienna in May and June 1891 (third congress at Lisbon, February and March 1885), took a further step in the direction of uniformity, and on 1st October 1891 the 2½d. rate was extended to foreign as well as colonial letters from the United Kingdom. The Australasian colonies gave their adhesion to the Union at this congress, leaving the Cape Colony, British Bechuanaland, and St Helena the only important parts of the British Empire still outside. St Helena and Ascension joined the Union in 1896, and the Cape signified its adhesion at the next congress (Washington, May and June 1897), while British Bechuanaland and Rhodesia entered in 1900, and practically the whole of the British Empire is now included in the International Union. Abyssinia, Afghanistan, Arabia, China, and Morocco are the chief countries which remain outside.

Imperial Penny Post.—Advantage was taken of the presence in England of special representatives of India and the principal British colonies, to hold an Imperial Postal Conference in London in June and July 1897, under the presidency of the Duke of Norfolk, Postmaster-General. The duke was authorized by the Government to announce that on and from Christmas Day, 1898, an imperial penny post would be established with such of the British colonies as were prepared to reciprocate. The new rates (1d. per ½ oz.), which had long been advocated by Mr Henniker Heaton, came into effect in most cases on the appointed day, and with the other colonies and protectorates shortly afterwards, with the exceptions of Australasia and the Cape, where the 2½d. rate remained unaltered. The Cape came afterwards into the scheme, which has also been extended to Rhodesia, British Bechuanaland, Orange River Colony, Transvaal, and New Zealand. The Australian colonies are now the only important exception. At the same conference it was proposed that the parcel rates with British possessions should be lowered and simplified by the adoption of a triple scale for parcels exchanged by sea, namely, 1s. up to 3 lb, 2s. from 3 to 7 lb, and 3s. from 7 to 11 lb. This scale has been adopted by many of the British colonies. The parcel post has been gradually extended to nearly the whole civilized world, with the exception of the United States, while the rates have in many cases been considerably reduced.

On 1st January 1885 the post office at Malta was transferred from the control of H.M. Postmaster-General to that of the local administration, and a similar change was made as regards Gibraltar on 1st June 1896.

Foreign Mail Service.—Remarkable improvements have been effected in the speed and frequency of the mails sent abroad, and contracts are entered into from time to time with the mail steamship companies, of which the Peninsular and Oriental, the Orient, the Cunard, the Oceanic or White Star, the Pacific, and the Royal Mail are the principal lines. The approximate time occupied in course of post between London and the following places is: Cairo, 6 days; New York, 8 days; Bombay, 14 days 16 hours; Cape Town, 19 days; Hong Kong, 29 days; Adelaide, 30 days 16 hours. The transit charges for special trains conveying mails through France and Italy for Egypt, India, Australia, and the Far East have been successively reduced until they now stand at the ordinary Postal Union transit rates.

Army Post Office Corps.—Mention should be made of the Army Post Office, which is now an essential accompaniment of military operations. On the outbreak of hostilities in South Africa in 1899, the British Post Office supplied a force of 10 officers and 392 men for the purpose of sorting and delivering the mails of the forces, despatching their replies, selling postage stamps, dealing in postal orders, &c. Contingents were also sent by the Canadian, Australian, and Indian Post Offices. During the first eight months of the campaign the letters despatched to the seat of war numbered over 5½ millions, while about half that number were sent home. Including telegraphists, and men of the army reserve, 3400 post office servants were sent to the front.

Money Order Rates.—The decrease in the number of inland money orders till 1890–91 was due to the competition of postal orders (introduced on 1st January 1881), and to the reduction (on 1st January 1878) of the charge for registering a letter from 4d. to 2d.[1] Between 1878 and 1886 the commission on money orders under 10s. was 2d., but on the 1st September in the latter year the rates were altered as follows:—

Orders not exceeding £1	2d.
,, ,, ,, 2	3d.
,, ,, ,, 4	4d.
,, ,, ,, 7	5d.
,, ,, ,, 10	6d.

On 1st February 1897 new rates were introduced: on orders not exceeding £3—3d.; over £3 and not exceeding

[1] The total sums remitted did not fall off to the same extent, showing that the small orders alone were affected. The average amount for ordinary inland orders is now £2, 19s. 5d.

£10—4d. The cost of a money order transaction (at least 3d.) is very little affected by the amount of the remittance, and it was thought undesirable to continue the unremunerative business of sending small sums by money order at less than cost price at the expense of the senders of larger orders. The needs of smaller remitters appeared to be sufficiently met by postal orders and the registered letter post. It appeared, however, that the new charges fell with great severity upon mutual benefit societies, like the Hearts of Oak, which send large numbers of small money orders every week, and on 1st May 1897 the 2d. rate was restored for orders not exceeding £1.

Money Orders.—The following table shows the movement of money-order business since 1883:—

Year.	Inland Orders. Number.	Inland Orders. Amount.	Inland Orders. Increase per Cent. on Number.	Inland Orders. Increase per Cent. on Amount.	Colonial Orders. Number.	Colonial Orders. Amount.	Colonial Orders. Increase per Cent. on Number.	Colonial Orders. Increase per Cent. on Amount.	Foreign Orders. Number.	Foreign Orders. Amount.	Foreign Orders. Increase per Cent. on Number.	Foreign Orders. Increase per Cent. on Amount.	Grand Total. Number.	Grand Total. Amount.	Grand Total. Increase per Cent. on Number.	Grand Total. Increase per Cent. on Amount.
		£				£				£				£		
1884-85	11,958 127	23,536,699	dec. 13·3	dec. 5·9	337,420	1,263,590	7·7	6·7	569,189	1,430,387	1·7	dec. ·2	12,864,736	26,230,676	dec. 12·3	dec. 5·
1889-90	9,027,750	23,333,417	2·1	inc. 1·6	453,102	1,631,616	6·6	7·2	893,292	2,200,872	4·5	inc. 3·	10,374,144	27,165,905	1·2	inc. 2·
1894-95	9,190,304	24,953,532	inc. 1·7	1·5	518,562	1,711,818	·5	dec. 3·1	976,340	2,257,777	dec. ·5	dec. 5·	10,685,206	28,923,127	inc. 1 5	·7
1899-1900	10,292,890	30,505,351	5·8	6·6	617,340	1,876,411	4·0	inc. ·9	1,177,229	2,819,500	inc. 1·4	inc. ·1	12,087,459	35,201,262	5·3	5·7
1900-01	11,375,518	34,454,859	10·5	12·9	680,370	2,074,495	10·2	10·5	1,207,679	2,845,311	2·5	·9	13,263,567	39,374,665	9·7	11·8

Foreign and Colonial Money Orders.—The rates brought into force on 1st January 1883 were as follows:—

	s.	d.
Not exceeding £2	0	6
,, ,, 5	1	0
,, ,, 7	1	6
,, ,, 10	2	0

On 1st February 1897 these rates were reduced to the present scale:—

	s.	d.
Not exceeding £2	0	6
,, ,, 6	1	0
,, ,, 10	1	6

Money orders may be sent to almost any country in the world. Russia, Spain, Greece, and some of the states of Central and Southern America are the principal exceptions.

The money order system is largely used by the British Government departments for the payment of pensions, separation allowances, remittance of bankruptcy dividends, &c.; and free orders may be obtained by the public, under certain conditions, for the purpose of remitting their taxes. The cost of management of the Money Order Office was reduced by the substitution, since 1898, of a number of women clerks for men and boys.

Telegraph Money Orders.—On 2nd September 1889 the issue of telegraphic money orders between London and seventeen large towns was commenced as an experiment, and on 1st March 1890 the system was extended to all head post offices and branch offices in the United Kingdom. Two years later it was extended to every office which transacts both money order and telegraph business. The rates were:—

	s.	d.
Not exceeding £1	0	4
,, ,, 2	0	6
,, ,, 4	0	8
,, ,, 7	0	10
,, ,, 10	1	0

in addition to a minimum charge of 9d. for the official telegram of advice. The rate was lowered on 1st February 1897 to 4d. for sums not exceeding £3, and 6d. for sums from £3 to £10, and the minimum charge for the telegram was reduced to 6d. The sender of a telegraph money order may give instructions that, instead of being left at the post office to be called for, it should be delivered at

Table showing the Number and Value of Postal Orders issued to the Public from the commencement on the 1st January 1881 to the 31st March 1900, with those of typical years.

	Number of each Class of Postal Orders issued (000's omitted).																Total.	
	s. d. 1 0	s. d. 1 6	s. d. 2 0	s. d. 2 6	s. d. 3 0	s. d. 3 6	s. d. 4 0	s. d. 4 6	s. d. 5 0	s. d. 7 6	s. d. 10 0	s. d. 10 6	s. d. 12 6	s. d. 15 0	s. d. 17 6	s. d. 20 0	No.	Value.
																		£
1885-86 .	1,624	1,169	1,531	1,581	1,343	703	1,497	565	3,987	1,146	3,874	694	..	1,127	..	4,943	25,790	10,788
1889-90 .	3,256	2,338	2,951	2,699	2,418	1.391	2,837	1,126	6,637	2,003	6,027	1,389	..	1,795	..	7,839	44,712	17,737
1894-95 .	4,838	3,539	4,301	3,930	3,356	1,997	3,894	1,673	8,924	2,841	7.684	1,978	..	2,304	..	9,416	60,681	22,759
1899-1900 .	8,906	5,088	6,252	5,419	4,593	2,676	5,419	2,237	11,686	3,737	9,461	2,558	..	2,863	..	11,214	82,115	28,633
1900-01	8,229	5,358	6,546	5,715	5,024	2,954	5,651	2,361	12,363	3,936	9,977	2,766	..	2,982	..	11,522	85,390	29,881
Totals .	81,401	55,462	64,334	61,900	50,366	29,539	58,449	24,449	139,225	43,678	120,972	28,933	628	36,139	339	150,071	945,895	357,044

RATES OF POUNDAGE.

To 31st May 1884.	Poundage.	½d.		—	1d.	—				1d.		2d.	—	2d.			
—	Amount of Order .	s. d. 1 0	s. d. 1 6	s. d. 2 0	s. d. 2 6	s. d. 3 0	s. d. 3 6	s. d. 4 0	s. d. 4 6	s. d. 5 0	s. d. 7 6	s. d. 10 0	s. d. 10 6	s. d. 12 6	s. d. 15 0	s. d. 17 6	s. d. 20 0
From 1st June 1884.	Poundage.	½d.		1d.										—	1½d.	—	1½d.

Postal orders for the sums of 12s. 6d. and 17s. 6d. were abolished on the 31st May 1884.
Postal orders for the sums of 2s., 3s., 3s. 6d., 4s., 4s. 6d., and 10s. 6d. were established on the 1st June 1884.

the payee's residence, and that it should be crossed for payment through a bank. He may also, on paying for the extra words, send a short private message to his correspondent in the telegram of advice.

Telegraph money orders may also be sent to Austria, Belgium, Egypt, France, Germany, Holland, Hungary, Italy, Luxemburg, Norway, Rumania, Sweden, and Switzerland. A fee of 2d. is required in addition to the usual money order commission and the cost of the telegram. The system is being rapidly extended to other countries.

The telegraph inland money orders in 1899–1900 amounted to 311,943, and the sums so remitted to £999,086, an average of £3 4s. 1591 were sent abroad for a total of £7213, while 2183 for £12,576 were received from foreign countries.

Postal Orders.—The table at foot of preceding page relates to postal orders.

It will be observed that in 1884 six new denominations of postal orders were introduced, while those for 12s. 6d. and 17s. 6d., which were comparatively little used, were discontinued. At the same time permission was given to make up broken amounts by affixing postage stamps for sums not exceeding 5d. to the order. The stamps so affixed now amount to £100,000 a year. The postal orders for 1s. have recently greatly increased, owing to the number of sporting competitions, for which a fee of 1s. is required. British postal orders may also be obtained at Constantinople, Malta, Gibraltar, India, Straits Settlements, Hong Kong, and Newfoundland, and by sailors on H.M. ships.

Savings Banks.

A succinct account of the history of the Post Office Savings Bank, "so far as depositors and the general public are concerned," will be found in an Appendix to the Forty-third Report of the Postmaster-General (1897). The growth of business is shown in the following table:—

Year ending 31st December.	Average Number of Accounts.	Average Amount of Deposits.	Average Balance in each Account.	Average Number of Offices.
			£ s. d.	
1863-68 .	663,000	7,000,000	11 3 5	3,390
1869-74 .	1,373,000	18,000,000	13 5 3	4,498
1875-80 .	1,889,000	29,000,000	15 12 5	5,742
1881-85 .	3,088,000	42,000,000	13 11 3	7,348
1886-90 .	4,248,000	59,000,000	13 16 10	9,025
1891-95 .	5,776,000	83,000,000	14 7 0	10,888
1896-99 .	7,444,744	119,000,000	16 0 4	12,404

"It is no slight testimony," says the report referred to, "to the skill of the able men who drew the original regulations of 1861, that these regulations remained unchanged, in spite of the vast expansion of the Bank, until a new code was prepared under the Act of 1887" (50 & 51 Vict. c. 40). The code of 1st November 1888, issued under this Act, did not enlarge the limits of deposits or make any great and conspicuous change in the general system, but the Postmaster-General obtained power to offer certain facilities for the transfer of money from one account to another, for the easier disposal of the funds of deceased depositors by means of nominations, and in various ways for the convenience of the customers of the bank. Arrangements were made for reducing to 1s. the cost of certificates of births, deaths, and marriages required for savings bank purposes. In July 1889 Local Loans 3 per cent. stock was made available for purchase through the Post Office Savings Bank.

"In July 1891," continues the report, "another Act of Parliament was passed by which the maximum amount which might be deposited was raised from £150 to £200, inclusive of interest. The annual limit remained at £30, but it was provided that, irrespective of that limit, depositors might replace in the bank the amount of any one withdrawal made in the same year. The object of this provision was to avoid curtailing the saving power of a person who might be driven by emergency to make an inroad upon his store, but who might nevertheless, when the emergency had passed, find himself none the poorer and able to replace the money withdrawn.

"The Act provided also that where on any account the principal and interest together exceeded £200, interest should cease only on the amount in excess of £200, whereas previously interest ceased altogether when it had brought the balance of an account up to £200.

"The next striking development of the Savings Bank arose out of the Free Education Act, passed in September 1891. The Government of the day desired that advantage should be taken of the opportunity to inculcate upon parents and children alike a lesson of thrift—that they should save the school pence which they were no longer bound to pay. The Education Department and the Postmaster-General worked in concert to realize this end. School managers were urged to press the matter upon all concerned, special stamp slips were prepared and issued, managers were supplied on credit with stocks of stamps to be sold to the children, and clerks from the nearest post offices attended at schools to open accounts and receive deposits. The arrangement began in January 1892; about 1400 schools adopted the scheme at once, and three years later this number had risen to 3000. A sum of nearly £14,000 was estimated to have been deposited in schools in 5 months, and about £40,000 in the first year.

"Concurrently with the spread of the stamp-slip system in the schools, the extension of School Penny Banks, connected intimately with the Savings Bank, was a conspicuous result of the effort to turn into profitable channels the pence which no longer paid school fees.

"In December 1893 another Act of Parliament extended the annual limits of deposits from £30 to £50. The maximum of £200 remained unchanged, but it was provided that any accumulations accruing after that amount had been reached should be invested in Government stock unless the depositor gave instructions to the contrary.

"In December 1893 arrangements were made for the use of the telegraph for the withdrawal of money from the Savings Bank. Postmasters-General had hesitated long before sanctioning this new departure. It was known that the system was in force abroad, and it was recognized that there might be, and doubtless were, cases in the United Kingdom where the possibility of withdrawing money without delay might be all-important, and might save a depositor from debt and distress. But, on the other hand, it was strongly held that the cause of thrift was sometimes served by interposing a delay between a sudden desire to spend and its realization; and it was also held to be essential to maintain a marked distinction between a bank of deposit for savings and a bank for keeping current accounts."

On the whole, the balance of opinion was in favour of the change, and two new methods of withdrawal were provided. A depositor might telegraph for his money and have his warrant sent to him by return of post, or he might telegraph for his money and have it paid to him in an hour or two on the authority of a telegram from the Savings Bank to the Postmaster. The first method cost the depositor about 9d., the second cost him about 1s. 3d. for the transaction. In 1899, 161,190 applications were received for withdrawal by telegraph, and 11,405 telegrams were received requesting payment by return of post.

By an Act which came into force on 1st January 1895, building societies, duly incorporated, were enabled to deposit at any one time a sum not exceeding £300, and to buy Government stock up to £500 through the Savings Bank.

Savings Bank Finance.—The increase in the deposits lodged in the Post Office Savings Bank must be ascribed to a variety of causes. Numbers of trustee banks have been closed, and have transferred their accounts to the Post Office Bank; greater facilities have been offered by the bank; the limits of deposit in one year, and of total deposit, have been raised; and, since October 1892, deposits may be made by cheque; while the long-continued fall in the rate of interest made the assured 2½ per cent. of the Post Office Savings Bank an increasing temptation to a class of investors previously accustomed to look elsewhere. The high price of Consols, due in part to the magnitude of purchases on Savings Bank account, proved a serious embarrassment to the profitable working of the bank, which had shown a balance of earnings on each year's working until 1896, after paying its expenses and 2½ per cent. interest to its depositors. Economical working minimized, but did not remove, the difficulty. The average cost of each transaction, originally nearly 7d., has been brought down to 5⅜d. Down to the year 1896, £1,598,767 was paid into the Exchequer under sec. 14 of the Act 40 Vict. c. 13, being the excess of interest which had accrued year by year. But since 1895 there have been deficits amounting to £6162 in 1896, £9232 in 1897, £7018 in 1898, and £11,711 in 1899—in all, £34,123.

The Central Savings Bank having outgrown its accommodation in Queen Victoria Street, London, a new site was purchased in 1898 for £45,000 at West Kensington, and the foundation-stone of a new building, to cost £300,000, was laid by the Prince of Wales on behalf of Queen Victoria on 24th June 1899.

Under the Workmen's Compensation Act of 1897, sums awarded as compensation may be invested in the Post Office Savings Bank. This arrangement proved so convenient, that an Act of 1900 authorized a similar investment of money paid into an English county court in ordinary actions at common law, and ordered to be invested for the benefit of an infant or lunatic.

Inducements to Thrift.—By arrangement with the War Office in July 1893, the deferred pay of soldiers leaving the army was invested on their behalf in the Post Office Savings Bank, but it was found that the majority of the soldiers draw out practically the whole amount at once, and the experiment was discontinued in 1901. At the request of large employers of labour, an officer of the Savings Bank attends at industrial establishments on days when wages are paid, and large numbers of workmen have thus been induced to become depositors. The advantages of the Savings Bank are brought prominently before the public by notices and leaflets, and appear to be now thoroughly appreciated throughout the United Kingdom, as shown by the following table:—

	On 31st December 1900.			
	Number of Depositors.	Total Amount to Credit of Depositors.	Average Amount to Credit of each Depositor.	Proportion of Depositors to Population.
		£	£ s. d.	
England and Wales	7,685,317	122,365,193	15 18 5	1 in 4
Scotland . .	372,801	5,126,299	13 15 0	1 in 12
Ireland . . .	381,865	8,058,153	21 2 1	1 in 12
Totals .	8,439,983	135,549,645	16 1 3	1 in 5

Between the foundation of the bank and the end of 1899, upwards of £648,000,000, inclusive of interest, was credited to depositors, of which £474,000,000 was withdrawn. There were 232,634,596 deposits, 81,804,509 withdrawals, 27,071,556 accounts opened, and 18,631,573 accounts closed. The cross-entries, or instances where the account is operated upon at a different office from that at which it was opened, amounted to 33 per cent. It is chiefly in respect of this facility that the Post Office Savings Bank enjoys its advantage over the trustee savings bank. In 1900, 14,969,849 deposits were made, amounting to £40,516,436. In the same year the withdrawals numbered 5,406,347, the total sum withdrawn being £38,231,372. The interest credited to depositors was £3,145,978, and the total sum standing to their credit on 31st December 1900 was £135,549,645.

A classification of accounts opened for 3 months in 1896, and assumed to be fairly typical, showed the following results:—

Occupation as stated by Depositors in opening Account.	Percentage to Total.
Professional	1·55
Official	2·81
Educational	1·01
Commercial	3·88
Agricultural and fishing	1·83
Industrial	18·43
Railway, shipping, and transport	2·96
Tradesmen and their assistants	8·14
Domestic service	8·61
Miscellaneous	0·37
Married women, spinsters, and children . .	50·41
	100·00

Women and children of all ranks are believed to be 60·59 of the total number of depositors.

The accounts open at the end of 1895 showed the following division of deposits:—

		Per Cent.
Balances not exceeding . .	£50	36·1
Exceeding £50 and not exceeding	100	24·5
,, 100 ,, ,, ,,	150	17·3
,, 150 ,, ,, ,,	200	14·8
,, 200		7·3
		100·0

The division according to number of accounts, in the same groups, was 90·8, 5·3, 2·2, 1·3, and 0·4 respectively.

Investments in Government Stock.—In September 1888 the minimum amount of Government stock which might be purchased or sold through the Post Office Savings Bank was reduced from £10 to 1s., and it was also provided that any person who had purchased stock through the Savings Bank could, if he so desired, have it transferred to his own name in the books of the Bank of England. The Act of 1893 raised the limit of stock to £200 in one year, and £500 in all; but any depositor might purchase stock, to replace stock previously sold, in one entire sum during that year. If a depositor exceeds the authorized limits of deposit in the Post Office Savings Bank, the excess is invested in stock by the Post Office on his behalf.

During the year 1900 the investments of depositors in Government stock were 41,030, amounting to £2,830,513. The sales were 12,028, amounting to £678,510. On the 31st December there were 93,965 depositors, whose total holding of stock amounted to £10,468,290.

Annuities and Life Insurances.—The Act of 1882, which came into operation on the 3rd June 1884, utilized the machinery of the Post Office Savings Bank for annuities and life insurances, which had been effected through the Post Office at selected towns in England and Wales since 17th April 1865. Under the Act of 1882 all payments were to be made by means of money deposited in the Savings Bank, and an order could be given by a depositor that any sum—even to 1d. a week—should be devoted to the purchase of an annuity or insurance so long as he retained a balance in the Savings Bank. In February 1896 new life insurance tables came into operation, with reduced annual rates, and with provision for payment of sums insured at various ages as desired. In 1900 contracts were entered into for 2258 immediate annuities for £49,893, 137 deferred for £2722, and 677 life insurances for £32,512. The receipts for the year were £728,142 immediate and £19,852 deferred annuities, and £22,185 for life insurances. The payments amounted to £503,297 in respect of immediate annuities, to 31,409 persons; £12,921 deferred annuities, to 1020 persons; and 364 persons had claims amounting to £15,422 on account of life insurances, on death and surrender.

Telegraphs and Telephones.

On the 5th of February 1870 the monopoly conferred upon the Postmaster-General by the Telegraph Act of the previous year took effect. The Post Office assumed control of telegraphic communication within the United Kingdom, and it became possible to send telegrams throughout the country at a uniform charge irrespective of locality or distance. The purchase-money paid to the telegraph companies, the compensation to railway companies for their interest in telegraph business, and the expense of new lines, amounted to upwards of ten millions sterling. On the day of the transfer a thousand

Telegraphs.

post offices and 1900 railway stations were opened as telegraph offices. The public at once showed their appreciation of the change. In 1869 but seven millions of telegrams passed on the companies' wires. In 1870 the Postmaster-General transmitted ten millions.

In 1885 sixpenny telegrams were introduced. The charge for a written telegram which came into force in 1870 was one shilling for the first twenty words, and threepence for every additional five words, the addresses of sender and receiver being sent free. In 1885 the charge was reduced to a halfpenny a word throughout, including addresses (a system of abbreviated addresses, which could be registered on payment of a guinea a year, being introduced), with a minimum charge of sixpence. The effect of this reduction was to raise the number of telegrams in two years from 33,000,000 to 50,000,000. During the first six months the number of telegrams increased by 48 per cent., while the gross telegraph revenue fell off to the extent of £40,233, though £18,124 had been received in respect of abbreviated addresses. In April 1886 the telegrams exceeded those for April 1885 by 40 per cent.; the revenue was £11,800 less. In May the increase in telegrams was 51 per cent., and the revenue £4100 less than in the previous May. In June the increase was 61 per cent.; the revenue £2800 less. The working expenses were thus increased, while the receipts were diminished. In London alone the receipts from local messages fell off by as much as 74 per cent.

The following table shows the total number of telegrams forwarded from telegraph offices in England and Wales, Scotland, and Ireland, in each year since 1883:—

Year.	Number of Telegrams. 000's omitted.					
	England and Wales.			Scotland.	Ireland.	Total.
	Provinces.	London.	Total.			
1884–85	15,195	12,930	28,125	3,257	1,894	33,278
1885–86	18,029	15,081	33,110	3,812	2,223	39,146
1886–87	24,044	18,276	42,320	5,106	2,816	50,243
1887–88	26,052	18,872	44,924	5,430	3,047	53,403
1888–89	28,269	20,263	48,532	5,991	3,241	57,765
1889–90	30,873	21,562	52,435	6,545	3,420	62,403
1890–91	32,827	22,831	55,658	7,077	3,673	66,409
1891–92	34,854	23,911	58,765	7,155	3,674	69,685
1892–93	35,382	23,554	58,936	7,100	3,871	69,907
1893–94	36,129	23,501	59,630	7,279	3,987	70,899
1894–95	36,098	24,117	60,215	7,334	4,038	71,589
1895–96	39,411	27,025	66,436	8,095	4,307	78,839
1896–97	40,305	26,645	66,950	8,094	4,378	79,423
1897–98	42,542	27,419	69,961	8,463	4,605	83,029
1898–99	44,781	28,468	73,249	9,064	4,729	87,043
1899–1900	46,144	29,971	76,115	9,387	4,910	90,415
1900–01	46,029	29,355	75,384	9,289	4,903	89,576

In 1891 the terms under which a new telegraph office was opened, on the request of a person or persons who undertook to guarantee the Post Office against loss, were reduced. In 1892 rural sanitary authorities were empowered to give such guarantees out of the rates. In 1897, as part of the Jubilee concessions, the Government undertook to pay one-half of any deficiency under guarantees. During the six years ended in 1891 the average number of telegraph offices guaranteed each year was 77. From 1892 to 1897 the average rose to 167. In 1898 and 1899 it amounted to 290. The number of telegraph offices opened without guarantee has increased apace, and there are now 11,512 telegraph offices in all. As part of the Jubilee scheme the charges for porterage—formerly 6d. per mile beyond the free postal delivery of a town, or beyond one mile from an office, and 1s. per mile from the office door when the distance exceeded 3 miles and a mounted messenger was sent—were reduced as follows: Up to 3 miles, free; beyond 3 miles, 3d. per mile, reckoned from the post office; and arrangements were made for the free delivery at all hours of the day or night of any telegram within the metropolitan postal district. The cost of free delivery up to 3 miles was estimated at £52,000 a year.

On the 26th April 1892 the House of Commons passed a resolution, moved by Sir E. Birkbeck, in favour of providing telegraphic or telephonic communication between coastguard stations, for the better prevention of loss of life and property by shipwreck. £20,000 a year was voted for 1892–93 and for each year in succession till 1900–01 (£30,000; 1901–02, £15,000), and a Royal Commission was appointed to consider the best means of connecting lightships and lighthouses with the telegraph system of the country. The *Post Office Guide* contains a list of 48 points at sea from which casualties can be reported by telegraph or telephone. A new line from London to Nevin, on the coast of Wales, and thence to Ireland, was laid in 1887, at a cost of £40,700. In June 1899 an additional cable was laid from Nevin to Newcastle, Co. Wicklow.

In order to obviate the damage and interruption resulting from storms, large numbers of wires have been laid underground; and a system of underground wires between London and Birmingham has been completed, to secure the storm-swept centre from the Wash to the Bristol Channel.

Foreign Telegrams.—The Sixth International Telegraph Conference, held at Berlin in 1884, effected a reduction in the charges to many countries. *E.g.*, the rate per word was reduced for Russia from 9d. to 6½d., Spain 6d. to 4½d., Italy 5d. to 4½d., and India 4s. 7d. to 4s. The cost of repeating a message was reduced from one-half to one-fourth of the original charge for transmission. The next Conference (1890) was held at Paris. Further considerable reductions were effected. The rates to Austria-Hungary and Italy were reduced from 4½d. to 3d., Russia 6½d. to 5½d., Portugal 5½d. to 4½d., Sweden 5d. to 4d., Spain 4½d. to 4d., Canary Islands 1s. 7½d. to 1s., &c. The minimum charge for any foreign (European) telegram was fixed at 10d. The Eighth Conference (Budapest, 1896) succeeded in making the following reductions, among others, from the United Kingdom: China 7s. to 5s. 6d., Java 6s. to 5s., Japan 8s. to 6s. 2d., Mauritius 8s. 9d. to 5s., Persia 2s. 5d. to 1s. 9d. At this Conference it was made incumbent upon every State adhering to the Union to fix in its currency an equivalent approaching as nearly as possible the standard rate in gold, and to correct and declare the equivalent in case of any important fluctuation. The limit of letters in one word of plain language was raised from 10 to 15, and the number of figures from 3 to 5. The International Telegraph Bureau was also ordered to compile an enlarged official vocabulary of code words, which it is proposed to recognize as the sole authority for words which may be used in cypher telegrams sent by the public. (See Appendix to Postmaster-General's Report, 1897.)

In the meantime progress had been made in the transfer of international cables from private companies to the State. The concession held by the Submarine Telegraph Company, for cables between the United Kingdom and the continent of Europe, expired in January 1889, but was extended to the 31st of March in that year. From that date the undertaking was purchased by the Governments concerned. France and Great Britain jointly acquired the cables between Calais and Dover, Boulogne and Folkestone, Dieppe and Beachy Head, Havre and Beachy Head, Piron, near Coutances, and Vieux Chateaux (St Heliers, Jersey). Belgium and Great Britain became joint-proprietors of the cables between Ramsgate and Ostend and Dover and De la Panne (near Furnes). The two cables to Holland and one of the cables to Germany were already the property of Great Britain, and the German Union Company's cable to Germany was purchased by the German Government. The offices of the Submarine Company in London, Dover, Ramsgate, East Dean, and Jersey were purchased by the Post Office, as well as the cable ship; and the staff, 370 in number, was taken over by the Government. The capital amount laid out by Great Britain was £67,163, and on 1st April the new business was commenced with a uniform rate to France, Germany, Holland, and Belgium of 2d. a word, with a minimum of 10d.

In 1890 Liverpool was placed in direct telegraphic communication with Hamburg and Havre, and London with Rome. The following year an additional cable was laid from Baeton, in Norfolk, to Borkum, in Germany, at the joint expense of the British and German Governments. Direct telegraphic communication was thus afforded between London and Vienna. In 1893 a contract was made with the Eastern and South Africa Telegraph Company for the construction, laying, and maintenance of a cable from Zanzibar to the Seychelles and Mauritius, a distance of 2210 miles, for a subsidy of £28,000 a year for twenty years, to be made up as follows: Great Britain 10 millions, India 10 millions, Seychelles 1 million, Mauritius 7 millions. The cable has been worked since November 1893. In 1894 the Eastern Extension Telegraph Company laid a cable from Singapore to Labuan and Hong Kong, thus duplicating the route and making it an all-British line. The following year the rates to and from East and South Africa were reduced, by negotiation, from charges varying from 7s. 9d. to 8s. 11d. a word to 5s. 2d. or 5s. Government messages were accorded a rate of 2s. 6d. and press telegrams from 1s. 6d. to 1s. 7½d. a word. In 1896 it was arranged to lay two new cables to France and one (for duplex working) to Germany. On 1st February 1898 a new cable was laid between Bermuda and Jamaica (*viâ* Turks Islands), giving an all-British line to the West Indies, with reduced charges. In 1900 direct telegraph working was established between London and Genoa, and a third cable was laid to South Africa *viâ* St Helena and Ascension.

Experiments by Sir W. Preece in electrical communication without wires have been reported from time to time by the Postmaster-General, and the method has been employed by the Post Office in practical working across the Severn Channel, and in instances where an inland telegraph has been interrupted.

Telephones. Ten years of State administration of the telegraphs had not passed before the Postmaster-General was threatened with a formidable rival in the form of the telephone, which assumed a practical shape about the year 1878, the first exchange in the United Kingdom being established in the City of London in that year. It was claimed by those in possession of the telephone patents that they could supply the means of telephonic communication to the public without the licence of the Postmaster-General, and could thus, in effect, compete with the State in the transmission of messages by means of electricity. The Postmaster-General resisted this view, and in 1880 it was judicially determined (Attorney-General *v.* The Edison Telephone Company, 6 Q. B. D. 244) that the telephone was a telegraph, and that telephone exchange business could not legally be carried on except by the Postmaster-General or with his sanction. Licences were then granted to the United Telephone Company, the owners of the master-patents, and to a number of subsidiary companies, to establish exchanges in specified places, on condition that a royalty of 10 per cent. on the gross receipts of each enterprise was paid to the Post Office. The business grew rapidly, and in 1884 the local licences (which were found to hamper business) were superseded by licences applicable to the whole country. At the same time a few Post Office exchanges were established, and the Postmaster-General undertook the business of supplying private telephone wires.

Between 1884 and 1889 the three principal telephone companies (the United, the National, and the Lancashire and Cheshire) greatly extended their business, and on 1st May 1889 they became merged in the National Telephone Company Limited. On 1st May 1890 the company reduced its rates in the North of England from £20 to £15 per annum, and on 1st January 1891 a general reduction of rates outside the metropolis took place from £15 and £12 per annum to £10 per annum. The remaining companies were shortly afterwards amalgamated with the National Telephone Company. In July 1891 the last of the patents expired, and in March 1892 Sir C. Cameron moved a resolution in the House of Commons in favour of nationalizing the telephone service. The Government therefore announced its intention of purchasing the trunk lines (*i.e.*, lines connecting town and town), leaving to the companies the local exchange business. A Treasury Minute of 23rd May 1892, printed in full in the Postmaster-General's Thirtieth Report (1892), sets out the objects of the Government's policy. It points out that the telegraph revenue was being checked by the telephones, and that at the same time the public was dissatisfied with the practical monopoly of the company, which by buying up its rivals had destroyed competition, while the system still lacked its necessary development. The charges for trunk conversations were to be fixed at 3d. for 3 minutes for any distance not exceeding 20 miles, 6d. for over 20 and not exceeding 40 miles, and 6d. for every additional 40 miles.

A Select Committee of the House of Commons in 1892, under Mr Goschen, recommended that the companies' licences should not be extended, but that the Government should on its own responsibility settle the details of an agreement to be laid before Parliament. The New Telephone Company had arisen in Manchester after the patents had expired, but by arrangement with its more powerful rival it went into liquidation, leaving the National Telephone Company alone in the field. The Telegraph Act, 1892 (55 & 56 Vict. c. 59), authorized the Treasury to borrow one million sterling for the purchase of the trunk telephone lines of the company, and for the connexion of business centres by new trunk lines; and also conferred upon the Postmaster-General additional powers in regard to wayleaves, upon which the efficiency of a telephone service largely depends. New trunk lines were at once laid down by the Post Office, and were opened to the public on 16th July 1895. The trunk fees were fixed as follows:—

	s.	d.	
25 miles or under	0	3	for 3 minutes.
Over 25 miles and not exceeding 50 .	0	6	,,
,, 50 ,, ,, 75 .	0	9	,,
,, 75 ,, ,, 100 .	1	0	,,
For each 40 miles beyond . .	0	6	,,

The heads of the agreement with the company were initialled on the 11th August 1892; but the complication and magnitude of the details to be arranged for the transfer of the lines occupied a period of nearly four years, and the final agreement was not signed until 25th March 1896. Nearly 30,000 miles of wires were taken over, at a cost of £459,114, and new areas were allotted to the company for the prosecution of its exchange business. All communication between one exchange area and another now involves the use of the trunk wires. A large number of the operatives employed by the company on the trunk wires passed into the service of the Post Office at the time of the transfer.

Meanwhile the draft agreement with the National Telephone Company, laid on the table of the House of Commons on 7th August 1894, had been followed by much public discussion. The principle of competition in exchange business again found favour with a section of the public, and the corporation of Glasgow, in particular, pressed its application for the grant of a licence to carry on telephone business. Local authorities objected in some instances (notably in London and Glasgow) to permit the company to take up the streets for the purpose of laying underground wires; while overhead wires, apart from æsthetic objections, were liable to interruptions from fire, storms, and accidents. Accordingly in 1895, a Select Committee of the House of Commons was appointed, with Mr Arnold Morley, Postmaster-General, as chairman, "to consider and report whether the provision now made for the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision, either by the granting of licences to local authorities or otherwise." As the dissolution of Parliament was imminent and the Committee was not unanimous, it failed to do more than report the evidence to the House.

The corporation of Glasgow persevered in its efforts to obtain a licence, and in 1897 the Treasury appointed Sheriff Andrew Jameson a Special Commissioner to hold a local inquiry in Glasgow whether the telephone service in that city was adequate and efficient; whether the price charged was reasonable; whether any inefficiency or inadequacy was due to the refusal of facilities on the part of the municipal authorities and others, and how far such refusal was reasonable or justifiable; and finally, whether it was expedient to grant the corporation a licence to carry on a telephone service. After taking evidence for a fortnight, the Commissioner reported that the service was inefficient, but adequate—*i.e.*, no undue conditions were imposed upon applicants. The price was reported to be reasonable. The corporation was held responsible for unreasonably withholding facilities, and so rendering the service inefficient; while it was held inexpedient to give the corporation a licence, on the grounds that (i.) the funds of a city ought not to be applied for the benefit of a limited class of citizens only, (ii.) that delay and waste result from two systems in one area, (iii.) that the acquisition of all telephones by the Government in 1911 would become more difficult and expensive, and that (iv.) the corporation had not proved that they could work the licence without throwing a new and serious burden on the rates.

On 1st April 1898 a further debate was opened in the House of Commons by Mr Caldwell, in the course of which Mr Hanbury, Financial Secretary to the Treasury and representative of the Post Office in the House, stated on behalf of the Government the objections to purchasing a company whose capital stock had been largely watered, whose plant was in many cases old-fashioned, consisting of single overhead wires, and whose term of existence was approaching its end. A Select Committee was appointed, with Mr Hanbury as chairman, to consider "whether the telephone service is, or is calculated to become, of such general benefit as to justify its being undertaken by municipal and other local authorities, regard being had to local finance"; and if so, under what conditions. The Committee reported (9th August) to the effect that the telephone service of the country was not likely to become of general benefit "so long as the present practical monopoly in the hands of a private company shall continue." The trunk service in the hands of the Government and worked on the toll system (*i.e.*, a separate payment for each service) was the most expensive in Europe. The exchange service, chiefly confined to annual subscribers to the National Telephone Company, was much behind what it should be as judged by Continental standards. The company's capital of £3,105,000 at the time of amalgamation included £1,292,000 of "water." £300,000 had been spent on patents which expired in 1891. And the service, practically limited to the wealthy classes or large users who could afford to become annual subscribers, was rendered precarious by the difficulty of obtaining way-leaves, which, even when secured, were held upon short notice. Out of 143,000 miles of wire, 120,000 were liable to be removed at 6 or 12 months' notice. The company's rates were unregulated, and it claimed the right to give preferences, or even to refuse its services altogether. The Committee found that the Post Office was "not prevented, either by legal agreement or by good faith, from limiting or ending the monopoly of the company"; and that "competition appears to be both expedient and necessary, in order, first, to extend and popularize the service, and, next, to avoid a danger, which is by no means remote if no alternative service is in operation, that a purchase of the company's undertaking at an inflated price may be forced upon the Government of the day." They therefore recommend that "general immediate and effective competition" should be at once undertaken either by the Post Office or by local authorities, while considering that "a really efficient Post Office service affords the best means for securing such competition." The Post Office should either start services of its own, or grant licences to local authorities, subject to proper regulations. Equal terms should be aimed at where the local authorities came into competition with the company; and proposals were made with a view to the purchase by the Post Office in 1911, at the then value, without any compensation for goodwill or future profits, of any suitable plant or buildings held by a competing and expiring licensee.

In addition to the £1,000,000 raised for trunk line purposes by the Act of 1892, further sums of £300,000 and £1,000,000 had been authorized by the Telegraph Acts of 1896 (59 & 60 Vict. c. 40) and 1898 (61 & 62 Vict. c. 33). Following upon the report of the Select Committee of 1898, the Telegraph Act, 1899 (62 & 63 Vict. c. 38), was passed for the purpose of enabling the Post Office to develop its exchange business, for which a loan of two millions was authorized, and to empower local authorities under certain conditions to carry on telephone exchange business under licence from the Postmaster-General. The position of the National Telephone Company was also defined in case of competition by local authorities, and its licence was extended to be coextensive with that of a new licensee in any locality on condition of its affording intercommunication and coming under the control of the Post Office as regards rates.

The Post Office opened its exchange telephone service in London in 1902. It has granted licences to the States of Guernsey (1898), Glasgow, Huddersfield, Tunbridge Wells, Brighton, and other centres.

Financial results of State telegraphy.

The principal reasons alleged for the unfavourable financial results of the working of the telegraphs are: (i.) The large price (£10,130,000) expended as purchase-money—an argument of little weight so long as working expenses are not paid. (ii.) The right accorded to railway companies at the time of the transfer, of sending postal telegrams free of charge. The number of these telegrams, at first insignificant, reached a total of 1,600,000 in 1891, with an average length of 25 words, representing a value of over £80,000 a year. Arrangements were afterwards made under which the companies surrender this privilege in return for permission to send a fixed number of free telegrams in the course of each year. (iii.) The loss on press telegrams. To quote the Forty-first Report of the Postmaster-General: "A still more serious burden is caused by the loss on press telegrams. The charge specified in the Telegraph Act of 1868 for press telegrams is 1s. for 75 words during the day, or for 100 words at night. But a proviso was added that for copies the charge was to be only 2d. per 75 or 100 words, and no condition was laid down as to the copy being for the same town as the original. The newspapers accordingly combined to receive from the News Associations messages in identical terms, and by dividing the cost they are enabled to get the benefit of a rate which comes nearer 2d. than 1s., the average charge being in fact about 4½d. per 100 words. Notwithstanding the economical arrangements which have been made for the transmission of the telegrams (5,400,000 in number, containing 650,000,000 words), the loss incurred by the Post Office in dealing with them is estimated to amount to £300,000 per annum." (iv.) The reductions in the tariff (especially in 1885 and 1897). (v.) The competition of the telephone (upwards of 450,000,000 messages a year transmitted by the National Telephone Company alone), though it must be remembered that the royalties of the company, exceeding £100,000 per annum, figure among the receipts of the Post Office telegraph service. (vi.) The increased wages paid to telegraphists: in 1880–81 the wages and salaries represented 44 per cent. of the total revenue; they now exceed 66 per cent.

The real success of the State administration of the telegraph lies not in any contribution to the revenue, but in cheap telegrams and a large use of the service. The average price paid for the ordinary inland telegram is 7¾d.; and there are far more telegrams sent in the United Kingdom, both positively and relatively to population, than in any other country, with the possible exception of the United States. For every 100 persons there are sent, in the United Kingdom, 184 telegrams, while in France there are but 108, and in Germany but 66. The accompanying table shows the revenue and expenditure of the telegraph service:—

Year.	Revenue.				Expenditure.									Net Revenue.	Interest on Stock created for Purchase of Telegraphs.
	Telegraph Receipts.	Extra Receipts.	Estimated Value of Services to other Departments.	Total.	Sites and Buildings.		Telegraph Extension.	Superannuations and other Non-effective Charges.	Salaries, Wages, &c.	Maintenance of the Telegraph System.	Other Expenditure.		Total.		
					Purchase.	Erection.					Under Telegraph Vote.	Under other Votes.			
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1884-85	1,739,586	17,731	27,097	1,784,414	10,150	40,450	260,021	21,666	939,354	375,661	124,188	49,274	1,820,764	36,350[1]	326,417
1889-90	2,307,444	20,326	36,329	2,364,099	13,908	42,112	149,131	26,776	1,382,414	445,566	162,126	56,953	2,278,986	85,113	306,076
1894-95	2,598,985	..	47,429	2,646,414	3,915	52,854	74,819	39,791	1,833,684	500,833	212,803	69,353	2,788,052	141,638[1]	298,888
1899-1900	3,389,746	..	70,746	3,460,492	18,029	59,529	277,193	81,031	2,279,722	705,819	238,610	89,151	3,749,084	288,592[1]	298.888
1900-01	3,380,589	..	78,764	3,459,353	32,297	48,199	260,740	86,334	2,342,896	695,826	248,718	97,559	3,812,569	353,216[1]	298,888

[1] Deficits.

Post Office Staff.

The staff of the Post Office on 31st March 1901 amounted to 173,184, or 1 in 236 of the whole population of the United Kingdom. Of these, 35,377 were women, a proportion of over one-fifth of the staff. The postmasters numbered 909 (including 11 employed abroad), and the sub-postmasters 21,027. The total number of offices (including branch offices) was 22,189. The unestablished staff, not entitled to pension, made up chiefly of telegraph boys, and of persons who are employed for only part of the day on Post Office business, included 79,052 out of the grand total, and almost the whole of the sub-postmasters. The pay and prospects of almost all classes have been greatly improved since 1884, when the number stood at 91,184. The principal schemes of general revision of pay have been:—1881, Mr Fawcett's scheme for sorting-clerks, sorters, and telegraphists (additional cost £210,000 a year), and for postmen, 1882, £110,000: Mr Raikes's various revisions, 1888, chief clerks and supervising officers, £6230; 1890, sorting-clerks, sorters, and telegraphists, £179,600; 1890, supervising force, £65,000; 1890, London sorters, £20,700; 1891, London overseers, £9400; 1891, postmen, £125,650: Mr Arnold Morley, 1884, London overseers, £1400, and rural auxiliaries, £20,000.

On June 10th 1895 a committee was appointed, with Lord Tweedmouth as chairman, to consider the pay and position of the whole Post Office staff, excluding the clerical force and those employed at headquarters. After exhaustive inquiry, the committee reported its recommendations on 15th December 1896, and these were adopted in their entirety by the Government at an immediate increased expense of £139,000 a year, which has since risen to £500,000. In 1897 a conference of members of the House of Commons, under the presidency of the Duke of Norfolk and Mr Hanbury, considered further representations of grievances on the part of the staff, and in the result additional concessions were made at a cost of £100,000 a year.

In July 1890 a number of postmen in London went out on strike. Over 450 were dismissed in one morning, and the work of the Post Office was carried on without interruption. The men received no sympathy from the public, and most of them were ultimately successful in their plea to be reinstated. A quasi-political agitation was carried on during the general election of 1892 by some of the London sorters, who, under the plea of civil rights, claimed the right to influence candidates for Parliament by exacting pledges for the promise of parliamentary support. The leaders were dismissed, and the Post Office has upheld the principle that its officers are to hold themselves free to serve either party in the State without putting themselves prominently forward as political partisans. Parliament has been repeatedly asked to sanction a parliamentary inquiry to reopen the settlement of the Tweedmouth Committee, and the telegraphists have been especially active in pressing for a further committee. The rates of pay now, and at various dates since 1881, are set out with great fulness in two Parliamentary papers (*Postmen*, No. 237 of 1897, and *Sorters, Telegraphists, &c.*, No. 230 of 1898).

The pay of a sorter or telegraphist in London rises to £160 a year, with prospects of promotion to higher classes. The maximum pay of a postman in London is 34s. a week, but he may receive as much as 6s. a week extra for good-conduct stripes. The Parliamentary returns above referred to show the perquisites in the form of overtime, allowances, double increments, uniform, free medical attendance, holidays, and pensions, &c., enjoyed in addition to the bare wages. "The mere scales of pay given to the staff only imperfectly represent the full advantages arising from their position; and the growing disinclination of the staff to leave the service, and the increasing desire of outsiders to enter it, afford a fair presumption that the position and prospects of the employés in the Post Office are at least equal, if not superior, to those of persons employed on similar duties outside the service."[1]

The estimated expenditure of the Post Office on account of salaries and wages in 1900–01 amounted to £8,620,171, representing 49·38 of the total revenue and 62·11 of the total expenditure. These percentages were respectively 36·72 and 50·32 in 1884–85, and have been steadily increasing, notwithstanding the considerable extension of Mr Fawcett's successful experiment of employing women and girls in the clerical work of certain branches of the service.

[1] Forty-first Report of the Postmaster-General, 1895, p. 11.

In November 1891 an important change was made in the method of recruiting the staff of postmen, with the object of encouraging military service, and of providing situations for those who after serving their country in the army or navy are sometimes left without employment at a comparatively early age. In making appointments to the situation of postman, preference was given to army, navy, and royal marine pensioners, and men of the army reserve. Due regard was paid to the legitimate claims of telegraph messengers or other persons who had prospects of succeeding to these situations, but on March 31st, 1892, no fewer than 1379 old soldiers and sailors were serving as postmen. Since that time the number has considerably increased. In August 1897 the Government decided to reserve one-half of all suitable vacancies for ex-soldiers and sailors, as postmen, porters, and labourers, and preference has been shown to them for employment as lift-attendants, caretakers, &c.

Finance.—The following table shows the financial working of the Post Office :—

Year.	Revenue.				Expenditure.									Net Revenue.
	Postal Receipts.	Extra Receipts.	Estimated Value of Services to other Departments.	Total.	Sites and Buildings.		Superannuations and other Non-effective Charges.	Salaries, Wages, &c.	Conveyance of Mails.	Packet Service.	Other Expenditure.		Total.	
					Purchase.	Erection.					Under P.O. Votes.	Under other Votes.		
	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1884–85 . . .	7,808,911	382,002	198,336	8,389,249	72,464	80,234	150,742	2,829,210	1,154,211	728,413	515,892	136,999	5,668,165	2,721,084
1889–90 . . .	9,467,165	36,279	218,037	9,721,481	70,900	79,840	153,921	3,359,563	1,249,821	664,342	553,910	142,788	6,275,085	3,446,396
1894–95 . . .	10,748,014	..	277,446	11,025,460	12,597	175,390	188,919	4,597,355	1,395,282	729,813	677,524	178,464	7,955,344	3,070,116
1899–1900 . . .	13,192,020	..	202,315	13,394,335	115,294	169,098	269,092	5,963,399	1,474,118	759,307	719,944	213,747	9,683,999	3,710,336
1900–01 . . .	13,776,886	..	218,584	13,995,470	81,949	175,000	286,238	6,277,275	1,516,859	764,804	726,101	236,677	10,064,903	3,930,567

Postage Stamps.

The pamphlet of Mr (afterwards Sir) Rowland Hill, *Post Office Reform: Its Importance and Practicability*, 1837, led to the appointment of a committee of the House of Commons on 22nd November 1837, "to inquire into the rates and modes of charging postage, with a view to such a reduction thereof as may be made without injury to the revenue." This committee reported in favour of Hill's proposals; and an Act, 2 & 3 Vict. c. 52, was passed in 1839, authorizing the Treasury to fix the rates of postage, and regulate the mode of their collection, whether by prepayment or otherwise. By Treasury Minute of 23rd August 1839, published in the press, it was announced that "My Lords . . . feel it will be useful that artists, men of science, and the public in general may have an opportunity of offering any suggestions or proposals as to the manner in which the stamp may be best brought into use." A premium of £200 was offered for the best, and £100 for the next best, proposal. The points to be considered were: "(1) the convenience as regards the public use; (2) the security against forgery; (3) the facility of being checked and distinguished at the post office, which must of necessity be rapid; and (4) the expense of the production and circulation of the stamps." To this invitation 2600 replies were received, but no improvement was made upon Rowland Hill's suggestions. A further Minute, of 26th December 1839, announced that the Treasury had decided to require that, as far as practicable, the postage of letters should be prepaid, and such prepayment effected by means of stamps. Stamped covers or wrappers, stamped envelopes, and adhesive stamps were to be issued by Government. The stamps were engraved by Messrs Perkins, Bacon, & Petch, of Fleet Street, from Hill's designs, and the Mulready envelopes and covers by Messrs Clowes & Son, of Blackfriars. The stamps were appointed to be brought into use on 6th May 1840, but they appear to have been issued to the public as early as 1st May. The penny stamp bearing a profile of Queen Victoria was coloured black, and the twopenny stamp blue, with check-letters in the lower angles (in all four angles from April 1858). Up to 28th January 1854 the stamps were not officially perforated, except in the session of 1851, when stamps, perforated by a Mr Archer, were issued at the House of Commons post office. In 1853 the Government purchased Archer's patent for £4000. The stamps were first water-marked in April 1840.

(i.) *Line-engraved Stamps.*

Halfpenny Stamp.—First issue, 1st October 1870 : size 18 mm. by 14 mm.; lake red varying to rose-red.

One Penny Stamp.—First issue, 1st (for 6th) May 1840 : the head executed by Mr Frederick Heath, from a drawing by Mr Henry Corbould of Mr Wm. Wyon's medal struck to commemorate her Majesty's visit to the City of London on 9th November 1837 : size $22\frac{1}{2}$ mm. by $18\frac{3}{4}$ mm.; black, watermarked with a small crown; a few sheets in 1841 struck in red, two essays were made in April and October 1840 in blue and blue-back. Imperforate. The *second issue*, 20th January 1841, differed only from the first issue as to colour—red instead of black. It is stated[1] that the colour, "though always officially referred to as 'red,' was really a red-brown, and this may be regarded as the normal colour; but considerable variations in tone and shade (brick-red, orange-red, lake-red) occurred from time to time, often accentuated by the blueing of the paper, though primarily due to a want of uniformity in the method employed for preparing the ink." The change of colour from black was made in order to render the obliteration (now in black instead of red ink) more distinct. Imperforate. *Third issue*, February 1854 : small crown watermark, perforated 16 (*i.e.*, 16 holes to 2 centimetres). The *fourth issue*, January 1855, differed only from the third issue in being perforated 14. *Fifth issue*, February 1855 : from a new die, with minute variations of engraving. In the second die the eyelid is more distinctly shaded, the nostril more curved, and the band round the hair has a thick dark line forming its lower edge. Small crown watermark. Perforated 16 and 14. *Sixth issue*, July 1855 : large crown watermark. Perforated 14; a certain number 16. *Seventh issue*, January 1858 : carmine-rose varying from pale to very deep. Large crown watermark. Perforated, chiefly 14. *Eighth issue*, 1st April 1864 : check-letters in all four corners instead of two only; large crown watermark. Perforated 14.

In 1880 the line-engraved one penny stamps were superseded by the surface-printed one of similar value in Venetian red, designed and printed by Messrs De la Rue & Co.

Three-halfpenny Stamp.—1st October 1870 : large crown watermark; lake-red; perforated 14. Superseded in October 1880 by De la Rue's surface-printed stamp.

Twopenny Stamp.—First issue, 1st (for 6th) May 1840 : small crown watermark; light blue, dark blue; imperforate. *Second issue*, March 1841 : small crown watermark; white line below "Postage" and above "Twopence"; dull to dark blue; imperforate. *Third issue*, February (?) 1854 : small crown watermark; blue, dark blue; perforated 16. *Fourth issue*, March 1855 : small crown watermark; blue, dark blue; perforated 14. *Fifth issue*, July 1855 : large crown watermark; blue; perforated 16; blue, dark blue; perforated 14. *Sixth issue*, May (?) 1857 : large crown

[1] Wright and Creeke, *History of the Adhesive Stamp of the British Isles available for Postal and Telegraph Purposes.* London, 1899.

watermark; white lines thinner, blue, dark blue; perforated 14; dark blue; perforated 16. *Seventh issue*, July 1858: large crown watermark; white lines as in fifth issue; deep to very deep blue; perforated 16. *Eighth issue*, April (?) 1869: large crown watermark; white lines thinner; dull blue, deep to very deep blue, violet blue; perforated 14. Superseded in December 1880 by De la Rue's surface-printed stamp.

(ii.) *Embossed Stamps.*

Produced by Dryden Brothers, of Lambeth, from designs submitted by Mr Ormond Hill of Somerset House, engraved after Wyon's medal.

Sixpence.—1st March 1854: violet, reddish lilac, dark violet; imperforate. Superseded in October 1856 by De la Rue's surface-printed stamp.

Tenpence.—6th November 1848: pale to very deep chestnut-brown; imperforate. Superseded by De la Rue's surface-printed stamp in 1867.

One Shilling.—11th September 1847: emerald green, pure deep green, yellow green; imperforate. Superseded in November 1856 by De la Rue's surface-printed stamp.

(iii.) *Surface-printed Stamps before 1880.*

Twopence Halfpenny.—First issue, 1st July 1875: small anchor watermark; lilac-rose; perforated 14. *Second issue*, May 1876: orb watermark; lilac-rose; perforated 14. *Third issue*, 5th February 1880: orb watermark; cobalt, and some ultramarine; perforated 14. *Fourth issue*, 23rd March 1881; large crown watermark; bright blue; perforated 14.

Threepence.—All perforated 14. *First issue*, 1st May 1862: heraldic emblems watermark; carmine (pale to deep). *Second issue*, 1st March 1865: same watermark as above; carmine-pink. *Third issue*, July 1867: watermarked with a spray of rose; carmine-pink, carmine-rose. *Fourth issue*, July 1873: watermark as third issue; carmine-rose. *Fifth issue*, 1st January 1881: watermark large crown; carmine-rose. *Sixth issue*, 1st January 1883; watermark as fifth issue; purple shades overprinted with value in deep pink.

Fourpence.—All perforated 14. *First issue*, 31st July 1855; watermark small garter; deep and dull carmine. *Second issue*, February 1856: watermark medium garter; pale carmine. *Third issue*, 1st November 1856: watermark medium garter; dull rose. *Fourth issue*, January 1857; watermark large garter; dull and pale to deep rose, pink. *Fifth issue*, 15th January 1862: watermark large garter; carmine-vermilion, vermilion-red. *Sixth issue*, July 1865; watermark large garter; pale to dark vermilion. *Seventh issue*, 1st March 1876: watermark large garter; pale vermilion. *Eighth issue*, 27th February 1877: watermark large garter; pale sage-green. *Ninth issue*, July 1880: watermark large garter; mouse-brown. *Tenth issue*, 1st January 1881: watermark large crown; mouse-brown.

Sixpence.—All perforated 14. *First issue*, 21st October 1856: no letters in angles; watermark heraldic emblems; dull lilac. *Second issue*, 1st December 1862: small white letters in angles; otherwise as first issue. *Third issue*, 1st April 1865: large white letters in angles; otherwise as first issue. *Fourth issue*, June 1867: watermark spray of rose; otherwise as third issue; some in bright lilac. *Fifth issue*, March 1869: as fourth issue; lilac, deep lilac, purple-lilac. *Sixth issue*, 1st April 1872: as fourth issue; bright chestnut-brown. *Seventh issue*, October 1872: as fourth issue; buff. *Eighth issue*, April 1873: as fourth issue; greenish grey. *Ninth issue*, 1st April 1874: watermarked as fourth issue; large coloured letters in angles; greenish-grey. *Tenth issue*, 1st January 1881: large crown watermark; otherwise as ninth issue. *Eleventh issue*, 1st January 1883: as tenth issue; purple, overprinted with value in deep pink.

Eightpence.—11th September 1876: watermark large garter; chrome-yellow, pale yellow; perforated 14.

Ninepence.—All perforated 14. *First issue*, 15th January 1862: watermark heraldic emblems; ochre-brown, bright bistre. *Second issue*, 1st December 1865: watermark as above; bistre-brown, straw. *Third issue*, October 1867: watermark spray of rose; straw.

Tenpence.—1st July 1867: watermark spray of rose; red-brown; perforated 14.

One Shilling.—All perforated 14. *First issue*, 1st November 1856: watermark heraldic emblems; no letters in angles; dull green, pale to dark green. *Second issue*, 1st December 1862: as above; small white letters in angles; pale to dark green. *Third issue*, February 1865; as above; large white letters in angles; pale to dark green, bluish green. *Fourth issue*, August 1867: watermark spray of rose; otherwise as third issue; pale to dark green, bluish green. *Fifth issue*, September 1873: large coloured letters in angles; otherwise as fourth issue; light to dark green, bluish green. *Sixth issue*, 14th October 1880: as fifth issue; pale red-brown. *Seventh issue*, 15th June 1881: watermark large crown; otherwise as sixth issue; pale red-brown.

Two Shillings.—Watermark spray of rose; perforated 14. *First issue*, 1st July 1867; pale to full blue, very deep blue. *Second issue*, February 1880: light brown.

Five Shillings.—First issue, 1st July 1867: watermarked with a cross *paté*; pink, pale rose; perforated $15\frac{1}{2}$ by 15. *Second issue*, November 1882: watermark large anchor; carmine-pink; perforated 14.

Ten Shillings.—First issue, 26th September 1878: watermark cross *paté*; green-grey; perforated $15\frac{1}{2}$ by 15. *Second issue*, February 1883: watermark large anchor; green-grey; perforated 14.

One Pound.—First issue, 26th September 1878: watermark cross *paté*; brown-violet; perforated $15\frac{1}{2}$ by 15. *Second issue*, December 1882: watermark large anchor; brown-violet; perforated 14.

(iv.) *After* 1880.

In 1880–81 the halfpenny, penny, three halfpenny, and twopenny surface-printed stamps superseded the line-engraved stamps of the same value, and a new surface-printed stamp of fivepence was introduced. These stamps are distinguished from the stamps already described by the absence of plate-numbers and (except in the penny stamp) of check-letters in the corners; also by the coarser style of engraving necessary for printing by machines driven by steam-power.

One Halfpenny.—First issue, 14th October 1880: large crown watermark; pale green, bluish green, dark green; perforated 14. *Second issue*, 1st April 1884: slate-blue.

One Penny.—1st January 1880: large crown watermark; venetian red; perforated 14.

Three Halfpence.—14th October 1880: large crown watermark; venetian red; perforated 14.

Twopence.—8th December 1880: large crown watermark; pale to very deep carmine red; perforated 14.

Fivepence.—15th March 1881: large crown watermark; dark dull indigo, indigo-black; perforated 14.

The Customs and Inland Revenue Act which came into force on 1st June 1881 made it unnecessary to provide separate penny stamps for postal and fiscal purposes. By an Act of 1882 (45 & 46 Vict. c. 72) it became unnecessary to provide separate stamps for postal and fiscal purposes up to and including stamps of the value of 2s. 6d. A new series was therefore issued:—

One Penny.—All perforated 14. *First issue*, 12th July 1881: large crown watermark; 14 pearls in each angle; purple-lilac, purple. *Second issue*, 12th December 1881: as first issue; 16 pearls in each angle; purple.

Three Halfpence.—1st April 1884: large crown watermark; purple; perforated 14.

Twopence.—Ditto.

Twopence Halfpenny.—Ditto.

Threepence.—Ditto.

Fourpence.—Ditto, except in colour (sea-green).

Fivepence.—As fourpence.

Sixpence.—Ditto.

Ninepence.—Ditto.

One Shilling.—Ditto.

Two Shillings and Sixpence.—22nd July 1883: watermark large anchor; purple, dull lilac, dark purple; perforated 14.

Five Shillings.—1st April 1884: ditto; pale to very deep carmine.

Ten Shillings.—Ditto; pale blue, cobalt, light to dull blue.

One Pound.—First issue, 1st April 1884: large crown watermark, 3 appearing in each stamp; brown-violet; perforated 14. *Second issue*, 27th January 1891: same watermark; bright green; perforated 14.

Five Pounds. — 21st March 1882: large anchor watermark; orange-vermilion, vermilion, bright vermilion; perforated 14.

Following upon the Report of a Committee of Officials of the General Post Office and Somerset House, a series of new stamps, commonly known as the "Jubilee" issue, was introduced on 1st January 1887, all of which between one halfpenny and one shilling exclusive were printed either in two colours or on a coloured paper, so that each stamp was printed in part in one or other of the doubly-fugitive inks—green and purple.

One Halfpenny.—1st January 1887: large crown watermark; orange vermilion to bright vermilion; perforated 14.

Three Halfpence.—1st January 1887: as the halfpenny; green and purple.

Twopence.—Ditto: green and scarlet to carmine.

Twopence Halfpenny.—1st January 1887: blue paper; watermark large crown; dark purple; perforated 14.

Threepence.—1st January 1887: yellow paper; watermarked with a large crown; purple; perforated 14.

Fourpence.—1st January 1887: watermark and perforation as in threepence; green and brown.

Fourpence Halfpenny.—15th September 1892: as the fourpence; green and carmine.

Fivepence.—1st January 1887: as the fourpence; purple and blue.

Sixpence.—1st January 1887: pale red paper; watermarked with a large crown; purple; perforated 14.

Ninepence.—1st January 1887: large crown watermark; purple and blue; perforated 14.

Tenpence.—24th February 1890: as the ninepence; purple and carmine-red.

One Shilling.—1st January 1887: as the ninepence; green.

The various fiscal stamps admitted to postage uses, the overprinted official stamps for use by Government departments, and the stamps specially surcharged for use in the Ottoman Empire, do not call for detailed notice in this article.

The distinctive *telegraph stamps* are as follows:—

One Halfpenny.—1st April 1880: shamrock watermark; orange-vermilion; perforated 14.

One Penny.—1st February 1876: as the halfpenny; reddish brown.

Threepence.—Perforated 14. *First issue,* 1st February 1876: watermark spray of rose; carmine. *Second issue,* August 1881: watermark large crown; carmine.

Fourpence.—1st March 1877: watermark large garter; pale sage-green; perforated 14.

Sixpence.—Perforated 14. *First issue,* 1st March 1877: watermark spray of rose; greenish grey. *Second issue,* July 1881: as first issue; watermark large crown.

One Shilling.—Perforated 14. *First issue,* 1st February 1876: watermark spray of rose; green. *Second issue,* October 1880: watermark spray of rose; pale red-brown. *Third issue,* February 1881: watermark large crown; pale red brown.

Three Shillings.—Perforated 14. Slate blue. *First issue,* 1st March 1877: watermark spray of rose. *Second issue,* August 1881: watermark large crown.

Five Shillings.—*First issue,* 1st February 1876: watermark cross *paté;* dark to light rose; perforated 15 by 15½. *Second issue,* August 1881: watermark large anchor; carmine-rose; perforated 14.

Ten Shillings.—1st March 1877: watermark cross *paté;* green-grey; perforated 15 by 15½.

One Pound.—1st March 1877: watermark shamrock; brown-purple; perforated 14.

Five Pounds.—1st March 1877: watermark shamrock; orange-vermilion; perforated 15½ by 15.

In addition to these, there were stamps specially prepared for the army telegraphs.

II. Foreign Countries.

Postal statistics for different countries will be found under the separate headings for each. But the following tables show comparatively the business done in the principal countries:—

Postal Statistics, 1900.

Country.	1 Sent by Inland Letter Post (Millions).	2 Inland Parcel Post (Millions).	3 Total of Articles posted per Head of Population.	4 No. of Post Offices (Thousands).	5 No. of Persons employed (Thousands).	6 No. of Inland Money Orders (Millions).	7 Receipts in Millions of Francs.	8 Expenses in Millions of Francs.	9 Surplus + or Deficit − in Millions of Francs.	10 Remarks.
Austria . .	741	22	37·4	7	22	24	112	102	+10	
Belgium . .	402	2	66·3	1	4	3	25	14	+11	
Canada . .	242	3	50·1	10	·7	·8	22	26	− 4	
France . .	2106	46	52·2	11	46	41	276	208	+68	Including Algeria.
Germany . .	3263	171	61·6	45	121	141	559	537	+22	
Holland . .	269	4	57·2	1	5	3	20	16	+ 4	
Hungary . .	265	9	18	5	7	15	47	34	+13	
India . . .	504	1	1·8	13	34	13	31	28	+ 3	Br. India only.
Italy . . .	716	7	26·1	8	11	13	61	59	+ 2	
New South Wales	118	·5	96·2	2	4	2	20	18	+ 2	
New Zealand .	63	·2	84·3	2	·2	·2	8	6	+ 2	
Russia . .	520	2	4·3	6	18	10	205	143	+62	
Switzerland .	178	16	67·7	4	6	6	36	33	+ 3	
United States .	7130	. .	95·6	78	16	32	530	555	−25	
Victoria . .	99	·2	97·1	2	2	·1	15	13	+ 2	
United Kingdom	3642	78	88·9	22	114	97	353	254	+99	

In column 1 the figures for Canada and the United Kingdom include the foreign letters.

,, ,, 2 the figures for Canada and the United Kingdom include the foreign parcels.

,, ,, 5 the figures for Austria, France, Germany, Hungary, New South Wales, Russia, and the United Kingdom include telegraph employés.

,, ,, 6 the figures for France, New South Wales, and the United Kingdom include postal orders (5 millions in France, 85 millions in the United Kingdom).

,, ,, 7, 8, and 9 the figures for Austria, France, Germany, Hungary, New South Wales, and Victoria include telegraphs.

Telegraph Statistics, 1900.

Country.	No. of Telegrams (in Millions).	No. of Telegraph Offices (in Thousands).	Length of Wires (in Thousands of Kilometres).	Remarks.
Austria . . .	16	5	106	
Belgium . . .	7	1	34	
France . . .	53	14	548	Including Algeria.
Germany . .	46	24	473	
Holland . . .	6	1	23	
Hungary . .	8	3	115	
India . . .	7	5	291	Br. India only.
Italy . . .	12	6	132	
Russia . . .	20	6	498	
Switzerland . .	4	2	22	
United Kingdom .	93	12	556	

These figures in some cases include, and in others exclude, the telegraph lines of railway companies, &c.

(H. H*.)

III. United States.

The financial statements of the United States Post Office for a series of years show the following figures:—

Year ended 30th June.	Revenue.	Expenditure.	Deficit.
1893 . . .	$75,896,933	$81,074,104	$5,177,171
1894 . . .	75,080,479	84,324,414	9,243,935
1895 . . .	76,983,128	86,790,172	9,807,044
1896 . . .	82,499,208	90,626,296	8,127,088
1897 . . .	82,665,462	94,077,242	11,411,780
1898 . . .	89,012,618	98,033,523	9,020,905
1899 . . .	95,021,384	101,632,160	6,610,776
1900 . . .	102,354,579	107,740,267	5,385,688
1901 . . .	111,631,193	115,554,920	3,923,727

The revenue quoted does not include any allowance for the large quantity of official matter carried for other public departments, &c.; nor does the expenditure include the amounts certified to the Treasury for the transportation of mails over aided Pacific railways, or any allowance for the use of such buildings as are provided by the Government. Contrary to expectations repeatedly expressed, each year since 1883 has shown a deficit. This is partly explained by reductions in charges. The rate of postage on first-class matter was reduced from three cents to two cents on 1st October 1883, and the unit of weight was increased from half an ounce to one ounce on 1st July 1885. On the latter date, also, the postage on second-class matter was reduced from two cents to one cent per pound. This low rate has led to wholesale violation of the purpose of the law. In his report for 1899 Mr Emory Smith, Post-master-General, estimated that "fully one-half of all the matter mailed as second-class, and paid for at the pound rate, is not properly second-class within the intent of the law"; and that the cost of mere transportation of this wrongly-classed matter exceeded the revenue derived from it by more than $12,000,000 for the year.

Recent Developments.—The free delivery service has grown rapidly during recent years. On 1st July 1901, 866 cities and towns were included in the scheme, and 16,389 letter-carriers were serving a population of 32,000,000. An extension to rural districts was started in 1896, and by December 1901, 4,000,000 of the rural population were within the scope of free delivery. Since 1st October 1885 a system has been in force for the immediate delivery by special messengers of letters, parcels, &c., for addresses within certain areas. A special ten-cent stamp is required in addition to the ordinary postage. Under this arrangement, 7,133,263 articles were transmitted during the year ended 30th June 1901, resulting in a net profit of $167,727. A step towards the popularization of the registry system was authorized in December

1899: letter-carriers in many city districts now accept and register letters at the door of the householder. Sea post offices for sorting mails during the Atlantic transit were established in December 1890 on the steamers of the North German Lloyd and Hamburg-American lines, and later on the vessels of the International Navigation Company. This plan effects a saving of from two to fourteen hours in the delivery of mails from Europe. The issue of "postal notes," commenced in 1883, was abandoned in 1894. The introduction of "postal checks" for small fixed amounts is now being advocated. A new postal convention with Canada, removing the former restriction against sending merchandise, came into force on 1st March 1888. Uniformity of postage rates having been previously established, the United States and Canada became virtually one postal territory.

The limit of weight for domestic parcels in the United States is four pounds. A convention for an exchange of parcels with Jamaica, admitting articles not exceeding eleven pounds, was, however, agreed to in 1887; and since then conventions on similar lines have been concluded with a number of other colonies and countries in America. The first arrangement of the kind with any European country was made with Germany, and came into operation on 1st October 1899. During the year to 30th June 1901, 76,148 parcels of a total weight of 252,791 pounds were despatched to foreign countries, &c., and 42,522 foreign parcels of a total weight of 281,813 pounds were received.

Considerable progress has been made in the organization of the postal service in the newly-acquired possessions and Cuba. The postal laws, regulations, and domestic conditions of the United States have been extended, by Act of Congress, to Porto Rico and Hawaii. The "island possessions" (Guam, the Philippine Archipelago, and Tutuila) have also been brought within the scope of the domestic conditions, including the rates of postage. The service introduced into Cuba, though modelled on the American plan, is practically autonomous.

The following statistics are taken from the report of the Post Office Department for the fiscal year ended 30th June 1901. On that date the number of post offices was 76,945. The sales of stamps for the year amounted to $102,023,473, and the collections from publishers and newsagents for second-class postage to $4,294,445. The total estimated number of letters was 3,604,322,767, of post cards 659,614,800, of pieces of second-class matter (newspapers and periodicals) 2,206,791,539, of pieces of third-class and fourth-class matter (books, circulars, parcels of merchandise, &c.) 953,661,223. The registered letters and parcels numbered 20,814,501, and the irrecoverable losses are given as 466, or one in every 44,666 articles registered. It is estimated that there were sent to foreign countries 76,536,229 letters, 4,324,709 post cards, and 90,153,343 packets containing printed matter, commercial papers, or samples of merchandise; and that there were received from foreign countries 62,698,084 letters, 3,584,208 post cards, and 58,123,993 packets of printed matter, &c. A total of 8,507,257 articles of undelivered mail was received at the dead-letter office; 23,362 magazines, illustrated papers, &c., which could not be returned, were distributed among the inmates of various charitable institutions. The total number of domestic mail routes of all classes was 35,316, their aggregate length 511,808 miles, and the annual transportation 466,146,059 miles. Of these, the "star" routes had a total length of 267,357 miles and an annual transportation of 134,404,541 miles, the railway routes a total length of 183,358 miles and an annual transportation of 302,613,325 miles, and the steamboat routes a total length of 33,970 miles and an annual transportation of 4,652,257 miles. The "railway mail service" maintained 1306 lines of travelling post offices (on railway trains, steamboats, and electric and cable cars), covering a total length of 182,154 miles. It employed 9182 clerks, who during the year travelled "in crews" a total distance of 210,221,576 miles. Their manipulations of pieces of ordinary mail matter numbered 14,181,224,420, and of packages and pouches of registered matter 21,284,833. The number of domestic money orders issued was 35,586,379, representing $274,546,067. The international orders issued numbered 1,247,888 and amounted to $20,072,613, while those paid numbered 492,408 and amounted to $7,972,453.

Telegraphs.—The formation of a postal telegraph system has continued to be a subject of discussion by the Postmasters-General. In his report for the year 1888, Mr Dickinson proposed the appointment of an expert commission authorized to erect short experimental lines. His successor, Mr Wanamaker, for four years vigorously advocated a limited postal telegraph service. Under this proposal, contracting telegraph companies were to furnish lines, instruments, and operators, and to transmit messages at rates fixed by the Government; the department was to receive a small sum per message, to cover its expenses in collection and delivery. In 1894 Mr Bissell expressed the opinion that a Government system would be unprofitable and inexpedient.

Savings Banks.—The establishment of postal savings banks was also recommended by Mr Wanamaker in his reports for the years 1889 to 1892, and by Mr Gary in 1897. What is regarded as a step in this direction was taken in 1898, when the postal regulations were modified to allow money orders to be made payable at the office of issue. This change is described by Mr Emory Smith as "establishing a mild and very convenient adaptation of the European savings bank system, without the payment of interest." (E. J. H*.)

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The various postal and telegraph rates and regulations are set out in the quarterly *Post Office Guide* (price 6d.) and the *Post Office Handbook* (price 1d.), which may be purchased at any post office. The penny handbook was first issued in 1886, and has a circulation of over half a million.

Pöstyén (*Pistyan*), a market town of Hungary, in the county of Nyitra, situated near the Vág, with 5661 inhabitants in 1901. It is famous for its sulphur and mud baths, which in 1900 attracted 6600 patients. There are separate bathing-houses for poor people.

Potenza, a town, bishop's see, and capital of the province of the same name, Basilicata, Italy, 93 miles by rail west by north of Taranto. It stands 2712 feet above sea-level, its mean temperature being 53° Fahr.; Jan., 37·8°; July, 70·9°. It has a school of the industrial arts and sciences, grows good wine, and makes bricks. Population (1881), 17,978; (1901), 16,520.

Potgieter, Everhardes Johannes (1808–1875), Dutch prose writer and poet, was born at Zwolle, in Overyssel, 17th June 1808. As a young man Potgieter went to Antwerp, where he started a commercial career at the office of a local merchant. In 1831 he made a journey to Sweden, subsequently described in two volumes, which appeared at Amsterdam in 1836–40. Soon after his return from the North, he settled in Amsterdam, still engaged in commercial pursuits, on his own account, but with more and more inclination towards literature. With Heije, the popular poet of Holland in those days, and Bakhuizen van den Brink, the rising historian (see also GROEN VAN PRINSTERER), Potgieter founded *De Muzen* ("The Muses," 1834–36), a literary review, which was, however, soon superseded by *De Gids* ("The Guide"), a monthly which became the leading magazine of Holland. In it he wrote, mostly under the initials of "W. D——g," a great number of articles and poems, collected and published both before and after his death. The first collected edition of his poems (1832–1868) appeared in 2 vols. (Haarlem, 1868–75), preceded by some of his contributions to *De Gids*, in 2 vols. also (Haarlem, 1864), and followed by 3 vols. of his *Studien en Schetsen* ("Studies and Sketches," Haarlem, 1879). Soon after his death (3rd February 1875) a more comprehensive edition of Potgieter's *Verspreide en Nagelaten Werken* ("Miscellaneous and Posthumous Works") was published in 8 vols. by his friend and literary executor, Johan C. Zimmerman (Haarlem, 1875–77), who likewise supervised a yet more complete edition of Potgieter's writings which appeared at Haarlem in 1885–90 in 19 vols. Of Potgieter's *Het Noorden in Omtrekken en Tafreelen* ("The North in Outlines and Pictures") the third edition was issued in 1882, and an *édition de luxe* of his poems followed at Haarlem in 1893. Under the title of *Personen en Onderwerpen* ("Persons and Subjects") many of Potgieter's criticisms had collectively appeared in 3 vols. at Haarlem in 1885, with an introduction by his lifelong friend and collaborator, Busken-Huet, the famous critic, to whom we owe the best biographical notice and the truest appreciation of Potgieter. The latter's great influence upon Dutch language and literature in the second half of the 19th century is undisputed. It was largely enhanced by his *Gids* circle in Amsterdam, all the more prominent *littérateurs*, poets, and artists of his day frequenting it at his house in Amsterdam. Potgieter, with all his learning and accomplishments, was a very modest man. His favourite master among the Dutch classics was Hooft, whose peculiarities in style and language he admired and imitated. The same vein of altruistic, if often exaggerated and biassed, abhorrence of the wonted conventionalities of literary life runs through all his writings, even through his private correspondence with Huet, parts of which have been published. Potgieter remained to his death the irreconcilable enemy of the Dutch "Jan Salie," as the Dutchman is nicknamed who does not believe in the regeneration of the Dutch people. Potgieter held up the Netherlanders of the golden age of the 16th and 17th centuries as models to be emulated. In these views he essentially differed from Huet. Yet the two friends worked harmoniously together; and when Potgieter reluctantly gave up *De Gids* in 1865, it was Huet whom he chose as his successor. Both then proceeded to Italy, and were present at the Dante festivities at Florence, which in Potgieter's case resulted in a poem in twenty stanzas, *Florence* (Haarlem, 1868), which certainly proved, if nothing else, that he could appreciate and glorify greatness in a Southern people, as well as in a Northern. In Holland Potgieter's influence has been very marked and beneficial; but his own style, that of an ultra-purist, was at times somewhat forced, stilted, and not always easily understood. (H. TI.)

Potosi, a department of Bolivia, bounded on the N. by the departments of Oruro and Cochabamba, on the S. by Chile and the Argentine Republic, on the E. by Chuquisaca and Tarija, and on the W. by Tarapacá and Chile. Area, 52,100 square miles. Population (1893), 360,400. The capital, Potosi, situated 13,350 feet above sea-level, has 40,000 inhabitants. The department is divided into 9 provinces, and in 1898 had 63 schools and 2900 pupils.

Potsdam, a town of Prussia, 16 miles by rail southwest of Berlin, beautifully situated at the centre of the network of Havel lakes. The town has been greatly embellished, and the gardens and parks with which it is surrounded have been laid out with care. There is an excellent railway service with Berlin, with which it is connected by a third suburban line of railway running by way of Wannsee. Among modern buildings must be mentioned the new stone bridge, ornamented by statues, which connects the Altstädt with the suburb of Teltow. To the Friedenskirche is attached a mausoleum built after the model of a chapel at Innchen in Tirol, in which lie the Emperor Frederick, his consort, Princess Royal of Great Britain, and two of their children who died in infancy. The Marble Palace on the "Leiliger See" was the residence of Kaiser Wilhelm II. until his accession. To Potsdam has been removed the Geodetic Institute, which occupies extensive premises. Population (1880), 48,447; (1900), 59,814.

Pott, August Friedrich (1802–1887), German philologist, was born at Nettelrede, Hanover, 14th November 1802. He studied in Göttingen, and in 1825 became schoolmaster at Celle, Hanover; but after two years removed to Berlin, where he became *privat docent* at the university. He applied himself to the study of comparative philology, and in 1883 was made professor at Halle, where he lived till his death on 5th July 1887. His *magnum opus* was his *Etymologische Forschung* (1834–36), which entitled him to rank as Bopp's foremost disciple in the Indo-Germanic science of language. See the article PHILOLOGY (vol. xviii.). Pott also devoted much attention to the origins of the gipsies (*q.v.*).

Potter, Henry Codman (1835-——), American bishop of the Protestant Episcopal Church, born in Schenectady, New York, 25th May 1835, is a son of Bishop Alonzo Potter of Pennsylvania. He was a graduate of the Theological Seminary of Virginia in 1857, and was ordained in 1858. After serving churches at Greensburgh, Pa., Troy, N.Y., and Boston, Mass., he became rector of Grace Church, New York City, from 1868 to 1884. In 1883 he was chosen assistant bishop of New York; and on the death in 1887 of the bishop, his uncle, he became bishop of the diocese. He published *Sisterhoods and Deaconesses* (1872), *The Gates of the East* (1876), and other ecclesiastical and religious works; and he received the degrees of D.D. and LL.D. from Union College (New York), and D.D. from Trinity College (Connecticut), Harvard, Oxford, and Cambridge Universities.

Pottery and Porcelain.—Recent advances in the potter's art, as practised in Europe, have sprung fundamentally from the growth of real scientific knowledge of the potter's materials and methods. Until well within the 19th century the potter's knowledge was purely empirical, built up on traditional methods of working with the materials of a particular district, and failing when the conditions changed. Since 1850, however, the foundations at least of sounder knowledge have been laid by the labours of men of an eminently scientific turn of mind, of whom Brongniart, Salvétat, and Seger must be regarded as the chief. These men and their disciples have examined not only all modern materials and methods, but those of the past as well; and as their researches have been published, they have had the most direct influence on the work of the practical potters of every country. The bodies (clay mixtures), glazes, and colours of the older forms of pottery, Persian and Rhodian faience, Italian majolica, Hispano-Moresque ware, Chinese porcelain, are no longer forgotten secrets or "lost arts"; they are, or may be, as well known as the bodies, colours, and glazes of the most everyday pottery produced in Staffordshire or Delft. Neither is the potter any longer dependent on the materials or the technical methods found in his own particular district: he has the materials and the knowledge of a continent at his disposal; and the science of his craft has been so far reduced to system, that he can readily produce a hundred varieties of ware, running through all the range of earthenware, stoneware, and porcelain, with a higher degree of technical accomplishment in each than his fellow of a previous century would have attained in one kind alone.

This remarkable growth and concentration of accurate knowledge regarding the chemical laws underlying the composition of the different materials used by potters, as well as their behaviour, singly and in combination, when exposed to varying temperatures and conditions of the kiln, have been accompanied by changes almost as important in the mechanical methods of mixing and purifying the materials, forming the clay articles into shape, and supporting them during the firing, so that even the commonest wares are now produced with a degree of certainty, accuracy, and finish formerly undreamt of. The extended modern use of articles made from clay for the construction and decoration of buildings, for lavatories and other sanitary appliances, and for the technical work of the chemist, the distiller, and the electrician, has only become possible because of this advance in precise knowledge. Admirable and entirely useful as this development of the technical side of pottery has been, the fear has often been expressed by persons qualified to judge, that progress in this direction would inevitably destroy the artistic qualities which have in the past been such a precious possession of the potter's productions. The first results of the changed conditions were undoubtedly depressing from the artistic point of view. Certainty of result, precision and finish of manufacture, together with mechanical imitation of well-known effects, seemed to result in the production only of wares the merits of which were in the sharpest contrast with all that made the old pottery artistically admirable.

The development of scientific and mechanical knowledge and skill has brought with it a much juster appreciation of the familiar qualities and possibilities of different substances and processes. The success achieved by Deck and De Morgan in adapting the principles of the Persian, Cantigalli those of the Italian Cinque-cento, and Copenhagen those of the Japanese pot painter, compared with Wedgwood's reproduction of classic pottery or Dresden imitation of Chinese porcelain, proves that vital progress has been made. The present position is one of development and change, even more so than at any previous period in the history of the art. Pottery is now being made in all the leading European states, and in some states of the American Union, possessing a high degree of technical excellence, and in such a variety of forms as all the previous centuries combined have not produced. The great bulk of this production is frankly utilitarian, either making no pretence of art, or manifesting such debased and mechanical ideas of it as to be infinitely more objectionable. In every country, however, there is a general endeavour to infuse a spirit of art into modern production, manifesting itself in two distinct ways—first, in the efforts of the large commercial firms to make some portion of their productions as artistic as may be under their methods of working; and, secondly, by the labours of a number of individual artist potters, caring for the artistic side of their work above everything, and by their example influencing the large manufacturers. As an actual result, the potter's art is full of vitality; more alive and more energetic, indeed, than at any time since the rise of the china factories of the 18th century, while the variety of uses to which pottery is being put shows that, through all the changes of fashion and of taste, pottery holds its own in popular favour and appreciation.

Among modern wares of considerable technical interest, mention must be made of the fine semi-porcelains produced in Staffordshire, in which the ordinary English earthenware body has been pushed to its utmost limits. The ware is thin, light, beautifully potted, and of the utmost durability. Sanitary appliances, electric fittings, door furniture, and wall tiles are also produced with almost the same high degree of technical excellence. The tendency to use some finer form of pottery than ordinary brickwork for the construction or embellishment of buildings, has brought about a great extension of the manufacture of architectural terra-cotta, faience, and stonewares. For all such purposes the hard-fired varieties are undoubtedly best fitted; and while the colours obtainable in terra-cotta or in faience are the more brilliant, the once-fired stonewares have greater durability. In Germany and France this use of pottery has made even greater advances than in the United Kingdom. On the Continent the material has been considered more sympathetically; in England it is too often apparent that a design originally intended for stone construction has been executed unaltered in the plastic material.

Turning to the decorative side of pottery work, we have in *slip-painting* a method as old as primitive pottery itself, the practice of which persists in a variety of forms and on wares of every class. The work produced in Germany under the influence of Professor Laüger merits notice. It is simple and direct, almost brutal, in method; splashes of red, blue, or green clay, touched into shape by a brush or a modelling tool, on a ground of white, buff, or red; making no pretence but of directness and simplicity, and interesting only from the frankness of the work and the brightness and richness of the colour. At the opposite extreme in this method is the *pâte-sur-pâte*, first produced at Sèvres, but best known in connexion with M. L. Solon of Mintons'. Here material and method have been refined to their utmost. The clays used are of translucent china, white or delicately tinted for the raised ornament, and strongly tinted in brown, dark green, or celadon for the grounds. The ornament, largely figure work, is got by laying on successive layers of slip with a brush, with modelling when required to soften or define, as the case may be, much as an artist would work in gesso. When the work is finished and glazed with a rich glaze, the effect is like cameo work of the finest kind, but with a breadth and softness peculiarly its own. M. Taxil Doat, of Sèvres, has also done much excellent work by this method; and by superposing clays of different colours on the ground, he has obtained richly broken colour in an effective manner.

Apart from the production of stonewares for architectural and technical purposes, there has been a notable development of stonewares for jars, vases, and ornamental objects generally. Doultons undoubtedly led the way in this revival, and, under the direction of Mr John C. Sparkes, produced the Lambeth stonewares, which in their low key of greys and blues were admirably decorative, and formed a distinct advance on the stonewares of Germany and Flanders. It is on the Continent, and particularly in France, however, that one finds *grès* turned to the best account. A number of men, like Delaherche, Lachenal, Dalpayrat, as well as Taxil Doat and Chaplet, inspired obviously by the hard-fired unglazed wares of the Japanese, but showing an intimate knowledge and appreciation of their material, which stamps them at once as potters and as artists, are now working on stonewares. In the hands of one of these men the material is neither hidden out of sight nor exalted to vulgarity, but shows its qualities of texture, surface, colour, and plasticity perfectly yet quietly. Fine work has also been produced by such firms as Émile Muller, Bigot & Co., but in their case the results are often disfigured by unnecessary coarseness of execution.

Among the new departures that are being turned to artistic account, one of the most interesting is that of *crystalline glazes.* The first of these in point of time was the so-called "cat's-eye" or "tiger-eye" glazes produced by the Rookwood pottery in America. In this case the glaze is full of small metallic-looking spangles, which give it an appearance like the mineral known as "aventurine." The glazes produced at Rookwood are all very deep in colour, and are only obtained on a red body. In England, Pilkingtons have produced a series of glazes, yellow, brown, and green, all possessing the same appearance of gold-coloured spangles in the glaze; but, unlike Rookwood, they can produce the effect on any earthenware or china body. Totally different are the crystalline glazes produced by the Royal Copenhagen Works, and now also made at Sèvres, Berlin, Meissen, Rörstrand, and elsewhere. Here the crystallization generally occurs in radiating or star-like masses, apparently on the surface of the glaze, sometimes beautifully coloured blue, grey, yellow, or brown, but otherwise resembling the patterns formed by frost on a window-pane. These effects are always quasi-accidental, and only partially under the control of the potter. Occasionally they take the form of blobs and patches on the glaze which are positively unpleasant; but when the star-like forms are well developed and fairly disposed over the surface of the piece, the effect is magical.

About 1870, William De Morgan in England, and Cantigalli of Florence, rediscovered the method of producing iridescent lustres from copper and silver fired on the glaze in a reducing atmosphere, which had been so largely practised during the Middle Ages by the Persian potters, the Moors in Spain, and the Italian majolica potters. Since that time the production of this *reflet métallique* has been greatly extended. In the hands of Clément Massier in France most vivid effects of iridescence have been produced, apparently in many cases by acting on the glaze itself with reducing gases at high temperature. Zsolnay, of Fünfkirchen in Hungary, has produced a pottery decoration in which minute patterning of silver lustre is produced on a ground of dark copper or other metallic lustre. The patterns, which are often of the most intricate character, are evidently inspired by every phase of Oriental design, from ancient Assyrian downwards; but the effect is novel, rich, and in the best pieces subdued. The best lustre work, however, has been done, and already the vulgarization of the process has set in by the development of the cruder shades of colour from which the earlier work was free.

From time to time European potters receive fresh inspiration from the East. Reference has already been made to the influence of the Japanese potters on the production of *grès* in France. This influence is equally felt in the modern painted porcelains of the Royal Copenhagen Works, and in the somewhat similar effects obtained at Rörstrand and by the Rookwood Company. In the last case a Japanese artist was brought to the works for that specific purpose. Though the delicate underglaze painting on hard-fired porcelain of Copenhagen and Rörstrand owes its inception to this foreign influence, it proceeds on its own lines, and is far from being a slavish imitation. The temperature of firing having fixed a palette in which blue and some greyish or drabbish tones predominate, the artists have wisely adapted their painting to this, and have made the utmost of their available colour scheme. The rich glazes of the Oriental potter have also formed a point of departure for another set of potters. Deck in France, and afterwards Minton, Maw, De Morgan, and Moore in England, produced brilliant turquoise blue and violet glazes rivalling the Persian and Chinese. Even the long-sought secret of the Chinese *sang de bœuf* and *rouge flambé* glazes has been worked out in Europe. Salvétat in France and Seger in Germany analysed specimens of Chinese glazes, and synthesized the glaze from its elements. Chaplet in France and Bernard Moore in England produced pieces independently; and *flambé* glazes are now being produced by many potters in Europe on every kind of pottery ware, and with every variety of surface, from the driest and most opaque to the brightest and most transparent.

Within the last ten years of the 19th century, a certain reaction set in against the brilliant glazes in ordinary use, and potters began to produce glazes with a dull or egg-shell surface. In some cases this effect was apparently obtained by dulling the surface of an ordinary glaze by vapours of hydrofluoric acid or by the sand-blast, but in the best of them the effect was actually due to the nature of the glaze, which fired only to a dull vitreous surface. (For Japanese Keramics, see JAPAN.)

(W. B*.)

Pottstown, a borough of Montgomery county, Pennsylvania, U.S.A., on the Schuylkill river, at the intersection of branches of the Pennsylvania and the Philadelphia and Reading railways, in the south-eastern part of the state, at an altitude of 138 feet. Its industries consist chiefly in iron and steel manufacture, for which there are blast furnaces, rolling mills, bridge works, nail mills, and boiler works. Population (1890), 13,285; (1900), 13,696, of whom 802 were foreign-born and 292 negroes.

Pottsville, a borough of Pennsylvania, U.S.A., capital of Schuylkill county, on the Schuylkill river, in the eastern part of the state, at an altitude of 611 feet. The street plan is irregular, it is divided into seven wards, has a steam heating plant, and its water supply, obtained by gravity, is owned by private parties. It is on four railways, the Lehigh Valley, the Pennsylvania, the People's, and the Philadelphia and Reading. It is situated within the anthracite coal region, and is one of the principal coal-shipping points. Population (1890), 14,117; (1900), 15,710, of whom 1652 were foreign-born and 168 negroes.

Poughkeepsie, a city of New York, U.S.A., capital of Dutchess county, on the eastern bank of the Hudson river, 73 miles north of New York, in the south-eastern part of the state, at an altitude of 42 feet. Its street plan is irregular, it is divided into seven wards, and its water supply, derived from the Hudson, is pumped and filtered. It has four railways, the New York Central and Hudson River, the Poughkeepsie and Eastern, the West Shore (by ferry), and the Central New England. The latter road crosses the Hudson here by a fine cantilever bridge. The city is of importance in manufactures. In 1900 it contained 377 manufacturing establishments, with a total capital of $5,688,058; the hands numbered 3432, and the products were valued at $6,826,769. Among the principal articles of manufacture were clothing and iron and steel goods. Vassar College for women, situated 2 miles east of the city, had in 1900 a faculty of 64, and was attended by 700 students. In 1899 its property was valued at nearly $2,268,805, and its income was $319,957. Population (1890), 22,206; (1900), 24,029, of whom 3998 were foreign-born and 623 negroes.

Poulton-le-Sands. See MORECAMBE.

Poultry and Poultry-farming.—The later years of the 19th century witnessed a very great development in poultry-breeding, which could scarcely have been foreseen, and which in some of its aspects has contradicted opinions that had been more or less generally expressed during a period of less experience and knowledge. The broad result is that poultry-culture in one form or another has become a really important industry both in Europe and America, one in which much capital is invested, and the returns from which form a considerable item in national food and wealth.

Poultry Shows and Prize Poultry.—During the last ten years of the 19th century especially, the number of poultry exhibitions multiplied to such an extent that as many as twenty shows have been criticized in print in one week in Great Britain during the height of the season. Such a ceaseless round of competition has increased the money value of prize fowls, and created a large class—almost a profession—who have considerable pecuniary interests embarked in breeding and exhibiting such birds. This professionalism, and the interests at stake, have in turn naturally given rise to many proceedings of doubtful character, which it has been found needful to keep in check by an organization known as the Poultry Club. An enormous multiplication of varieties is another phase of this development, nearly all breeds having had their older subdivisions supplemented by new colours, produced through crossing and skilful selection, amidst which buff or orange, now bred in nearly all fowls, has had a curious popularity. There may also be mentioned the fact that whilst formerly the diminutive Bantams were confined to a few well-marked varieties, all the large breeds of poultry have now been dwarfed into Bantam size by the skill of breeders. To enter farther into this branch of the subject is beyond the scope of the present article, but it may be interesting to state that at a public auction in 1901 one prize fowl was knocked down to a *bonâ-fide* purchaser at the sum of £150.

Breeds.—Not only have many additions been made, either by discovery or manufacture, to the breeds known in 1880, but considerable changes have taken place in their relative importance, in some of which a principle of substitution can be traced. The unfortunate exaggeration of fluff and leg-feather has removed all Cochins—it is to be feared permanently—from amongst popular and useful breeds, and in only less degree the Brahma, once the most popular breed of the day. On the other hand, new sub-breeds, based upon a cross from one or the other of the Asiatic races, have been multiplied and largely bred, these being all of smooth-legged type, and somewhat less in size. To the original cuckoo-coloured Plymouth Rock have been added buff and white varieties; and by crossing Cochins and Brahmas with other fowls, American breeders produced another useful race of compact form with smooth yellow legs, and white feathers laced with black round the edges, called the silver-laced Wyandotte, to which were speedily added other colours and patterns of plumage. The feathered Langshan has given rise to the Black Orpington with smooth legs; and a local cross of Cochin and Dorking prevalent in Lincolnshire, to a buff breed with smooth white legs, now called the Buff Orpington, though quite unrelated to the former. All these are useful for table, and good layers. Among non-sitting breeds the white-faced Black Spanish, once the most widely kept, has almost disappeared; but the allied red-faced Minorca and the blue Andalusian have achieved great popularity as free layers of large white eggs; and the yellow-legged Leghorns of similar type, though rather smaller, have spread on all sides with much multiplication of varieties, the latest of which, with mottled black and white plumage, is termed the Ancona. Hamburghs have been depressed by the complicated system of breeding separate strains for each sex; but there has been introduced from the Continent the hardy Campine or Braekel, resembling the pencilled Hamburgh in plumage, but larger and with a single comb, and laying a large egg in great numbers. The older French breeds are less kept than formerly; but a race originated in France by crossing Houdans with Dorkings and Light Brahmas, and known as the Faverolles, is taking a strong position as a tender and quick-growing table fowl, and even in the Houdan district itself is displacing the Houdan, one of its ancestors. The Faverolles have single upright combs, beards and whiskers, slightly feathered legs, and five toes on each foot; and the general colour of the hen is salmon or fawn, with an almost white breast. This list might be extended, but must close with the supersession of the stilty exhibition Game fowl by the old and genuine type of English Game.

Most of these changes, broadly speaking, have been in the direction of replacing poultry with chiefly fancy points by really *useful* fowls, yet it is noteworthy that they have been carried out by fanciers, or breeders for exhibition, proving that there has not been that practical antagonism between the aims of these breeders and the production of food which some have alleged. But there has further been, since 1890 especially, a remarkable development of what has been termed "utility" poultry-breeding. It had always been taught by a few, but was only grasped later by the many, that a fowl could be bred with as much certainty for tender and juicy flesh, or great number of eggs laid in a year, as for some colour of feather, and without losing any real features of its race. Many varieties are now bred, and advertised and sold as being bred, for these objects; and thus the stock kept up by the fancy breeders is gradually becoming spread amongst farmers, to their marked advantage where properly used.

Feeding and Egg-production.—These aspects of poultry-culture are closely connected, and in both such advances have been made as almost amount to a revolution. As will appear natural if the enormous poultry interest in America is considered, in these matters the breeders of the United States have led the way, and, though it had first been taught in England, were the first to practise generally the systematic breeding, year after year, from the best layers only. It had always been known that some hens would lay from 150 to 200 eggs in a year, whilst many did not exceed 100, and some laid much less. This was tested (on a better stock than the average) at the Maine Experimental Station in 1898–99, 260 pullets being selected, of which 5 died and 19 were stolen. Of the remainder, 39 laid 160 eggs each or more, and 22 less than 100, the rest coming between these figures; the five best laid 200, 201, 204, 206, and 208 eggs in twelve months, and the three worst only 36, 37, and 38 in the same time. From such figures the money value of selective breeding is apparent. In England, those who practise it usually secure the better layers by selecting those which lay early in the season, or early in the day, or are first down from the perch in the morning; in America trap-nests have been used, which automatically confine the laying hen till she is released and her number or mark registered. As a proof of what may be done by systematic breeding, one American breeder obtained an average of 196 eggs per annum from as many as 600 White Leghorns, and another 194 eggs from 140 Plymouth Rocks: greater numbers have been obtained from single birds or small pens of fowls, but these are results from considerable flocks.

It has been proved, however, that such averages as these cannot be obtained unless they are fed for as well as bred for. Such an enormous production of albuminoids can only come from adequate supplies; while, on the other hand, such supplies as would be profitably turned into eggs by a prolific layer would only produce fat, or hypertrophy, or disease in a poor layer. The most successful egg-farmers now feed their poultry on definite "rations," compounded so as to give what is termed a proper "nutritive ratio," or proportion of albuminoids to carbonaceous material. The basis of such feeding is analysis of food-stuffs, in some form which shows simply their percentages of albuminoids, fats or hydro-carbons, carbohydrates (starch, sugar, &c.), salts, crude husk or fibre, and water. Fats being relatively much richer in carbon than the starch compounds, are generally multiplied by 2·25, and this product added instead to the carbohydrates; then the ratio of albuminoids or nitrogenous matter to this total of carbonaceous compounds is the "nutritive ratio." The following is a useful table of analyses made out in this way, taken from *The Book of Poultry* :—

Analyses of Poultry Foods.

Articles of Food.	Albuminoids or Flesh-formers.	Fats or Oils.	Fats × 2¼ = Value in Carbohydrates.	Carbohydrates.	Salts and Minerals.	Husk or Fibre.	Water.
Grains and Meals.							
Linseed Meal . .	32·9	7·9	=17·8	35·4	5·7	8·9	9·2
Beans and Peas .	24·0	1·5	= 3·4	48·0	2·5	10·0	14·0
Malt Sprouts . .	23·2	1·7	= 3·8	48·5	5·7	10·7	10·2
Oatmeal . .	18·0	6·0	=13·5	63·5	2·0	1·5	9·0
Middlings or Fine Sharps . .	16·0	4·0	= 9·0	57·0	4·5	4·5	14·0
Sunflower Seed .	16·0	21·5	=48·4	21·4	2·6	29·0	9·5
Bran . . .	15·5	4·0	= 9·0	44·0	6·0	16·5	14·0
Oats and Ground Oats . . .	15·0	5·5	=12·4	48·0	2·5	19·0	10·0
Wheat . . .	12·0	1·8	= 4·0	70·1	1·8	2·3	12·0
Barley (and Meal) .	12·0	1·4	= 3·2	56·0	3·6	14·0	13·0
Millet Seed . .	11·3	4·0	= 9·0	60·0	3·0	9·4	12·3
Maize . . .	10·5	8·0	=18·0	66·5	1·5	2·5	11·0
Rye . . .	10·5	1·8	= 4·0	72·5	1·9	1·7	11·6
Buckwheat . .	10·0	2·2	= 5·0	62·2	2·0	11·0	12·6
Hempseed . .	10·0	21·0	=47·2	45·0	2·0	14·0	8·0
Dari . . .	9·5	4·5	=10·1	68·7	1·5	3·3	12·5
White Bread . .	8·8	1·8	= 4·0	56·4	0·5	0·0	32·5
Rice . . .	6·6	0·4	= 0·9	80·0	0·0	0·0	13·0
Brewers' Grains .	5·4	1·6	= 3·6	12·5	1·0	3·8	75·7
Vegetables.							
Potatoes . .	6·5	0·0	= 0·0	41·0	2·0	0·0	50·5
Red Clover . .	5·0	0·8	= 1·8	13·3	2·4	6·5	72·0
Meadow Grass .	3·5	1·0	= 2·2	13·5	2·0	4·7	75·3
Hay . . .	8·4	2·6	= 5·8	41·0	6·2	27·2	14·6
Cabbage . .	2·4	0·4	= 0·9	3·8	1·4	1·5	90·5
Onions . . .	1·5	0·2	= 0·5	4·8	0·5	2·0	91·0
Turnips . . .	0·5	0·1	= 0·2	4·0	1·0	1·4	93·0
Animal Foods.							
Dry Meat Meal .	71·2	13·7	=30·8	0·3	4·1	0·0	10·7
Flesh of Fowls .	21·0	3·8	= 8·5	0·0	1·2	0·0	74·0
Horse-flesh . .	21·7	2·6	= 5·8	0·0	1·4	0·0	74·3
Lean of Beef . .	20·5	3·5	= 7·9	0·0	1·6	0·0	74·4
Fresh-cut Bone .	20·2	26·1	=58·7	0·0	24·0	0·0	29·7
Dried Fish . .	48·4	11·6	=26·1	0·0	29·2	0·0	10·8
Milk . . .	4·0	3·5	= 7·9	4·8	0·7	0·0	87·0
Skim Milk (separator) . . .	3·1	0·3	= 0·7	5·3	0·7	0·0	90·6
Eggs (yolk only) .	16·0	30·0	=67·5	0·0	1·0	0·0	53·0
,, (white only) .	12·0	2·0	= 4·5	0·0	1·2	0·0	84·8

A glance will show how greatly various foods differ in their nutritive ratio, what variety of composition is therefore possible, and that if we wish for cheapness to use some food of low ratio, it must be "balanced" by some other whose ratio is high.

Many writers have introduced unnecessary complication into a very simple matter. Some elaborately compute the amount of "dry matter," which is needless if our analyses show the proportion of water, as above. Others have calculated "digestibility," on the theory that food not rejected as excrement is "retained in the body." This theory has a basis in the case of animals which consume a large amount of hard indigestible fibre, excreted in such a form as horse manure; but fowls macerate all they eat in the crop, and grind it in the gizzard, and in their case the excreta represent very little undigested food, but mainly the final result of the vital processes, and of food usefully employed in carrying these on. We may be sure that we more than allow for any factor of indigestibility if we merely leave out any crude husk or fibre, giving that to the fowl for whatever it is worth, and calculate our ratio direct from the figures of the table.

Two extremely simple cases will suffice as examples of the modern method. Potatoes are often cheap, but on account of their starchy composition require a "balance," and the same may be said of maize: one method of balancing each will show what is meant, and the simplicity of the calculation. We will take potatoes and bran first :—

Ratio of Potatoes and Bran.

	Albuminoids.	Fat × 2¼.	Carbohydrates.	Salts.
1 lb Potatoes . .	6·5	0·0	41·0	2·0
1 lb Bran . . .	15·5	9·0	44·0	6·0
	22·0	9·0	85·0 +9·0	8·0
			94·0	

Adding here the fats × 2¼ to the carbohydrates, we get the ratio of the mixture as 22 : 94, or about 1 : 4¼, which is very good. Coming next to the maize, let us suppose that it is desired to feed this as grain in the evening, and to "balance" it by an equal weight of "mash" or soft mixture in the morning. One way would be as follows :—

A Diet containing Maize.

	Albuminoids.	Fat × 2¼.	Carbohydrates.	Salts.
3 lb Maize (× 3) .	31·5	54·0	199·5	4·5
1 lb Horse-flesh . .	21·7	5·8	0·0	1·0
2 lb Ground Oats (× 2)	30·0	24·8	96·0	5·0
	83·2	84·6	295·5 +84·6	10·5
			380·1	

This ration explains how in such a case we must multiply the figures for maize by 3, and those for oats by 2, being the proportions we are taking to one portion of horse-flesh. The ratio of this dietary comes out slightly lower than 1 : 4½.

The proper ratio for feeding fowls has received much discussion. Dietetic authorities mostly agree that about 1 : 5 is the best for maintenance of animal life generally, and more specifically that there should be of albuminoids about 18 parts in 100, of fats 7, and carbohydrates 75. That should suffice for growing chickens; but it is fairly obvious that fowls fattening may require more fat, while the constant production of eggs, whose high ratio is shown in the analyses, must require a larger amount of albuminoids. This fact is indicated by the hen herself, which when laying devours large earthworms, usually rejected with disgust at other times. She shows by this appetite how specially she needs albumen; and fowls on a wide range, though only fed with corn, may thus in summer "balance" a dietary for themselves by the worms and insects which they procure. When they cannot do this, more albumen must be supplied, and the general opinion of practical egg-farmers has tended towards a ratio of 1 : 4 or 1 : $4\frac{1}{4}$ for hens in full lay. One successful American breeder feeds as high as 1 : 3, and states that his results have been best at that figure.

Passing from theory, the greatest practical advance in poultry-feeding has probably been the discovery of the benefit to be derived from dividing the extra supply of albumen between fresh bones cut up small in a mill (known amongst breeders as "cut bone") and such green food as clover or cabbage. The bones, it will be seen, contain a good proportion of fat, and of mineral salts also, which careful experiments have shown to be of great importance both in egg-production and for growing stock. Green food had until recently been looked upon chiefly as a corrective, or necessity for health, though it was known that fowls on a pasture grazed largely. But the nutritive ratio of clover is as high as 1 : 3, and American poultry-farmers now use it largely as really albuminous food, to promote laying. Its use in this way also allows more animal food to be used without ill effect; and to this free use of clover and cut bone in conjunction the improved results upon American egg-farms are largely due. So beneficial is this combination found, that for winter use clover-hay is cut up small, or ground into "clover-meal," to be used in the same way, being generally mixed with boiling water in the other soft food at night, and kept covered to cook or soak until the morning. The following is the "mash" ration on a successful American egg-farm, and represents a high forcing diet: middlings or sharps 100 ℔, maize-meal 75 ℔, gluten-meal (a highly nitrogenous bye-product of American flour-milling) 25 ℔, clover-meal 80 ℔, meat meal 35 ℔; all weighed dry, mixed with boiling water in the evening, and kept covered all night.

This introduces another practical question. The majority of poultry-farmers give their stock each day one feed of grain, and one of soft meal-food or "mash," but by no means agree as to the times for these meals. In England, morning mash and evening grain are almost universal, the latter giving more support during the long fast at night, and the former more rapid recuperation on cold mornings. But in America and Canada, where the climate compels confinement of the fowls for months together in enclosed sheds, health and eggs can only be secured by constant "scratching," to promote which the grain is scattered amongst loose litter spread several inches deep. Many, therefore, prefer to scatter the grain in the morning and feed the mash at night, alleging that a good breakfast of mash makes the fowls lazy, with bad results. Others state that this is avoided by a rather scantier morning feed of mash, with a slight sprinkle of grain in the litter afterwards. In 1890 a careful experiment was made by the Massachusetts Agricultural College, two similar lots of pullets being fed upon similar food, on the two plans, for two periods of several months each, in summer and winter seasons, and each lot receiving, besides the morning and evening feeds, a slight sprinkle of millet in the litter, to promote exercise. In egg-production there was scarcely any difference, what little there was being in favour of the morning mash; and the birds thus fed became also somewhat the heaviest. The most remarkable result was that the weight of manure voided in the night was nearly double in the case of the evening-mash birds, showing the rapid digestion of mash food. This might have been expected; and in some cases the transference of so much weight of manure from day to night deposit might be found convenient.

Artificial Incubation and Rearing.—In this department immense progress has been made, which has created practically new industries. None of the incubators in use about 1875 has survived; but it is known now that while some of them failed from insufficient regulation of temperature, and others from want of a proper balance between ventilation and moisture, the cause of failure in most cases was lack of practical knowledge, and that some of them would give very good results in the hands of present operators. The incubators now used are of two distinct types, and it is noteworthy that British practice so far has mainly adopted one, while the best recent American practice prefers the other.

In what may be called the "tank" system, the heat from a lamp is led through flues traversing a tank of water which forms the upper side of the egg-chamber. Most usually the lamp has a vertical chimney, closed at the top by a valve rising or falling at one end of a lever, while the tank flue issues from one side of this chimney: then if the valve be raised, more heat passes directly into the outer air, and less through the tank, and so the temperature is lowered; while conversely, if the valve sinks, more heat is diverted through the tank, and its temperature is raised. The valve-lever is in Europe generally actuated by a thermostat invented by Mr C. Hearson, and known as the "capsule" regulator, which consists of two flat plates of thin brass soldered together round their edges. Between them is introduced a drop or two of ether, so diluted as to boil at a suitable temperature, after which the capsule is sealed. When the given temperature is exceeded, the ether vaporizes, and the bulging of the plates is easily made to work the valve-lever. Boiling-point being affected by pressure, it is only necessary to apply an adjustable weight to the rod resting on the capsule to alter the point at which the valve shall open, and thus all is easily controlled. This form of regulator, and all others which depend upon vaporization of a liquid, have, however, the serious defect that the boiling-point differs also with atmospheric pressure, to the extent in this case of about 2° F. for every inch of barometer; hence in England, where the barometer often varies as much as $1\frac{1}{2}$ inch and sometimes 2 inches, this kind of thermostat may vary the heat as much as 3° or 4° F., quite independently of the real necessities of temperature in the egg-chamber. Machines of this kind, therefore, require constant adjustment for rise or fall in the barometer.

In most British machines of this class, the eggs are laid in a drawer with perforated bottom, and the air enters below this, passing on the way either over an open tray of cold water or through cloths dipping in such a tray; it then passes through the perforated bottom of the drawer and between the eggs, escaping through holes round the upper part of the chamber, which is thus ventilated and supplied with fresh moist air. The chief point in regard to success, next to a proper uniform temperature and regular turning of the eggs, is a proper balance of ventilation and moisture. The chick ought at the end of the period to occupy about four-fifths of the shell, the other fifth being vacant. If too much moisture be supplied, the egg is too full and the chick perishes; while, on the other hand, if the egg is too much dried out by too great air-current without enough moisture, the fatal result equally follows in another way. Eggs are always tested at the end of five or six days, and unfertile ones withdrawn; as are any which perish later.

The other class of incubators, more general in America, is known as the hot-air or atmospheric type. In such machines there is no water-tank, but air heated by the lamp passes more or less directly into the egg-chamber, in different ways which cannot be described in detail here. This mode of heating is found more economical in oil, which in large establishments becomes of importance; and it is also more sensitive to outer changes of temperature, and responds more quickly to any regulation; but for that very reason it requires more efficient thermostats, and especially such as are not affected by the state of the barometer. The hot-air incubators of America are almost universally regulated by compound thermostatic bars of metal, which operate subject to temperature alone, and the best of which will keep the heat uniform within about half a degree.

Even in England the eggs hatched in incubators now probably equal, or nearly equal, those hatched under hens: in America the wide practice of artificial incubation is difficult to realize. Of small-sized machines one Illinois maker sold 14,800 in the year 1899; and in regard to large sizes, in 1900 at least seven names and addresses were known of operators who each used from 55 to as many as 85 machines, every machine holding 300 or more eggs: somewhat smaller plants were of course far more numerous. Experience on such a vast scale has led to a practical advance of considerable importance. While in England it is still usual to effect empirical adjustment of ventilation and moisture as above indicated, the better American incubators now dispense with direct moisture altogether. It was remembered that the hen hatches without moisture, and equally so the egg-ovens of Egypt; the absence of direct air-current, and consequently of any rapid evaporation, being the obvious explanation. The manufacturers therefore set themselves to slow the movement of the air; and when this object was effectually accomplished, it was found that there was no need for moisture, and that the chicks also hatched out stronger and in higher proportion. The general opinion in the United States, where many farmers tested both hens and machines on a large scale, whilst still undecided between them, is that the proceeds of artificial incubation are superior by about 10 per cent., and this is based upon hatches of thousands annually.

Artificial hatching necessitates artificial brooding, and in this also great changes have taken place, any real success in rearing having been for some years far behind that in hatching. The method universally attempted at first might be called the "coverlet" system, nestling material such as strips of flannel or wool, warmed from above, being provided for the chicks to nestle under, as they do under the feathers of the hen. Many were reared in this way, but failures were also terribly general, and these were ultimately traced to confinement and pollution and heating and rebreathing of the air, caused by the nestling material. That system is now abandoned, warmed but open chambers being provided, which the chicks use at pleasure, but which have no coverlet to rest upon their bodies. In some, heated pipes traverse the upper part of the chamber, some inches above the chicks; in others a warm iron plate radiates heat in the same way; in others warmed air is brought in by flues or openings; in some small ones the lamp itself burns in the chamber of the brooder: but the principle is common to all of a warmed shelter, open above, and generally with an outer chamber also, sheltered but not heated, which breaks the transition to the open air outside. In America a very large proportion of the chickens reared are brought up till hardy in the large brooder-houses mentioned below.

Poultry-farming.—The advances here described have brought poultry into greater prominence as an industry, and poultry-farming in a practical sense is now carried on somewhat extensively in various ways, understanding that term to include any case where poultry-culture is carried on for substantial profit, or as an important interest of the holding, beyond the mere breeding of prize birds for exhibition. The difficulty never had been, as some have stated, in ground getting tainted or rent costing too much. It is now well understood that in the English climate 100 birds per acre must not be exceeded, though it is far better to confine them to one-half or one-third of the space, while some crop is got off the remainder when they go yearly to absolutely fresh ground. The mere rent of an acre is not much for 100 fowls, but the real difficulty was and is that a fowl is such a *small* unit, entailing constant liability to small losses and wastes, and necessity for labour and oversight out of proportion. Hence at a time when 100 eggs per annum was thought a fair return for each bird, and there was but a poor and uncertain market for them, this difficulty was insuperable. A very different average production would now be worked for; while, on the other hand, the greater crowding into cities, and growing appreciation of eggs as an article of diet, have caused a market for "new-laid" eggs at good prices, which previously did not exist. It is these changes which have altered the conditions.

The chief development in England at the beginning of the 20th century was a very large increase in the poultry kept upon farms. Formerly very few were kept, looked after casually by the mistress or a boy, and only expected to provide for the household and occasionally a few shillings in cash, while any food expressly fed to them was grudged. It has now been taught all over the country, by lecturers under the County Council Technical Instruction Committees, that poultry pay best of any branch upon a farm. It has become generally known that, provided they can be run over the farm by using detached houses, and not huddled together, a dozen hens per acre can be kept upon a holding without interfering with any other stock; indeed, the curious fact is observed that horses and cattle prefer to graze over grass that might be thought soiled by the fowls. Where the statement was once derided, it is now a commonplace of County Council lecturers, that the additional manure thus made is really worth to the farm from sixpence per bird per annum for small breeds to as much as one shilling for very large ones. Out of a large number of similar instances collected in 1900, two specimens may be given. In Worcestershire 210 fowls had the run of 100 acres, lots of 20 to 30 being kept in detached houses. From 20,000 to 25,000 eggs per annum were marketed, and 150 to 200 chickens, the food averaging about £40, and the cash return £90 to £100. In Leicestershire, on part of a holding of 500 acres, 372 hens had in 1898 produced a profit of £100; the following year, owing to illness and consequent lack of oversight, 440 only paid a profit of £92. The almost universal opinion is that the manure pays for the labour, and that the annual profit averages from 4s. to 5s. 6d. per head. It has been estimated by many different observers that the number of poultry kept in Great Britain on farms is now probably five times as large as it was in 1875: in some districts "ten times as many" have been reported, but such are exceptional.

Poultry-farming on a larger scale than this is also carried on in connexion with the Sussex fattening industry, presently described. That was until recently a separate business, chickens being bought from neighbouring small rearers, or imported from Ireland, to go directly into fattening cages; and it has often been stated that rearing and fattening together were incompatible. This was so far true that the manure made by numbers of fattening poultry was very considerable, and had to be used upon a small holding kept in order to use it; such a holding, therefore, received as much as it could possibly bear, and was thereby "sickened" for live poultry running at large. But with an extra holding or larger holding this is not the case, and increasing competition and the desire for the two profits have led to a large amount of rearing and fattening combined. In 1894 one of the officers of the Agricultural Commission found 8000 chickens being reared and fattened annually on one farm of 200 acres, and this proved only a pioneer: in 1900 he found (amongst many such instances) 4000 reared upon 80 acres, 1500 upon 22 acres, and 5000 upon an extra holding (taken for the purpose) of 40 acres. In most cases the main cereal crop was oats, to be fed to the fowls; and some cows were kept, the skim milk from which was used in the same way; but the poultry was the controlling interest of the whole.

On any such scale as this the manure becomes of great importance, and the manner in which the compulsory use of large quantities has taught Sussex farmers its value is interesting. Of course there is no uncertainty about the value of manures, and about 1880 the late Dr Augustus Voelcker, chemist to the Royal Agricultural Society, made the following analysis of two samples, one moist or fresh dropped, the other freed from much moisture by storing under cover for four weeks:—

	Fresh Manure.	Partially Dried Manure.
Moisture	61·63	41·06
Organic matter and ammonia salts	20·19	38·19
Tribasic phosphate of lime	2·97	5·13
Magnesia, alkaline salts, &c.	2·63	3·13
Insoluble silicious matter (sand)	12·58	12·49
	100·00	100·00
Containing nitrogen	1·71	3·78
Equal to ammonia	2·09	4·59

Valued in the usual way, Dr Voelcker found that the moist manure was worth £2 per ton, and the drier stored manure £4 4s. per ton; but though the figures were indisputable, for many years such manure was practically unsaleable. Gradually in Sussex it became saleable at 6d. per bushel, and in 1900 some of the smaller fatters were selling it at prices varying from 4s. to 15s. per load; the larger men either used it themselves or obtained higher prices. In one district this manure was to be found in railway trucks, purchased for the growing of grapes and tomatoes under glass; and one fatter in a fairly large way, who once sold his at £2 10s. per ton for this purpose, having lost his market to some competitor, had put up a number of glass-houses and was using it himself for tomato culture. Others utilize it mainly for hay, the effect upon scrubby land being remarkable. Off one holding of 123 acres, some portion of which was wood and coppice, and the whole worn out when entered upon, the owner had sold nothing for several years but poultry products and hay: of the former, 8700 chickens had been marketed in one season, and of hay 90 tons had been cut, worth about £3 5s. per ton.

Really large poultry-farms are few in England, and it is difficult to state any recent facts without some risk that they may prove ephemeral; but a few existed at the end of 1900 which had by no means failed after two years, as some allege to be invariably the case. Two in Berkshire were selling eggs from over 2000 and 3000 laying hens; and there was one farm in the West of England, occupying 300 acres with the poultry (besides a shorthorn herd and some other branches), which had a stock of 5000 pullets for laying, and had been in existence four years, a large capital amounting to thousands of pounds having been sunk in it. The owner explained that two years was the critical period, simply because for about that time there were practically no returns, and that in his case he had only "turned the corner" after three years. Though a practical man already, he had begun in a small way with one incubator and training one man; gradually extending, building up his own market, organizing his own selling agency, and building a mill to grind his own grain. Only such gradual extension by practical men can ever lead to success: what people term "embarking" in poultry-farming can only end in ruinous failure. One reason is the error of supposing that buyers are waiting at a certain price for any new supply: the new-comer has to creep in, and find out for himself how to bring his supply and a profitable demand together. Unless this is done gradually, there is heavy loss, and while it is being done there is little return. The egg-farmer, again, has to breed up his own laying stock, as above indicated. And, finally, the business is terribly exacting: there is no rest, no holiday, no relief; intermission of labour and care for a few hours means loss or disaster, and paid oversight that will avoid this is both expensive and difficult to find.

Besides the breeding of prize poultry, which need not be discussed here, but which is remunerative enough to a certain number of persons who possess the necessary peculiar qualifications, the changes mentioned in the early portion of this article have led to another class of breeding directed to the supply of pure races from good stock, but bred mainly for purposes of utility. The demand for such stock, at fair prices, though far below those for prize stock, is a good index of the development of the poultry industry. The establishments which supply it furnish eggs for hatching, or stock birds, or newly-hatched chickens, which are now hatched in incubators and sold by thousands when only one day old, at which age they travel without needing food. Some of such establishments are quite large. One in Yorkshire occupies 43 acres solely devoted to this business. In 1900 there were on the farm about 100 breeding-pens of poultry, confined by 6½ miles of wire-fencing. The few waste eggs sold for market realized about £100; over 4000 sittings of eggs for hatching were sold, and about 1500 stock birds. This farm had then been carried on for ten years, and was purchased out of the proceeds of another held previously; but the business qualifications which could build up such an establishment must always be rare.

Poultry-farming has reached its fullest development in the United States, owing no doubt to the apparently inexhaustible market; butcher's meat being far less eaten than in England, and poultry and eggs to a large extent replacing it as national food. More especially is there an enormous demand for small chickens, known as "broilers," weighing from 1½ lb to 2 lb only, destined to be split in half and broiled on a gridiron. These birds being unfattened, and ready at ten or twelve weeks, give a quick turnover with less expense and risk than older fatted birds; and this peculiar demand has largely dominated American poultry-farming, a great deal of which runs in the direction of great "broiler-plants" solely devoted to the hatching and rearing of these broilers, while large "brooder-houses," similar to those used in that business, are prevalent on more miscellaneous farms. The broiler business started at Hammonton in New Jersey about 1880–85, when plant after plant was rapidly erected, some of which have since shut down; but many others have taken their place, and some of the originals are still running. The chicks are all hatched in incubators (many plants running from 20 to 40 machines), and then transferred to long "brooder-houses," built with a corridor all along one side, the rest being divided into successive pens for the chickens. These latter are moved along every few days to the next of the pens, which are arranged so as to give rather more space as the birds grow larger. Each pen has next the corridor a "hover" or brooding-shelter. These have no nestling material, but only a roof or cover somewhat to retain the heat, closed by a curtain cut into strips in front; and are warmed by hot-water pipes running along the building. Generally these pipes run some inches above the chicks reposing on the floor, and are set rather on a slant, so as to be higher for the bigger chicks in the larger pens; but in some cases they run under the floor, and warm the air which enters under the hovers. Every hover, with its inmates, can be reached from the corridor at the back of all. In many cases the chickens are confined in these small pens until large enough, the floors being littered and regularly cleaned; but some raisers have also small outside yards which they use in fine weather. The mortality in nearly all plants is great, as might be supposed. There are said to be some at Hammonton which only market 30 per cent. of the eggs incubated, yet pay a modest profit at that, which is allowed for. On the one hand, a broiler realizes about four times the cost of its own hatching and food; on the other hand, the labour is very heavy and the loss considerable: these factors obviously give a very wide margin of possibilities as regards success or failure.

The most remarkable establishment of this kind, embodying some novel features, was erected in Ohio at the end of 1896 by Mr J. Loughlin, and was still running in 1901, though many believe its permanent success doubtful. The plant cost over 60,000 dollars, and was designed to market 250 to 300 broilers per day regularly, weighing $1\frac{1}{2}$ lb each, which are sold alive to one large dealer at three dollars per dozen. Each day an average of 450 eggs are started, the chicks from which go into one pen. For the chicks, while small, there are thirty small pens, each with 5 by 10 feet of floor space, or at the rate of six chickens per square foot; and there are sixty larger pens each 8 by 12 feet, with outer runs to each of 8 by 20 feet. Every day the chickens are marketed from the ninetieth pen, and all the rest moved one pen forward, leaving the first small pen vacant for the day's hatch: thus fully 22,000 birds are in the plant at one time. The crowding appears very great—we should say far too great—yet the plant had run four years, and was stated to make a profit of 14,000 dollars annually.

In more general American poultry-farms the same system of brooder-houses largely prevails, and from many great numbers of broilers are sent to market; but as both heart and liver are perceptibly affected by such rearing, birds intended for stock are either taken out of doors early, or reared in detached brooders, as in England. Some establishments are mainly egg-farms, high averages being obtained by the system before described. Many breeders have a high reputation for their stock as layers, and derive large profit from selling stock or eggs to other farms. There are many immense duck-farms or "ranches," as mentioned below, which sell nothing except stock ducks or market ducklings. A great many combine the breeding and sale of exhibition poultry with some or all of these objects, fancy points being on the whole less distinct from useful qualities than in England, and the farmer and exhibitor far more commonly combined.

As a rule, American poultry-farmers employ long ranges of buildings divided into pens or houses, with enclosed yards in front; and the most remarkable fact is that interest can be paid upon the capital sunk in such buildings. The explanation in some cases is that much is put up by personal labour and energy of which British farmers have no idea, while the cheapness of land and feed are also favourable. But the climatic conditions also differ. During the winter months the birds have to be confined in what are called "scratching-sheds," and American farmers have successfully reduced to a system the keeping of them healthy and in profit by scratching amongst litter in a small space. During this period the outer runs sweeten and recuperate; smaller runs therefore suffice, and the stock is kept closer and more compact. Another system is pursued, more especially about Rhode Island, called the "colony" plan; detached rough houses, holding forty or fifty hens each, being scattered over the farm: there may be a hundred houses, but there is no fencing. This is very economical in buildings, but expensive in the labour of feeding and collecting eggs, and the system is only possible near the sea or where there is little snow. In several cases it has been abandoned for the system of houses and scratching-sheds.

There are a few very large establishments indeed in the United States, combining almost every branch; but some which did well on a rather smaller scale, when enlarged by companies have been less successful, and had either to contract again or shut down. The largest single establishment at the end of 1901 was probably the Meadow Brook Farm, in Pennsylvania, occupying 80 acres, the buildings of which totalled 112,000 square feet under cover. There were half a dozen brooder-houses; one hen-house is 1000 feet long; and the farm sent to market in one year 25,000 chickens and 20,000 ducklings, besides selling many stock birds, and an enormous number of eggs for hatching at an average price of $40 per thousand. But an even larger business has been built up in Ohio by the former minister of a church, whose health had broken down. The chief and centre establishment, known as Crescent Farm, is itself pretty large, and carries many buildings; but, by a system of contracts, there is also secured the absolute control of a number of other establishments, some of considerable size. A special business has been developed here of "stocking-up" new egg-farms and broiler-plants with laying stock in September, birds "bred to lay" being supplied in lots of one hundred at a dollar each. Ten thousand such birds are raised: there is also a reputation for exhibition stock; and the demand for eggs for incubation sometimes reaches nearly 3000 per day: one order for 20,000 eggs was received on 18th March 1901. Chickens and ducklings are also marketed, about 50,000 ducklings being the expected product of the year just named. Of course businesses like these are very exceptional; but farms on a more moderate scale are numerous, and intelligent American farmers reckon to make a profit of a dollar per annum for each head of their laying or breeding stock.

Table Poultry.—National taste governs the market for table poultry to a large extent. In England white meat, skin, and legs are preferred, and at one time black legs or yellow skin were heavily discounted. More knowledge has largely removed that prejudice, but white has a market value still. In France exceedingly white and smooth skin is preferred, but buyers are indifferent to black legs. In America yellow skin and legs are actually preferred, such fowls being thought more juicy; but there has been some tendency towards white meat of late. Belgian feeders think the best result follows from crossing a yellow-skinned race upon a white-fleshed one. It is some confirmation of this idea that one of the best English table fowls is the produce of a cross between Dorkings and the yellow-skinned Indian Game, while other similar instances might be cited. For some years past the quality of British table poultry has been shown by displays of plucked birds in connexion with the Christmas Smithfield Cattle Show. For many years France had a reputation for greatly surpassing British production; and as the best French fowls readily sell for £1 each and more in the Paris market, it would not be surprising if they were superior to such as have to be sold for 15s. per couple. French fatters appear to seek and obtain a smooth whiteness of fat under the skin, almost like that of a bladder of lard, which does not find favour in the British market; but the best judges have considered that the finest English specimens staged were equal to all comers, and some realized high prices. Foreign experts, equally with English, admitted in 1899 and 1900 that England had now little to learn from any foreign feeders.

The chief supply of the best fowls for the London market has long come from the Sussex district whose centre is Heathfield: these are termed "Surrey" fowls, though Surrey now sends few in comparison. This local industry has been founded in a curious way upon the "ground oats" of the district, the whole grain being ground up, husk and all, nearly as fine as flour. This is done by a peculiar local dressing of the stones, which are "stitched" into little pits by a pointed pick, instead of being dressed into narrow grooves, as for flour-milling; and this meal is found specially suitable for feeding and fattening poultry. In early times cottagers crammed a few fowls with pellets of meal dipped in milk, but this method is now quite superseded by machine-cramming, a rubber tube from the machine being introduced into the crop of each fowl, and a stroke of the foot on a pedal squeezing out a ration of thin, almost creamy, paste, composed of the ground oats, fat, and sour skim-milk, a food which puts on flesh fast and makes it white and delicate. Great experience is required in this business. When killed and plucked, the fowls are placed in a trough whilst still warm, close side by side, and their backs and breasts pressed closer together by a board loaded with heavy weights. This combination of fattening and subsequent shaping constitutes the Sussex system.

The trade in these fatted and shaped fowls is still increasing, so that in 1900 more than 2500 tons of poultry went up from Heathfield station alone to London. There are a few very large establishments; many small men fatten a few; and a fair number send up about four to six dozen fowls three times a week. This growth is in spite of the fact that increased competition and that of cheap foreign poultry have somewhat reduced profits, so that a large portion of the trade now consists of a lower class of birds, at a narrow margin. They are all carried up and the packages brought back empty at the inclusive charge of one penny per bird. The Sussex system is extending in some other parts of England, and many excellent fowls, well fed, but unfattened, are also supplied from Lincolnshire (known as "Bostons") and other districts. The largest provincial towns have similar supplies in less degree.

In America larger fowls are called "roasters," to distinguish them from the broilers above described; and quite recently there has grown up in the Eastern states a system of rearing these also in confinement. Hatching them begins in September, and the birds are at first reared in brooder-houses; but when large enough are placed about fifty together in small houses, with 6 by 8 feet of floor, in small yards about 20 feet square. One very successful raiser puts 200 birds into one pen 10 by 17 feet, in a warmed house, where they remain till killed at 7 lb or 8 lb weight. One firm had raised in this way, for seven years in succession, 2000 birds per annum upon half an acre of ground; but occasionally there is serious mortality in this kind of business, and as a rule only 60 per cent. are reared of those hatched, the loss of the rest being averaged and allowed for.

In western Europe there has grown up some demand for chickens fattened quite young, weighing only 8 oz. to 12 oz. each, and known as *petits poussins*, or "milk chickens." In Belgium somewhat older ones, weighing up to 1½ lb, are sold as *poulets de grains*. The demand for such birds in England is small, and confined to the West End of London, the flesh being too excessively tender for average English palates. Birds of similar sizes have lately been finding a market in the United States as "squab broilers," but are split and broiled, and not fattened, the difference being that a whole bird is served for one portion.

Ducks, Geese, and Turkeys.—Little need be added under these heads. During the last fifteen years of the 19th century the Indian Runner Duck, formerly known as the Penguin Duck, became very popular as a hardy forager and good layer, many birds laying 150 to 180 eggs in a year. It is small in body but good in flavour, and is a great favourite in many districts. Formerly the greater number of ducklings came to the London market from the Vale of Aylesbury, the birds being carried and empties returned for one penny per head, as in Sussex. This trade still continues, but the adherence of the Aylesbury duckers to old-fashioned methods, and the increasing demand, has led to great competition in other districts, such as Norfolk, Lancashire, Kent, &c. Some of the new duck-farmers market 10,000 to 15,000 annually, mostly hatched in incubators, and never allowed in the water or out of the small rearing-pens. In America, however, this kind of rearing has found its fullest development, the number who raise 10,000 ducklings or more being considerable, and a few sending to market, as above indicated, very large numbers indeed, requiring 40 to 80 incubators to keep up the supply. It is remarkable that while in England the Aylesbury is generally preferred, in America the Peking duck is universally used, and has been made by selection both larger and a better layer. Some duck-farmers in England have, however, also adopted the Peking.

Geese in England are declining in relative popularity. In Germany they are consumed to an enormous extent, and the British Consul-General at Berlin reports that even the large domestic supplies have to be supplemented by considerable imports from Russia, a special "goose-train" of fifteen to forty cars arriving daily from the Russian frontier at that city. In America there has been increased interest in goose-breeding, and in the Chinese Goose especially, which has been largely bred (with some trifling peculiarities) under the name of the African Goose, and crossed with the Embden and Toulouse. The produce of this African cross is considered very fertile and profitable to rear.

Turkey-breeding has been largely dominated by the magnificent American Bronze breed, derived from wild blood, and distinguished for size and weight. There is some question whether it does not require more space and fresher ground than the older English strains, and may not be more delicate on small holdings. French birds come largely to the Christmas market in London, but, as compared with English, are small.

National Interests and Commerce.—The foreign importations of eggs into Great Britain have increased rapidly, and are now very considerable. Taking only alternate years for brevity's sake, the following table shows the amount, value, and average price per 120 since the year 1870:—

Number, Value, and Price of Imported Eggs.

Year.	Number of Eggs.	Value.	Average Price.
		£	
1870 . .	430,842,240	1,102,080	6/1½
1872 . .	531,591,720	1,762,000	7/11¼
1874 . .	680,552,280	2,433,134	8/7
1876 . .	753,026,040	2,620,396	8/4
1878 . .	783,714,720	2,511,096	7/8¼
1880 . .	747,408,600	2,235,451	7/2
1882 . .	811,922,400	2,385,263	7/1
1884 . .	993,608,760	2,910,493	7/0
1886 . .	1,035,171,000	2,884,063	6/8
1888 . .	1,126,793,000	3,083,167	6/6
1890 . .	1,234,950,000	3,428,806	6/8
1892 . .	1,336,730,000	3,794,718	6/10
1894 . .	1,425,236,000	3,786,329	6/5
1896 . .	1,589,401,000	4,184,656	6/4
1898 . .	1,730,952,000	4,457,117	6/2
1900 . .	2,025,820,560	5,406,141	6/5½

From such figures the conclusion has been drawn, and at first sight is natural, that foreign eggs have been "ousting" British to a formidable extent; but such a conclusion is dispelled when we take into consideration questions of price and nationality. The following are the values imported from the chief foreign sources during the last ten years of the 19th century, taken every alternate year until the last:—

Value of Imports of Foreign Eggs.

Year.	France.	Russia.	Denmark.	Germany.	Belgium.
	£	£	£	£	£
1889	1,181,335	165,740	286,917	893,902	565,057
1891	1,259,099	383,791	395,963	781,903	539,666
1893	1,611,495	426,106	376,793	618,631	682,636
1895	1,069;580	601,460	447,709	916,821	713,458
1897	1,022,869	812,297	546,282	813,022	768,077
1899	867,865	1,183,031	808,543	966,641	759,250
1900	868,133	1,109,553	923,551	1,106,719	733,453

These eggs are of very different qualities and prices, France averaging for the year 1900, 7s. 7½d. per 120, Denmark 7s. 6¾d., Belgium 6s. 2d., Germany 5s. 9½d., and Russia 5s. 6d., many of the latter being almost putrid when sold in England, and chiefly used in manufactures, for which, at a low price, they answer perfectly. Many eggs are sent from Russia to Germany, Belgium, and even Denmark, so that some of these also come from her, at an original price with which no British producer could compete. The steady decline in imports of the higher-priced French eggs, and enormous increase of low-priced eggs, explain the drop in average price from 8s. 7d. per 120 in 1874 to 6s. 5½d. in 1900; and were this all, the inference would be simply that the selling price of eggs had fallen. But this is not so. While the higher-priced *foreign* eggs have thus been largely displaced from the market, there has grown up a very large demand for British "new-laid" eggs, at prices much higher than any of the above. Every observer must have noticed the many packages of such eggs now exposed for sale in all towns; and what is still more significant, there is now a wholesale market for such eggs in London, the lowest price (in May) for 1900 being 7s. 6d. to 8s. 6d., and the highest (in December) 19s. to 20s. per 120. This market is steadily increasing, the greatest difficulty being to ensure really genuine freshness from producers. The quantity of reputed "new-laid" British eggs now sold is simply enormous, and has grown up in the face of foreign imports, the native producer selling in spite of them, and at far better prices, many times more than he did, say, in 1875.

The following are the British imports of dead poultry and game for the last three years of the 19th century:—

Value of British Imports of Poultry and Game.

Year.	France.	Russia.	Belgium.	Other Countries.
	£	£	£	£
1898	217,703	164,498	127,923	127,368
1899	296,555	139,834	165,803	183,102
1900	333,148	199,282	213,603	264,327

The total for 1900 thus amounted to £1,010,360. The imports from France and Belgium are largely for the Christmas market. Those from Russia are chiefly very small fowls, wrapped in paper and packed in cases of a hundred each, which come over frozen, to be sold at 1s. 2d. or 1s. 3d. each. Other sources include America, Canada, and Australia, which have been sending smaller but increasing quantities of larger birds, packed in smaller numbers, and which realize 2s. 6d. to 3s. 6d. each, a few of the largest as much as 4s. each. Such supplies have somewhat affected the Sussex fattening industry, necessitating (as already hinted) the production of a lower class of bird at a lower price and narrower margin; but they look rough and inferior in colour, and chiefly supply restaurant and hotel demand. The foreign birds being cold-storage goods, which must be consumed quickly when taken out, a fresh Sussex fowl of the same weight will always sell for considerably more.

There are no statistics of British poultry; in Ireland they are collected. The year 1851 closed a decade in which the number of holdings under ten acres had decreased enormously, and the number of poultry in Ireland was then returned as 7,470,694. In 1889 this number had doubled to 14,856,517, and in 1899 there were 18,233,520, an increase in ten years of almost 25 per cent. The Irish Agricultural Organization Society is doing much to improve breeds and management, and the packing of eggs, of which Ireland is a considerable exporter to Great Britain. There is also now a considerable export of lean chickens for fattening to Sussex and other parts of England, and a smaller number have also been fattened in Ireland. Really great progress is manifest in the size and quality of the poultry in many districts, and in the freshness and packing of eggs for the English market.

The poultry industry is developing in Australia, and some export to England has arisen, but too recently for much definite information. Most of the federated States have a Produce Export Department, which receives eggs and dead poultry into cold storage and ships to London, managing, if desired, the whole business. That of South Australia shipped a good many eggs to England in 1895, but the temperature was found too low for eggs, and this trade has so far not developed. Dead poultry come in a similar way from West Australia and Victoria to London. In New South Wales such arrangements have inaugurated a small export business which seems the most active of any, and more seems known about the poultry industry in this state than in others. The Government statistician estimates the number kept in 1900 at 3,180,000 fowls, 320,000 ducks, 234,000 turkeys, and 97,000 geese, the annual consumption being about three-fourths of this, and of eggs about 97,000,000. Around Sydney there are many poultry and duck farms of one to a dozen acres, and one large duck-farm produces ten to twelve thousand ducklings annually. These farms supply the best export fowls for London, the Government depôt having to refuse many others sent in, as too small and poor to pay for export. From Tasmania there is no export as yet, but the colonial Government has started a poultry farm, in order to improve the stock kept and afford instruction in poultry-breeding.

In Canada the Government makes considerable effort to encourage poultry. It has established several stations where systematic fattening of chickens in the English manner is taught, and official experiments are also made on the results of various feeding-rations and other matters. From these stations shipments of fatted chickens were first made to Liverpool and London, commencing an export trade which shows signs of growth. In 1900 the eggs exported to England were valued at £288,945 in London; and the dead poultry shipped realized in Canada for 1898, 100,739 dollars; for 1899, 140,142 dollars; and in 1900, 211,181 dollars. These have improved in quality, and the largest have realized 3s. 6d. and 4s. each. There are no statistics of home production.

The poultry industry in the United States is the most gigantic in the world, and probably the greatest pecuniary interest the country possesses. By the census of 1900, which tabulates returns from 5,096,252 out of the 5,739,657 farms in the States, the number of fowls over three months old on 1st June 1900 was returned as 233,598,085, with 6,599,367 turkeys, 5,676,863 geese, and 4,807,358 ducks, or 250,681,673 birds in all, valued at 85,794,996 dollars. This, however, would include very few of the chickens raised that year, which would not have reached the age stated, and mainly represents breeding and laying stock, which thus averages about 49 birds to every holding; it also of necessity omits many of the smaller city-lot raisers. The value of the poultry raised during the whole year 1899 is given as 136,891,877 dollars, and of the eggs produced (1,293,819,186 dozen) at 144,286,186 dollars; a total year's product of over £56,000,000. Adding only a very moderate amount for city-lot and other small producers not making return, it will be seen that the poultry industry in America exceeds in value either the wheat crop, or swine crop, or cotton crop, which probably comes next in value. Reasons for this enormous production have been indicated, and much is done to foster it by the state governments, which carry out numerous experiments that are reported all over the country. The last development here also, dating only from 1899, is a commencement of export to England of some of the larger fowls produced in the establishments above described. The best are selected, the greater portion so far being sent by one firm in Chicago; and the birds vary in price from 1s. 6d. for the smallest to 3s. 6d. and 4s. for the largest, being sold chiefly to London hotels.

The importance of poultry in France has long been recognized, being due mainly to the prevalence of moderately small holdings and the national disposition to small rural industries. There are no very recent statistics available, but whereas in 1862 the poultry in France were reported as 43,000,000 head, these had increased in 1892 to 54,000,000 head, besides 9,000,000 ducks, geese, and turkeys. The eggs exported are collected from the farmers by such a well-organized system that eggs collected on Wednesday are in the London market the following Tuesday. The home consumption of eggs is also enormous, so that when prices for foreign eggs decreased in England, the Paris market paid better. In 1899 the Paris Municipal Council reported the consumption of eggs in that city alone in the previous year as 212 per head, and the taste for omelettes must make the number used in France very great. Eggs are imported from Italy to some extent.

The conditions in Belgium are somewhat similar to those in France. No domestic statistics are available. Some eggs are imported from Italy, and much of the home production is from imported Italian hens, kept laying for a year and then killed: eggs are exported chiefly to France, Great Britain, and Germany. There is a fattening industry somewhat similar to that in Sussex, lean chickens being bought for fattening in certain markets. The chief export of these is to Germany, but there is some to the London market, especially in December.

The Netherlands statistics for 1898 show that the number of poultry had increased considerably during the previous ten years, excepting turkeys, which had diminished. There were in that year 4,083,312 fowls, 430,022 ducks, 36,307 geese, and 13,130 turkeys; and there were about 70 special establishments for poultry-rearing, which were rather on the increase, chiefly for local requirements. Of eggs there were exported to Belgium 656,898, England 370,418, and Germany 3,212,845 kilos; but the imports were in excess of this by 2,916,269 kilos, and came chiefly from Russia. Dead fowls and ducks also go to the countries above named.

In Denmark there were in 1900 about 9,000,000 fowls, mostly local and Italian. The eggs exported numbered 332,000,000, practically all to England; there were imported 35,600,000, practically all Russian, re-exported to England. The flourishing export trade is due to a good co-operative system, to which the Government contributes £555 annually towards poultry-breeding and the holding of exhibitions.

The customs returns of Germany must truly represent her imports, but obviously give little idea of her exports, since eggs are only given as exported in 1899 to the value of £23,900 (reckoning 1 mark = 1 shilling), whilst English imports from her are above given as amounting to £1,106,719. Her enormous imports of geese have already been alluded to: these come alive from Russia, and in 1899 numbered 6,875,810, of the value of £978,350, all for home consumption. Other poultry and eggs are tabulated in quantities of 100 kilos, and were valued as follows: live fowls £508,350, other live poultry (than geese) £171,650, dead poultry £290,150, eggs £4,815,450, not far from the imports in England. It is clear, as was incidentally apparent before, that Germany is a large consumer rather than a producer of poultry products, and chiefly a carrier of her nominal exports. She imports eggs from Italy and Austria-Hungary as well as from Russia. These large imports may probably be profoundly affected by the new tariff legislation.

There are no domestic statistics for Austria-Hungary, but her trade in poultry and eggs is considerable. In 1900 the dual monarchy imported poultry to the value of £268,240 and eggs to the value of £1,230,655. But the exports of poultry amounted to £977,051, and of eggs to no less than £3,750,078. This country is therefore a very large producer, most of the eggs going to Germany, and some of them through her on to England.

Italy sends live fowls, for laying, to northern Europe, and some eggs to Belgium and France; but no definite figures are accessible.

In Russia the growth of the poultry industry has been very great since 1890. In that year her British trade was small: in 1900 we have seen that she bulked largest of all countries in eggs sent to England direct, and that some nominally from others really came from her. Her exports of eggs (reckoned as £1 = 10 roubles) were valued in 1898 at £3,113,386, and of live poultry (chiefly geese) at £637,000; but this latter sum is now exceeded by geese alone sent to Germany, as above noticed. Her vast southern provinces are, of course, the origin of this produce, which is collected by dealers from the farmers, the price realized by the latter for eggs being in summer sometimes less than a rouble per hundred. The Government has shown considerable interest in this growing industry in several ways, and produce is carried at almost incredibly low rates on the State railways; but the vast distances involved must always confine Russian produce to the supply of the cheaper class of demand in western Europe.

For these details we are mainly indebted to the consuls-general of Germany and the Netherlands in London, to the British consuls in Copenhagen, Antwerp, Vienna, and Berlin, and to various miscellaneous tables and returns, including those obtainable from the agents-general of the principal British colonies.

(L. Wr.)

Povoa de Varzim, a seaport and bathing resort of Portugal, district of Oporto, 17 miles north of Oporto, on a small and ill-sheltered bay. The people, who are good seamen, are mostly engaged in fishing, 2644 persons and 649 boats being so employed in 1898, the value of the fish caught being £22,000. Population (1890), 12,057; (1900), 12,623.

POWER TRANSMISSION.

I. Electric.

The electric transmission of power may be briefly defined as the art of delivering electric energy at any desired point and there transforming it into mechanical energy. It therefore involves not only the design and construction of the delivery circuits and the generators which feed them, but the properties and the use of the electric motors which accomplish the transformation. As the former considerations are somewhat contingent upon the latter, it will be convenient first to discuss the properties of the electric motor in its various forms, and later the transmission systems as such.

Motors.

Fundamentally, electric motors are electric generators reversed in function: they convert into mechanical energy the continued stresses between two electromagnetic fields relatively movable, just as generators convert into electromagnetic stresses the mechanical energy applied to them. Since no transformation of energy is ever absolutely quantitative, the conversions just considered are not accomplished without loss of energy to about the same extent in both cases. The sources of this loss are ohmic loss in the conductors, hysteresis, friction of bearings and brushes, air friction, and eddy currents; the sum of these losses in large modern machines does not exceed 5 or 6 per cent. The torque of the motor is the dynamical result of the electromagnetic stresses between the magnetic field of the motor and that due to the armature currents, the latter field being proportional to the strength of the current sheet due to the numerical strength of the current and the number of its effective convolutions. This applies to all types of motors, if one remembers that whenever either of these two factors is a periodic variable, as in the case of alternating motors, the torque is proportional to their geometrical co-directed product and not merely to their numerical product. At this point it will be convenient to distinguish between the various types of motors. The first broad distinction is between continuous-current and alternating-current motors, a distinction rather of convenience than of necessity, for in point of fact the two depend upon the same broad principles and can be considered on precisely the same lines. Each class is composed of numerous possible types, of which comparatively few are in considerable use for the purpose of power transmission, and of these few two or three go to make up the vast majority of those generally employed. Motors may be conveniently divided as follows:—

(A) *Continuous Current.*
1. Separately excited.
2. Series-wound constant current.
3. Series-wound constant potential.
4. Series-wound interdependent current and potential.
5. Shunt-wound constant potential.

(B) *Alternating Current.*
1. Synchronous constant potential.
2. Induction-polyphase constant potential.
3. Induction-monophase constant potential.

Of these, the series-wound constant potential, shunt-wound constant potential, and polyphase induction motors do a very large proportion of the active work of power transmission: the first-mentioned furnish power for electric railways; the second, power distribution from public electric supply stations; while the third are mainly relied upon in long-distance transmission systems.

In class (A) in general, for a certain value of the torque current must be forced through the armature against the motor electromotive force which results from the rotation of the armature in a given field. This demands a certain greater applied electromotive force to produce the current required, which is determined by the effective electromotive force, equal to the geometrical difference between the applied and motor electromotive forces, and by the impedance of the armature. For steady currents this is of course the same as the ohmic resistance, just as for steady electromotive force the geometrical and the numerical difference of the applied and motor electromotive forces are coincident. The torque depends, as heretofore noted, on the field strength and the strength of the current sheet due to the current thus determined. For small values of the torque the speed practically depends upon the applied electromotive force and the field, so that if the former and the latter be constant the speed is also sensibly constant. This is likewise the case if the armature resistance be very small, and in general the variations of speed at constant potential are determined by the product of this resistance and the torque, while the absolute speed depends essentially upon the field strength. Motors for low speed or high electromotive force must have both a strong field and many turns upon the armature, so that both the fundamental stresses may be large. As the field is generally strong—to secure economy of iron—low-voltage and high-voltage machines differ principally in the number of armature turns. For variable speed, this latter factor being fixed, field strength and applied electromotive force are the factors easily altered, and most of the speed variation is accomplished by changing one or both of them. Torque is at a maximum when the current is the greatest possible at the given voltage—that is, when the motor is at rest. With a small armature resistance, this current is generally far too great for convenience; hence the motors are usually started with a rheostat in series with the winding if the current is not limited by the generator itself. The torque then depends on the sum of the resistances in circuit, and can be made just sufficient to start the motor under the required load. By the same device, the motor can run at reduced speed, although with a considerable loss of energy in the rheostat; it is indeed, as a rule, difficult to get effective speed variation in motors of any kind without serious loss of energy. The field can be changed within wide limits only by a considerable increase of the iron in the magnetic circuit, the applied electromotive force cannot usually be varied except by increasing the resistances in circuit, and the number of armature turns cannot be varied without complication, although the effective number can be modified by shifting the brushes, probably at the expense of sparking. Altogether, if the speed variation demanded be more than 15 or 20 per cent., it causes, in one way or another, considerable expense and trouble, particularly if each speed must be closely held irrespective of load. No large change in absolute speed can readily be made without considerable change in the percentage variation of speeds at various loads. Practically the best results are obtained from motors of very low armature resistance, in which the field or the applied electromotive force, or both, are varied. The whole problem is nearly identical with the production of constant potential or constant current from generators driven at constant speed, and is solved by similar means. For any one absolute speed a generator can be made to give constant potential, nearly irrespective of load, by compound winding. Similarly, a motor may give a very nearly constant speed at constant potential by a differential winding in series with the armature, weakening the field as the armature current rises. This device, however, obviously increases the energy required for magnetization, and decreases the effective torque at starting. Practically the best continuous-current motors can be made to hold their speed to within 1 or 2 per cent. from no load to full load. Commercial machines, however, generally vary from 5 to 10 per cent. in speed. With respect to the direction of rotation of a motor, the torque changes sign with a change of sign in either field or armature current, but not with a change of sign in both. The input of the motor is numerically equal to the product of the current and the applied electromotive force, while the output is determined by the product of the current and motor electromotive force; hence the efficiency of the motor, as a transformer of energy, is the ratio between these two quantities. The output is a maximum when the applied electromotive force is double the motor electromotive force, and the efficiency is a maximum when the motor and applied electromotive forces are substantially equal. At the point of maximum output, the speed is that sufficient to reduce the current to one-half its static value. No motor is worked at or near this point, except momentarily, on account of the low efficiency and severe heating in the armature. These theoretical values are slightly modified in practical machines by the small miscellaneous losses subject to independent variations.

(A) 1. *Separately excited Motors* are seldom used in power-transmission work, but they are interesting principally on account of the very efficient method of speed regulation possible by their use. In this method the field of the motor is excited from the supply mains, and the armature current is furnished by a motor-generator running at constant speed. A rheostat in the shunt field of the latter element enables the applied electromotive force to be varied to any desired extent, and hence the working motor can be given full torque at any speed up to that assigned by the maximum value of the electromotive force which can be applied to the armature. Moreover, if the armature resistance be small, the motor is fairly self-regulating at all speeds. The effect is rather startling, since the motor may be giving a very great torque when it is merely turning over at a few revolutions per minute; and although the process is complicated, it leads to excellent results.

(A) 2. *Series-wound Constant-current Motors* were early worked to a considerable extent on arc-light circuits, but have now passed out of use save in a small number of constant-current power-transmission systems on the continent of Europe. In these motors the motor electromotive force is directly proportional to the output, the torque being constant. They will not start with more than a certain definite load, but once started, the speed will increase until added work (internal or external) balances the torque. The type is intrinsically bad in speed regulation, and must be treated by the same methods as are adopted to secure constant current in arc machines. The most successful device in most cases is to vary the field strength by shunting the field coils, or to vary the number of effective armature conductors by shifting the brushes. Both methods are carried out mechanically rather than by purely electrical means—in the first case by an automatic rheostat, and in the second by an automatic brush shifter—but neither is wholly satisfactory.

(A) 3. *Series-wound Constant-potential Motors* comprise nearly all motors used for electric traction—aggregating not less, probably, than one million horse-power; hence they are of great practical importance. These traction motors are usually highly specialized machines with very powerful armatures, and fields strongly saturated at all working values of the current. The brushes have an invariable position. Such motors behave much like separately excited motors having a rather large armature resistance. Speed regulation has to be obtained by varying the applied electromotive force. In early traction motors this variation depended upon inserting a rheostat; in modern practice it is customary to employ two or even four identical motors on each car, operated in series for low speeds and in parallel for full speed. In practice, however, resistances are inserted when necessary to prevent too sudden changes of speed, and to secure intermediate steps between those obtained by the series-parallel connexions. In rare instances a still further variation is secured by the use of a field only partially saturated at ordinary loads.

(A) 4. *Series-wound Motors with Interdependent Current and Potential* are used only in connexion with generators of similar design, motor and generator forming a dynamical unit. This system is occasionally used with good results in power transmission. Assuming the motor field to be saturated, if the speed is to be constant the applied electromotive force must rise with the load to an amount depending on the resistances in circuit. If the corresponding generator has a field less fully saturated, the increase in current demanded by the increment of torque in the motor can be made not only to raise the applied electromotive force enough to compensate for armature resistance, but for the total resistances in circuit, including the line. With this difference in saturation, the motor will automatically maintain constant speed. The fields of the machines need not be designed for a given saturation, since shunting them with a suitable resistance will give the same result.

(A) 5. *Shunt-wound Motors at Constant Potential* are the mainstay of continuous-current distributions for industrial purposes. At constant potential the field remains sensibly constant, and the torque is directly proportional to the current. The motor then behaves much like a separately excited motor, and the armature resistance being generally very small, the speed is very nearly constant, varying less than 5 per cent. from no load to full load in the best commercial machines. Operating on a compound-wound generator, a single motor of this type can be made to regulate with great precision, as in the previous case. If the motor field be only moderately saturated, its strength, and hence the motor electromotive force, rises and falls with the applied electromotive force; and therefore at constant load these motors run at very nearly constant speed, in spite of small variations of voltage. If speed variation be required, it can be obtained to a moderate extent by a rheostat in the field circuit. At starting, a rheostat is necessary in the armature circuit. The differentially wound modification is now seldom used.

(B) 1. *Synchronous Alternating-current Motors.*—The simplest starting-point in the consideration of this class is the continuous-current generator. This machine actually generates within the armature alternating currents; and if the commutator be replaced by two or more slip-rings connected symmetrically to two or more points on the armature winding, alternating currents, monophase or polyphase, according to the number of connexions and the points touched, can be withdrawn therefrom. The simplest case involves only two slip-rings, joined to the winding at diametrically opposite points. Consider two such modified machines as motor and generator. The condition of complete reversibility is that the instantaneous values of the currents, and the instantaneous values of the angular displacements between poles and armature coils, shall be equal throughout. This evidently requires that the rotation of the motor should be synchronous, pole for pole, with that of the generator. Here, as before, the torque depends on the two fundamental stresses, but the torque has no determinate sign in the absence of an initial rotation. The instantaneous value of the torque depends on the instantaneous value of the current and on its angular displacement. The speed of the motor being invariable, its motor electromotive force depends only on the effective excitation, including the armature reactions, and it may or may not, according to the conditions of load, be in phase with the impressed electromotive force. In the case of the continuous-current motor, the motor output is numerically equal to the product of current and motor electromotive force; and since, in the alternating circuit, these quantities are usually not in phase, in alternating motors the activity is determined by the co-directed part of their product. The current in the alternating motor depends, not on the ohmic resistance, but upon the impedance, and upon the geometrical difference between the applied and motor electromotive forces. At a given applied electromotive force and an armature impedance assumed constant, the fundamental variables in the motor are the output, motor electromotive force, and motor current. The two last factors are interdependent, so that the current may have a wide range of values, according to the excitation, while the output remains constant, or itself remaining constant, may cover a variety of values of the power corresponding to different excitations. These changes involve changes in the phase angle between the motor electromotive force and the current, so that, at given output, the power-factor of the motor — that is, the ratio between the numerical and geometrical products of current and electromotive force—may be given various values at will by changing the field excitation of the motor, a most unique and valuable property. If the motor electromotive force be fixed and the output varied, the phase angle between current and motor electromotive force varies by reason of the armature taking up a new angular position with respect to the field, backward for increasing load, forward for decreasing load. The minimum value of the current for a given load is reached when the excitation is such that the applied electromotive force and current are in phase, at which point the real and the apparent energy in the circuit coincide. The input can then be accurately measured by voltmeter and ammeter readings, and the motor is working at its best efficiency for the given load. For greater values of the motor electromotive force, the current leads in phase with respect to the applied electromotive force; for less values it lags. The former condition is accompanied by the rising of the electromotive force at the motor terminals, the latter by its fall. It therefore becomes possible to use a synchronous motor, if the necessary current due to the load be not too great, as a voltage and phase regulator upon an alternating circuit, a function very valuable in power-transmission work. If the excitation be set to produce leading phase at small loads, the phase angle will gradually diminish as the load rises, and then, passing through zero, increase again with the lagging current, thus holding the power-factor near to unity at all working loads. In a well-designed synchronous motor, by proper initial adjustment of the field, the power-factor can easily be kept between 0·95 and 1 from quarter load to full load, and very close to unity within the ordinary working range. Save for its inability to start, the synchronous motor is a highly desirable addition to a transmission system. Starting is generally accomplished by the help of an induction motor or other auxiliary power, and the motor is treated exactly like an alternator to be thrown in parallel with the supply circuit. A synchronous motor will pull itself up to synchronism if brought near to its synchronous speed, but this requires a very large amount of current. Operating from a generator of its own, it can be brought to speed by giving it a small initial rotation and raising the generator speed very carefully and gradually, when the two machines will accelerate in synchronism. Polyphase synchronous motors obey these same general laws; they can, however, be started as quasi-induction motors with an open field circuit, the pole faces serving as secondary conductors, but require so large currents in thus starting themselves that it is better practice to bring them to speed by extraneous means.

Synchronous moters sometimes cause serious trouble by "pumping," a phenomenon closely allied to the surging of current between alternators in parallel, and due to similar causes. If not due to defective governing of the prime mover, it usually starts with a change of load or of phase, producing fluctuations in the electromotive force in the system great enough to interfere seriously with incandescent lighting, and continuing with uniform amplitude and frequency for hours if unchecked. The amplitude varies with the conditions, but in the same machine the frequency is nearly constant. The fluctuation affects both the armature and the field circuits, but it can as a rule be controlled by varying the excitation until a neutral point is found, usually when the phase angle is near to zero. Motors with solid pole pieces give little trouble of this sort, the oscillations being rapidly counteracted by the eddy currents. In motors with laminated fields, the most effective remedy is chamfering away the edges of the pole pieces so as to admit heavy copper shoes running along and under the edges, and even bridging the spaces between the pole pieces. The eddy currents in these shoes completely check the "pumping."

Rotary Converters.—These are, in effect, synchronous motors, and have the same general properties so far as their motor functions are concerned. When practicable, it is desirable to start them from the continuous-current side; otherwise, through auxiliary motors. They often show an inclination towards "pumping," and, as in all parallel working of alternators and in synchronous motor practice, they work best when all the machines involved have similar characteristics, and, as nearly as may be, the same form of electromotive wave.

(B) 2. *Polyphase Induction Motors.*—Speaking broadly, an induction motor is one in which the armature current is introduced into the armature windings by electromagnetic induction instead of by brushes. It is at once an alternating current transformer and an alternating current motor, operating in the latter function by virtue of the current received from the former. In the commonest form the alternating currents are of two or more phases interacting in carrying on these duplicate functions. Induction motors consist of two concentric masses of laminated iron taking the form of short hollow cylinders, of which the outer is fixed and the inner fitted to revolve. The outer surface of the inner drum and the inner surface of the outer drum are slotted or perforated, to receive the primary and secondary windings of the apparatus. The outer winding is usually the primary, and the inner (or armature) winding the secondary. The primary winding is almost universally a multipolar drum in character; the secondary is, in the most highly developed motors, of the same character, but very often consists merely of numerous insulated armature bars united at each end of the drum by a common end-plate or end-ring, forming the structure usually known as a "squirrel-cage" winding. In polyphase motors of the usual type the primary drum winding is in duplicate or triplicate, resembling very closely the armature winding in a two- or three-phase generator. The actions which go on in these motors have been the subject of much debate; most of the theoretical discussions of the matter have been based upon the concept of a rotary magnetization produced by two simple sinusoidal magnetisms superimposed in quadrature upon the same core, or in the case of a three-phase motor, three superimposed in a similar symmetrical manner. This hypothesis is often most convenient, being merely an application of the general physical thesis that two equal simple harmonic motions in quadrature produce circular motion, as in the case of the conical pendulum. All the results of this hypothesis follow, however, from the introduction of two alternating magnetizations, acting in quadrature in time but independently; and one or the other view of the matter is convenient according as, in the structure considered, the effective magnetizations do or do not produce a definite physical resultant. There is no discrepancy between the two hypotheses; they are merely two points of view of the same phenomena. In the general case, one need make no supposition as to the existence or non-existence of the physical resultant rotary magnetization; it is merely necessary to note that if one phase-winding predominately produce a magnetic field, and the other a current in the rotary member fitted to react with that field, torque will result, whether the two phase-windings act upon the same magnetic structure, or upon two entirely separate magnetic structures merely connected by the leads which deliver current from one to the other.

Induction motors having both these forms of structure are in successful use. If one considers the latter case, the two phase-windings have exchanged functions every 90 degrees in the two-phase structure, each phase-winding serving to produce a magnetic field and to deliver, almost as if it were merely a pair of brushes, current to react with this field alternately, and the two halves of the motor structure exchange functions every 90 degrees. Considering the motor in which the two phase-windings are superimposed on the same core, there is a virtual magnetic resultant rotating at a speed determined by the frequency of the current and the number of poles, and setting up induced currents in the secondary member, which currents are so disposed as to react with the field to produce rotary motion. At rest, the secondary electromotive force produced by the machine as a transformer is a maximum; when the motor is running at speed, unloaded, it is a minimum, and an increment of load causes the secondary member merely to slip behind synchronous speed far enough to receive an increment of transformed energy sufficient to carry the new load. If the secondary member is of very low resistance, the slip behind synchronism is very small even at full load, less than 2 per cent. in motors developed for this particular property. An increase of secondary resistance produces increased falling behind from synchronous speed; and if resistance be added to the secondary member by interpolating rheostats in its circuits, the motor can be made to produce uniform torque over a very wide range of speed, as is the case with continuous current motors. The percentage of slip is the percentage of energy lost in the secondary member, as likewise in continuous-current motors if one regards their synchronous speed as that at which the motor electromotive force would equal that impressed. Polyphase induction motors start, when properly designed, with a very powerful torque, even up to three or four times the full load running torque of the same motor. With a very low-resistance secondary member, this torque demands an immensely large current, the structure acting almost like a short-circuited transformer, and the lag in the secondary circuit is considerable. In motors in which this large starting current is objectionable, it may be reduced very greatly by interpolating resistances in the secondary circuits at starting, the effect of these being to diminish the lag in the secondary circuit and to decrease the demand for primary current. A certain critical value of this resistance gives a maximum torque per ampere in the primary circuit. Where a small primary current in starting is of considerable importance, this extra resistance is frequently introduced at starting and cut out afterwards, particularly in cases where large torque is necessary. If great starting torque is not necessary, the primary electromotive force is often diminished by inductive resistances, or a change in the connexions of the transformer from which the motor is fed. Both methods of starting are in commercial use on a very large scale.

In efficiency and closeness of speed regulation and good general running properties, polyphase induction motors approximate very closely to the best continuous-current practice. They produce, however, a certain amount of lag between primary electromotive force and current, which causes the apparent input to be larger than the real input, as often happens in alternating current work. The ratio between the real and the apparent watts input is the power-factor of the motor. In well-designed modern machines this is usually from 85 to 90 per cent. at rated load; it should seldom fall below the former figure, and rarely rises more than 1 or 2 per cent. above the latter, though in rare instances power-factors as high as 94 or 95 per cent. have been obtained. Condensers have sometimes been employed in connexion with such motors to increase the power-factor, and with considerable success, particularly in maintaining the power-factor at low and moderate loads, but their use is generally unnecessary. The weakest point in these polyphase induction motors is the importance of employing a very small clearance between armature and field, in order to increase the power-factor by making the structure more efficient, considered merely as a transformer. The clearances in ordinary use are seldom greater than one-sixteenth of an inch even in motors as large as one hundred horse-power, and in smaller machines are frequently not more than one thirty-second of an inch. Induction motors, however, possess many valuable properties, and are the mainstay of long-distance power-transmission work at the present time.

(B) 3. *Monophase Induction Motors* closely resemble the polyphase motor in construction, but have only a single-phase winding in the primary. The theories of their action are very similar to those of polyphase motors. The essential point of difference is that the stable angular displacement between the field magnetization and the armature currents which co-act with it is obtained in the polyphase motor by the time-displacements in the several phase windings, while in the single-phase motor it is obtained by the angular space-displacement of the armature, which has to be set up by an initial rotation. Single-phase motors therefore are not inherently self-starting, and run in either direction equally well when once started. The torque is always in the direction of the initial rotation. This rotation is sometimes given by hand and sometimes by auxiliary phase-windings supplied by derived current from the main circuit, or merely short-circuited on themselves and receiving induced currents from the main winding. Both these devices give a small initial torque in a definite direction. Once up to speed, the single-phase motors act much like the polyphase. They are conspicuously weak in the matter of power-factor, however, as well as in that of starting-torque, and have as yet not come into very extensive commercial use, although under special conditions they have been and are successfully employed. A theoretically interesting form of induction motor is a modification which runs at absolutely synchronous speed, receiving the necessary energy in the secondary not in virtue of slip behind synchronous speed, but from great difference in wave form between the primary and secondary circuits, so that energy is periodically received by the armature in spite of synchronism in speed. Such motors are not employed commercially, but sometimes find a field for usefulness in the laboratory.

General Methods of Power Transmission.

The largest single department of power transmission—that is, transmission for traction purposes—is at present almost wholly carried on, as has already been indicated, by continuous currents. The usual voltage is 500 to 600, and the motors are almost universally series-wound constant-potential machines. The total amount of such transmission in daily use reaches almost to a million horse-power. In power transmission proper continuous currents are not used to any considerable extent, owing mainly to the difficulty of generating continuous currents at sufficient pressure to be available for long-distance work, and the difficulty of reducing such pressure, even if it could be conveniently obtained, far enough to render it available for convenient distribution at the receiving end of the line. Single continuous-current machines have seldom been built successfully for more than about 2000 volts, if at the same time they were required to deliver any considerable amount of current. About 200 kilowatts per machine at this voltage appears to be the present limit. For distances at which more than this very moderate voltage is desirable, one must either depend on alternating currents or use machines in series. In American practice the former alternative is universally taken. On the continent of Europe a very creditable degree of success has been achieved by adopting the latter, and plants upon this system, aggregating something like 20,000 horse-power, are in use, mostly in Switzerland. In these, generators are worked at constant current, a sufficient number in series being employed to give the necessary electromotive force. They have usually had a total voltage of less than 10,000, although in one instance the plans call for about double this figure. These systems are, however, characterized by the fact that the full working pressure is only carried at extreme load, and under ordinary conditions of working this is greatly reduced. They are subject, however, to a very grave inconvenience in the utilization of the power transmitted; and in the present state of the art of insulation, both in machines and lines, the advantages of the system are not generally conspicuous, although in particular cases it may be of material service.

The great bulk of power transmission all over the world is at the present time carried on by the use of polyphase alternating currents. The alternating current, as such, possesses for this purpose conspicuous advantages. In the first place, whatever the voltage of transmission, the voltage of generation and that of distribution can be brought within moderate limits at a very high degree of efficiency by the use of transformers; and, in the second place, it is possible to build alternating-current generators of any required capacity, and for voltages high enough to permit the abolition of raising transformers except in unusual circumstances. At present such generators, giving 10,000 to 12,000 volts directly from the armature windings, are in common and highly successful use in America and elsewhere; and while the use of raising transformers is preferred by some engineers, experience shows that they cannot be considered essential, and are probably not desirable for the voltages in question, which are as great as at the present time seem necessary for the vast majority of transmission plants. But for very large transmission work to considerable distances where still higher voltages are requisite, such transformers cannot be dispensed with. Alternating currents are practically employed in the polyphase form, on account both of increased generator output in this type of apparatus, and of the extremely valuable properties of the polyphase induction motors, which furnish a ready means for the distribution of power at the receiving end of the line. As between two- and three-phase apparatus, the present practice is about equally divided; the transmission lines themselves, however, are, with rare exceptions, worked three-phase, on account of the saving of 25 per cent. in copper secured by the use of this system. Inasmuch as transformers can be freely combined vectorially to give resultant electromotive forces having any desired magnitudes and phase relations, the passage from two-phase to three-phase, and back again, is made with the utmost ease, and the character of the generating and receiving apparatus thus becomes almost a matter of indifference. As regards such apparatus, it is safe to say that honours are about even: sometimes one system proves more convenient, sometimes the other. The difficulty of obtaining proper single-phase motors for the purpose of general distribution has so far prevented any material use of single-phase transmission systems.

Generators for Power Transmission.

The generators are usually large two- or three-phase machines, and in the majority of instances they are driven by water-wheels. Power transmission on a large scale from steam plant has, up to the present, made no substantial progress. The size of these generators varies from 100 to 200 kilowatts in small plant up to several thousand in the larger ones. The voltage of the generators varies greatly. When raising transformers are used, it is usually from 500 to 2000 volts; without them, the generators are usually wound for 10,000 or 12,000 volts. Intermediate voltages have sometimes been employed, but are rather passing out of use, as they seem to fulfil no particularly useful purpose. The tendency at the present time, whatever the voltage, is towards the use of machines with stationary armatures and revolving field magnets, or towards a pure inductor type having all its windings stationary. At moderate voltages such an arrangement is merely a matter of convenience, but in high-voltage generators it is practically a necessity. Low-voltage machines are usually provided with polyodontal windings, these windings having several separate armature teeth per pole per phase, while the high-voltage machines are generally monodontal; in both classes the edges of the pole pieces are usually chamfered away in such form as to produce at least a close approximation to the sinusoidal form for the electromotive force. For this purpose, and to obtain a better inherent regulation under variations of load, the field magnets are, or should be, particularly powerful. In the best modern generators the variation of electromotive force from no load to full load, non-inductive, is less than 10 per cent. at constant field excitation. Closeness of inherent regulation is an important matter in generators for transmission work, inasmuch as there is as yet no entirely successful method of automatic voltage regulation on very large units; and the less hand regulation the better. Moreover, the design which secures this result also tends to secure stability of wave form in the electromotive force, a matter of even greater importance. There has been much discussion as to the best wave form for use on alternating circuits, it having been conclusively shown that the sinusoidal wave does not give the most economical use of iron in the transformers. For transmission work, however, particularly over long lines, this is a matter of inconceivably small importance compared with the stability and the freedom from troubles from higher harmonics that result from the use of a wave as nearly sinusoidal as can possibly be obtained. In every alternating circuit the odd harmonics are considerably in evidence in the electromotive force, either produced by the structure of the generator or introduced by the transformers and other apparatus. These are of no particular moment in work upon a small scale, but in transmission on a large scale to long distances they are, as will be seen in the consideration of the transmission line itself, a serious menace, the gravity of which is just coming to be fully realized. Inasmuch as the periodicity of an alternating circuit must be maintained sensibly constant for successful operation, great care is usually exercised to secure such governing of the prime movers as will give constant speed at the generators. This can now be obtained, in all ordinary circumstances, by several forms of sensitive hydraulic governors which are now in use. The matter of absolute periodicity has not yet settled itself into any final form. American practice is based largely upon 60 cycles per second, which is probably as high a frequency as can be advantageously employed. Indeed, even this leads to some embarrassment in securing good motors of moderate rotative speed, and the tendency of the frequency is rather downward than upward. An inferior limit is set by the general desirability of operating incandescent lamps off the transmission circuits. For this purpose the frequency should be held above 30 cycles per second; below this point, flickering of the lamps becomes very serious —so serious, indeed, as practically to prohibit their successful use—and plant installed for such low frequencies is generally confined to motor practice, or to the use of rotary converters, which are somewhat easier to build in large units at low than at high periodicities. Nearly all the work of power transmission, however, is carried on between 30 and 60 cycles per second. The inferior limit at which it is possible to operate alternating arc lamps is about 40 cycles; and if these are to be and to remain an important feature in transmission systems, the indications are that practice will tend towards a periodicity of between 40 and 50 cycles per second, at which all the accessory apparatus can be successfully operated.

Transmission Lines.

Power transmission lines differ from those used for general electric distribution principally in the use of higher voltage and in the precautions entailed thereby. The economic principles of design are precisely the same here as elsewhere, save that the conductors vary less in diameter and far more in length. Inasmuch as transmission systems are frequently installed prior to the existence of a well-developed distribution system, the conditions of load and the market for the power transmitted can seldom be predicted accurately; consequently, the cases are very rare in which Kelvin's law can be applied with any advantage; and as it is at best confined to determining the most economical conditions at a particular epoch, this law is probably of less use in power transmission than in any other branch of electric distribution. A superior limit is set to the permissible loss of energy in the line by the difficulty attending regulation for constant potential in case the line loss is considerable. The inferior limit is usually set by the undesirability of too large an investment in copper, and lines are usually laid out from the standpoint of regulation rather than from any other. In ordinary practice, it seldom proves advantageous to allow more than 15 per cent. loss in the line even under extreme conditions, and the cases are few in which less than 5 per cent. loss is advisable. These few cases comprise those in which the demand for power notably overruns the supply as limited by the maximum power available at the generating station, and also the few cases in which a loss greater than 5 per cent. would indicate the use of a line wire too small from a mechanical standpoint. It is not advisable to attempt to construct long lines of wire smaller than No. 4 American wire-gauge (·204 inch diameter), although occasionally wire as small as No. 6 (·162 inch diameter) may safely be employed. The vast majority of transmission lines are composed of overhead conductors. In rare instances underground cables are used. In single-phase work these are preferably of concentric form, which, however, gets too complicated in the three-phase lines, generally employed to secure economy in copper; for the latter, triplicate cables lead sheathed, laid in glazed earthenware ducts, seem to give the best results. On account of the cost and the difficulty of repair of such lines, they are not extensively used, and cables have not yet been produced for the extremely high voltages desirable in some very long circuits. As to the material of the conductors, copper is almost universally used. For very long spans, however, bronze wire of high tensile strength is occasionally employed as a substitute for copper wire, and more rarely steel wire; aluminium too is beginning to come into use for general line work. Bronze of high tensile strength (say 80,000 to 100,000 ℔ per square inch) has unfortunately less than half the conductivity of copper; and unless spans of several hundred feet are to be attempted, it is better to use hard-drawn copper, which gives a tensile strength of from 60,000 to 65,000 ℔ to the square inch, with a reduction in conductivity of only from 3 to 4 per cent. As to aluminium, this metal has a tensile strength slightly less than that of annealed copper, a conductivity about 60 per cent. that of copper, and for equal conductivity is almost exactly one-half the weight. Mechanically, aluminium is somewhat inferior to copper, as its coefficient of expansion with temperature is 50 per cent. greater; and its elastic limit is very low, the metal tending to take a permanent set under comparatively light tension, and being seriously affected at about half its ultimate tensile strength. Joints in aluminium wire are difficult to make, since the methods of soldering amount to little more than cementing the metal with the flux; in practice the joints are purely mechanical, being usually made by means of tight-fitting sleeves forced into contact with the wire. With great caution in stringing, aluminium lines can be successfully used, and are likely to serve as a useful defence against increase in the price of copper. Overhead lines are most commonly strung upon wooden poles, set generally fifty to the mile; a pole forty feet long set seven feet in the earth is a favourite size in American practice. The conductors are systematically transposed, to suppress inductive disturbances; or if, as usually, they are worked three-phase, the three-wire system is often disposed at the vertices of an equilateral triangle, and the transposition is effected by spiraling the lines in cyclic order. The distance between wire and wire is usually from 18 to 24 inches—at extreme voltages, more. The insulators are of a rather large triple-petticoat design, of porcelain or glass: the former material, when thoroughly vitrified, has the greater mechanical strength, and is less likely to weather on the surface from protracted use, but glass insulators are more uniform in quality, less subject to inherent electric and mechanical defects, and moreover are materially cheaper.

Voltage.—The most important factor in the economy of the conducting system is the actual voltage used for the transmission. This varies within very wide limits. For transmissions only a few miles in length, the pressures employed are generally from 2000 to 5000 volts, but for the serious work of power transmission less than 10,000 volts are now seldom used. This pressure, under all ordinary conditions and in all ordinary climates, can be and is used with complete success, and apparently without any greater difficulty than would be encountered at much lower voltage. It is regarded as the standard transmission voltage in American practice for distances up to 20 or 25 miles. Beyond this, and sometimes even on shorter lines, it is greatly increased; up to 20,000 volts there seems to be no material difficulty whatever in effecting and maintaining a sufficient insulation of the line. Forty thousand volts is in successful use on two or three American transmission systems without any serious difficulty having been encountered. The longest transmission yet attempted commercially —that of 1000 kilowatts from Colgate, California, to Stockton, California, 218 miles (viâ Mission San Jose)—is at 40,000 volts, the line being three-phase at 60 cycles per second; and on this system there has been no more trouble in maintaining the insulation of the line than would be met in ordinary working at one-tenth the voltage in question. Above 40,000 volts the situation is complicated by a tendency towards breaking down of the air as a dielectric, and the establishment of serious leakage or even actual arcs between wire and wire. With a wave form very closely sinusoidal, transmission at 60,000 volts may be successfully accomplished; but small variations from a sinusoidal wave make themselves felt seriously, in an increase of the tendency to leaking and arcing. The lines become self-luminous at a little above 20,000 volts, and at 40,000 or 50,000 volts the phenomenon, which is often closely connected with *resonance*, becomes of a striking, not to say startling, character.

Resonance, in substance, is due to synchronism of the periodic electromotive force, or a harmonic thereof, with the electromagnetic time-constant of the system. The frequency of the currents actually employed in transmission work is so low that resonance with the fundamental frequency must be extremely rare; resonance with the harmonics is, however, common—much commoner than is generally supposed. In every electromotive force wave the odd harmonics are more or less in evidence, particularly the third, fifth, and seventh. If the electromotive force wave departs notably from a sinusoidal form, traces of harmonics up to at least the 15th may generally be found; the third, seventh, and the alternate higher harmonics are manifest in flattening the crest of the wave. Supposing, what is seldom quite true, that the harmonics are symmetrically disposed in phase with the fundamental, all the harmonics tend somewhat to elevate the shoulders of the wave; a wave, therefore, with peaked shoulders and a depression in the centre is certain to be affected by harmonics, while if it has a high central crest, there is evidence of great predominance of the fifth and higher harmonics. Generally the harmonics are slightly out of phase with the fundamental, so that the wave is both deformed and unsymmetrical. As to the amplitude of these harmonics, the third is usually the largest, and may sometimes in commercial machines amount to as much as 20 per cent. of the amplitude of the fundamental, and frequently 10 per cent. In machines giving nearly sinusoidal waves, it is of course much less, but it is not difficult to find even the seventh and higher harmonics producing variations as great as 5 per cent. Since, other things being equal, the rise in electromotive force due to resonance is directly proportional to the magnitude of the harmonics, and the chance of getting it increases rapidly with the presence of those of the higher orders, the desirability of using the closest possible approximation to a sinusoidal wave is self-evident. The greater the inductance and capacity of the system and the less its ohmic resistance, the greater the chance of getting serious resonance. As regards the distributed capacity and inductance due to the line alone, the ordinary conditions are not at all formidable; the general effect of such distributed capacity and inductance is to produce in the system a series of static waves, their length varying inversely with the frequency. At commercial frequencies the wave length is very great, so great that even in the longest lines at present employed only a small fraction of a single wave length appears; the total length of the line is generally less than one quarter the complete wave length, and the only notable effect is a rise of potential along the line. The time-constant of the alternating circuit is

$$T = \cdot 00629\sqrt{LC}$$

where L is the inductance in henrys and C the capacity in microfarads; and if the frequency, or a marked harmonic thereof, coincide with this time-period, resonance may safely be looked for, and resonance of the harmonics may appear conspicuously in lines of ordinary lengths. The following table gives the values, both L and C, per mile of line, of the sizes (American wire-gauge) ordinarily employed for transmission circuits, the wires being assumed to be strung 18 inches apart and about the height already indicated:—

Size No.	Diameter (inch).	L.	C.
0000	·460	1·48	·0102
000	·410	1·52	·0099
00	·365	1·56	·0097
0	·325	1·59	·0095
1	·289	1·63	·0093
2	·258	1·67	·0090
3	·229	1·71	·0088
4	·204	1·74	·0086
5	·182	1·78	·0084
6	·162	1·82	·0083

In cases where underground cables form a part of the system, the above values are likely to be very largely increased, and the probability of resonance is in proportion enhanced. A still further complication is introduced by the capacity and inductance of the apparatus used upon the system, which may often be far greater than that due to the entire line, even if the latter be of considerable length. In point of fact, it is altogether probable that resonance due to the distributed capacity and inductance of the overhead line alone is of rare occurrence and generally of trivial amount, while it is equally probable that resonance due to capacity and inductance other than that of the line conductors may, and often does, cause very serious disturbances upon the system. The subject has never been adequately investigated, but the tendency towards formidable sparking and arcing at various points on long-distance transmission systems is generally far greater than can be accounted for by consideration of the nominal voltages alone. The conditions may be still further complicated by the effect of earths or open circuits, which sometimes may produce, temporarily, appalling resonance phenomena, through bringing into action the capacity and inductance of the apparatus. In ordinary working the resonance of the harmonics is not very conspicuous, and the fact that it occurs not systematically, but only in special ways and under special conditions, indicates more strongly than anything else that the vital point is not the time-constant of the line alone, but those of the apparatus connected thereto. A definite and persistent tendency towards resonance may sometimes be effectively checked by the introduction of suitable inductance in the parts of the system most seriously affected, but the best general policy is to avoid as far as possible the presence of the higher harmonics which are the chief sources of danger.

Maintenance.—Generally speaking, a transmission line is rather less than more difficult to maintain than an equal amount of distribution system, for it generally encounters fewer sources of trouble. Transmission lines are, when practicable, laid out through open country, and along roads which furnish easy access for inspection and repairs. The chief sources of danger in temperate climates are mechanical injury from the falling of branches of trees across the circuits, sleet and wind storms, and lightning. The first-mentioned difficulty may be avoided by keeping clear, so far as possible, of wooded country, and it should be remembered that, at the voltages customarily used for transmission, a twig the size of a lead-pencil, falling across the wires, may set up arcing, and it will end by burning the wires completely off—not directly by fusion, but by persistent arcing. A properly constructed overhead line is practically safe against all storms, save those of most extraordinary violence, and with care may be made secure even against these. As a matter of practice, interruptions of service upon transmission systems are very rarely due to trouble upon the main line itself, but are far more likely to occur in some part of the distributing system. The most dangerous combination of circumstances is a sleet storm sufficient to coat the wires with ice, followed by heavy winds; if the line, however, is constructed with proper factors of safety, bearing this particular danger in mind, there need be very little fear of serious results. Lightning is a much more formidable enemy. The lightning discharges observed upon electric circuits are of two general descriptions:—first, a direct discharge of lightning upon the line, more or less severe, and always to be dreaded; and secondly, induced discharges due to lightning flashes which do not hit the line, or to static disturbances which may or may not produce actual lightning. Discharges of the former class are vastly more severe than those of the latter, and, fortunately, are somewhat rare. They may actually shatter the line, or may distribute themselves along it for a considerable distance, leaping from wire to pole, and thence to earth, without actually damaging the line to any marked degree. The induced discharges are felt principally in the apparatus, causing many of the burn-outs observed in transformers and generators. There is no complete protection against the effects of lightning upon the apparatus. The best lightning arresters are palliatives rather than preventives. If, however, a number of arresters are put in parallel, with reactance coils between them on the way towards the apparatus, the vast majority of lightning discharges, to whatever cause they may be due, will be deflected harmlessly to earth. Moreover, the apparatus itself has a considerable power of resistance, due to its high insulation. The ends of the line should be very thoroughly protected by such lightning arresters, and other points, such as prominent elevations along the line, should receive similar additional protection. In some cases a strand of barbed wire, stretched along the tops of the poles, and well grounded at frequent intervals, has been found very advantageous. With the best protection at present available, lightning is not a serious menace to continuity of service, and the apparatus of the distributing system is far more difficult to protect than the main line and its apparatus.

Sub-stations.—In most long-distance transmission work, the transmission line itself terminates in a sub-station, which bears to the general distribution system precisely the same relations which are borne by a central electric supply station to its distributing lines. Such a sub-station should be treated, in fact, as a central station, receiving its electric energy from a distance instead of employing local generators driven by prime movers. The design of the sub-station, however, is somewhat different from that of the ordinary central station. The transmission lines terminate generally in a bank of reducing transformers, bringing the voltage from the 10,000 or 20,000 employed upon the line to the 1000 or 2000 used in the distribution. These transformers are usually large, and their magnitude should be determined by the same considerations which apply to determining the size of the units to be employed in a generating station. The general rule to be followed is that the separate units shall be of such size that one of them may be dispensed with without serious inconvenience. In the case of transformers, the unit in two- or three-phase working is the bank of transformers which must be used together. In Continental practice three-phase reducing transformers are frequently made to include all three phases in a single structure; this practice is not followed in American plant, separate transformers being used in each phase. In this case, two or three transformers, according as the two- or three-phase system is used, constitute a single transformer unit in the sense just mentioned. If a change is to be made from three-phase line to two-phase distribution, the change is made by the appropriate vector connexion of the transformers. In any case, the sub-station is furnished with voltage regulating appliances, to enable the voltage upon the distribution lines to be held constant and uniform, just as in the case of central-station distribution. These regulators are, in practice, transformers with a variable transformation ratio. This is obtained in divers ways—sometimes by changing the inductive relations of the primary and secondary coils, sometimes by changing the relative number of effective turns in primary and secondary. Sets of these inductive regulators enable the voltage to be controlled over a sufficiently wide range to secure uniform potential on the system, and with a degree of delicacy that obviates any undesirable changes in voltage. The regulation is usually manual, no automatic regulator yet having proved entirely satisfactory. In very large systems, it is worth noting that the so-called "skin effect" in alternating current conductors may become conspicuous. In the transmission circuits themselves the wires are, in practice, never large enough to produce any sensible difference in conductivity for continuous and for alternating currents. In the heavy omnibus-bars of a large sub-station this immunity may not be continued, but in such cases flat strips are frequently employed. If these are not more than, say, a centimetre in thickness, the "skin effect" is practically insignificant for all frequencies used commercially. Not infrequently the sub-station also contains devices for the changing of alternating to continuous current, usually rotary converters feeding either traction systems or electric lighting mains. Beyond these rotary converters the system becomes an ordinary continuous-current system, and is treated as such. When very close regulation is necessary, motor-generators are often preferred to rotary converters. Arc lighting from transmission circuits is a much more serious problem. At the present time two methods are in vogue:—first, the operation of continuous-current series-arc machines by synchronous or induction motors driven from the transmission system; and, secondly, series alternating apparatus for feeding alternating arcs. This apparatus consists either of constant-current transformers with automatically moving secondaries, or of inductive regulators, also automatic in their action, supplemented by transformers to supply them with the necessarily rather high voltage employed for arc distribution. As between these two systems practice is at present divided; electrically, the alternating apparatus gives a rather higher real efficiency, but involves the use of alternating arcs, which are somewhat less efficient, watt for watt, as light producers than the continuous-current arcs. The apparatus, however, requires practically no care, while the arc machines, driven by motors, require the same amount of care as if they were driven by other power. Arc light transformers, however, are likely to have low power factors, hardly above ·8 at full load, and rapidly falling off at lower loads. Rectifiers changing the alternating current into a unidirectional current, suitable for use with arc lights, have been employed with some measure of success, but not to any considerable extent. They are, of course, satisfactory in avoiding the use of alternating currents in the arc, and consume but little energy in the transformation from one form of current to the other, but involve the use of static transformers automatically giving constant current, which are somewhat objectionable on the score of low power-factor.

Distances of Transmission.—Obviously the ultimate determining factor in the distance to which power can be commercially transmitted is the economic side of the transmission, the maximum distance being the maximum distance at which the transmission will pay. As a mere engineering feat, the transmission of power to a distance of several hundred miles is perfectly feasible, and, judging from the somewhat extensive data now available, the phenomena encountered in increasing the length of lines have not been of such character as to cause any hesitation in going still farther, provided the increase is commercially feasible. In American practice, it is within the truth to say that nearly all transmissions of reasonable size (say a few hundred kilowatts) to distances of twenty miles, or less, are pretty certain to pay. At distances up to fifty miles, in a large proportion of cases power can be delivered at prices which will enable it to compete with power locally generated by steam. From fifty to one hundred miles (on a large scale—several thousand kilowatts) the chances for commercial success are reasonably good. The larger the amount of power transmitted, the better on the whole is the commercial outlook. In rare instances transmissions of still greater length will prove feasible. The longest one yet operated (218 miles) has already been noted, and may be regarded as a commercial success. In attempting transmissions over far greater distances, one fact (sometimes forgotten) must be borne in mind—that the conditions which indicate profit may not persist. In certain localities where the cost of fuel is extremely high, transmissions of several hundred miles may prove successful from a commercial as well as an engineering standpoint, but the growth of industry, which indicates the necessity for such a transmission, may go on until, through improved facilities of transport, the cost of fuel may be greatly lowered and the economic conditions entirely changed. Such a modification of the conditions sometimes takes place much more quickly than would be anticipated at first sight, so that when very long distance transmissions, involving the locking up of large amounts of capital in apparatus and lines, are under consideration, the permanence of the conditions which will render them profitable should be a very serious subject of consideration. Cases may arise of transmissions over very long distances on an enormous scale to regions in which the fuel conditions may have already reached stability, and in these there may be assurance of a continued profitable market for power, but it is necessary to say that at the present time such instances seem to be extremely rare. As the world's coal supply is diminished, and industrial growth goes on, colossal transmissions of power from fuel beds and natural or artificial hydraulic sources, including the tides, may become an important factor in the world's work; but this state of things belongs to the future rather than to the present. (L. BL.)

II. HYDRAULIC.

The first proposal for a general transmission of hydraulic power was made by Bramah in 1802. In 1846, Lord Armstrong's hydraulic crane was erected at Newcastle, and was worked from the town water mains, but the pressure in such mains was too low and uncertain to secure satisfactory results. The invention of the accumulator in 1850 enabled much higher pressures to be used; since then 700 ℔ per square inch has been adopted in most private hydraulic power transmission plant. An attempt to give a public supply of hydraulic power was made in 1859, when a company was formed for laying mains in London along the river Thames between the Tower and Blackfriars, the engineer being Sir George Bruce; but though an Act of Parliament was obtained, the works were not carried out. The first public hydraulic supply station was established at Hull in 1877. In 1883 the General Hydraulic Power Works, Messrs Ellington and Woodall being the engineers, were started in London, and they now form the largest system of hydraulic power transmission in existence. Works of a similar character have since been established in several other towns. The general features of hydraulic power transmission are:—(1) a central station where the hydraulic pressure is created, usually by means of steam pumping engines; (2) a system of distribution mains; (3) machines for utilizing the pressure. In cases of public supplies there is the further important matter of registration. The theoretical principles involved belong to the subject of Hydromechanics, and this article has reference only to their practical application.

Central station.

When dealing with any practical problem of hydraulic power transmission, it is of the first importance to determine the maximum demand for power, its duration and frequency. If the duration of the maximum demand is limited and the frequency restricted—for instance, when a swing bridge has to be opened and closed only a few times in the course of a day—a small pumping plant and a large accumulator (see *Ency. Brit.*, 9th ed., vol. xii. p. 522) will be desirable. If the maximum demand is more or less continuous, as when hydraulic pressure is used for working a pump in a mine or a hydraulic engine in a workshop, the central station pumping engine must be capable of supplying the maximum demand without the aid of an accumulator, which may or may not, according to circumstances, be provided to serve as a regulator. The aim should be to employ a pumping engine of such capacity that it can be worked as nearly as possible continuously at its maximum output; the same consideration should, in the main, determine the size of the pumping units in a station where more than a single unit is employed. In most hydraulic power transmission plants the demand is of a very intermittent character, the periods of approximate maxima rarely exceeding in the aggregate two or three hours a day (cp. Fig. 2). With a number of units, each can be worked, when in use, at or near the most economical speed. Moreover, reserve plant is necessary if the supply of power is to be constant, and where the units are many the actual reserve required is less than where the units are few.

An effect of the multiplication of power units is to increase the capital outlay; indeed, it may be stated quite generally that economy in working and maintenance cannot be obtained without a larger capital outlay than would be required for a simpler and less economical plant. A high degree of economy estimated on financial data—the ultimate base on which these practical questions rest—can only be obtained in large installations where the averaging effect of the combination of a large number of comparatively small intermittent demands for power is greatest. The term *load-factor*, since it was first coined by Mr R. E. Crompton in 1891, has come into common use as an expression of the relation between the average and the maximum output from any central source of supply. No argument is required to show that a given central station plant working continuously at its maximum speed day and night all the year round, say for 8760 hours in a year, should produce the power more cheaply per unit, not only as to the actual running cost, but also as to the capital or interest charges, than the same plant running on the average at the same speed for, say, one-third the time, or 2920 hours. In this case the load-factor 2920/8760 = ·333, or 33·370 per cent. The saving on the whole expenditure per unit is not in direct proportion to an increase in the load-factor, and its effect on the various items of expenditure is extremely variable. The influence is greatest on the capital charges, and it has no influence at all, or may even have a detrimental effect, on some items; for instance, the cost of repairs per unit of output may be increased by a high load-factor. Its effect on the coal consumption depends very much on the kind and capacity of the boilers in use; on whether the engines are condensing or non-condensing; on the hours of work of the engine staff, &c. The economic value of the load-factor is of great importance in every installation, but its influence on the cost of supply varies at each central station, and must be separately determined. There is a load-factor peculiar to each use for which the power is supplied, and the whole load-factor can only be improved by the combination of different classes of demands, which differ in regard to the time of day or season at which they attaint heir maximum. It is in this respect that the great economy of a public distribution of power is most apparent, though there is also, of course, a direct economy due simply to the presumably large size of the central stations of a public supply. Demands for power of every kind have unfortunately a tendency to arise at the same time, so that in the absence of storage of power there seems no prospect of the load-factors for general supply of power in towns exceeding, in the most favourable conditions, 40 per cent. The load-factor of most public hydraulic power supplies is considerably under 30 per cent. It is questionable, however, whether a very high load-factor conduces to economy of working expenses as a whole in any general supply of energy. The more continuous the supply during the twenty-four hours of the day, the greater is the difficulty of executing repairs, and the greater the amount of the reserve plant required.

In all central station work where fluctuating loads have to be dealt with, it is most important that there should be ample boiler power. In a comprehensive system of power supply, demand arises in a very sudden and erratic manner, and to meet this by forcing the boilers involves greater waste of coal than keeping steam up in sufficient reserve boilers. For this purpose, boilers with large water capacity, such as the Lancashire, are preferable to the tubular type, if sufficient space is available. Feed water heaters or economizers should always be used, all steam and feed pipes should be carefully protected from radiation, and the pipe flanges should be covered; in short, to secure good results in coal consumption, every care must be taken to minimize the stand-by losses which are such serious items in central station economy when the load-factor is low. Though hydraulic power has the peculiar advantage, as regards coal consumption, that it is the speed of the engines which varies with an intermittent demand, nevertheless at the London stations it has been found that during a year's working only from 60 to 75 per cent. of the coal efficiency of trial runs of the engines can be obtained—*i.e.*, at least 25 per cent. of the coal is wasted through the stand-by losses and

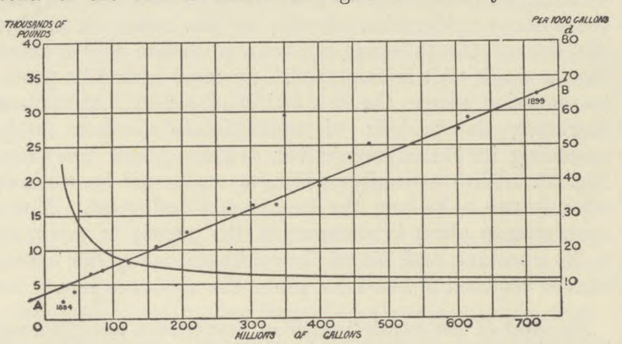

Fig. 1.

through the pumping engines having to run at less than full power. The use of superheated steam, which is now being introduced, will certainly lead to further economy.

To determine the scale on which a central station plant should be designed is frequently a difficult matter. The rate of growth of the expected demand for the power is an important factor, but it has been clearly established that the reduction of working expenses resulting from the increase of size of an undertaking proceeds in a diminishing ratio. The diagram (Fig. 1) of the costs of the London undertaking and the amount of power supplied shows this very clearly. The curve on the diagram gives the cost per 1000 gallons. The straight line A B has been drawn approximately as a mean through the points marking the total expenses of each year in relation to the output of power. This line cuts the boundary above the origin O at A, and indicates by the amount of the running expenses the initial size of the central station adopted in this case. Whether it is more economical to have several smaller stations, in any particular system of power transmission, or a single centre of supply, is mainly governed by the cost of the mains and the facilities for laying them in the area served. No general rule can, however, be formulated, for, as in many engineering problems, it is a question of balance of advantages, and the solution must be obtained by consideration of the special circumstances of each case as it arises.

There were in 1900 four central stations at work in connexion with the public supply of hydraulic power in London, having an aggregate of 4600 i.h.p.; a fifth station which had been begun at Rotherhithe would raise the horse-power to 6200. All the stations and mains are connected together and worked as one system. There are nine accumulators with a total capacity of 2600 gallons, most of them having rams 20 inches diameter by 23 feet stroke. The pumping engines are able together to deliver 7000 gallons

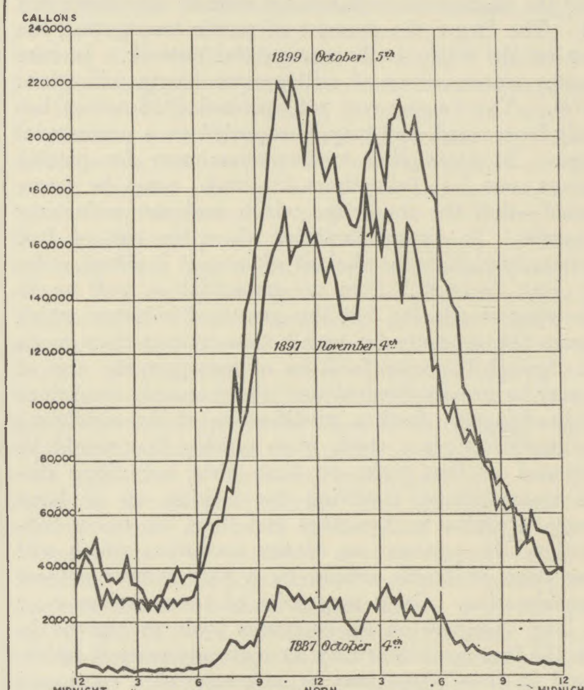

Fig. 2.

per minute, and the accumulators are principally of use in regulating the pressure and facilitating the control of the work of the stations. Details of the London supply are given in Fig. 2 and in the following table:—

Year.	Gallons pumped.	Annual Load-Factors.	Max. 24 hours Load-Factors.	Cost of Fuel per 1000 gallons.	Price of Fuel per ton in bunkers.	No. of Machines at work.	Miles of Mains.
				d.	s. d.		
1889	163,883,000	0·328	0·524	3·11	10 9	1022	38
1891	267,671,000	0·339	0·462	3·21	12 9	1503	53
1894	400,316,000	0·338	0·553	1·96	10 0	2204	73
1896	472,507,000	0·347	0·481	1·91	10 0	2796	89
1897	600,974,000	0·379	0·518	1·88	10 5	3141	98
1898	620,662,000	0·340	0·483	1·98	11 3	3515	109
1899	718,028,000	0·332	0·466	2·11	12 9	3964	118

The load-factors are calculated on the actual recorded maximum output, and not on the estimated capacity of the plant running or installed. The daily periods of maximum output are shown in Fig. 1. The very high load-factor in 1897 was due to special circumstances. The table shows that the load-factors have not been affected either by the increase of the area of supply or by the increased consumption of power. The coal used has been principally Durham small. The capital cost of the London undertaking has been about £650,000. In the central station at Wapping, erected in 1891, there are six sets of triple-expansion, surface-condensing vertical pumping engines of 200 i.h.p. each; six boilers with a working pressure of 150 ℔ per square inch, and two accumulators with rams 20 inches diameter by 23 feet stroke loaded up to 800 ℔ per square inch. The engines run at a maximum piston speed of 250 feet per minute, and the pumps are single-acting, driven directly from the piston rods. The supply given from this station in 1899 was approximately 6,000,000 gallons per week, and the cost for fuel, wages, superintendence, lighting, repairs, and sundry station expenses, 3½d. per 1000 gallons, the value of the coal used being 12s. 6d. per ton in bunkers. The capital cost of the station, including the land, was £70,000. The load-factor at this station for 1899 was ·39, and the supply was maintained for 163 hours per week. The conditions are exceptionally favourable, and the figures represent the best result that has hitherto been obtained in hydraulic power central station work.

The installation in Hull differs little from the numerous private plants at work on the docks and railways of the United Kingdom. The value of the experiment was chiefly commercial, and the large public hydraulic power works established since are to be directly attributed to the Hull undertaking. In Birmingham gas engines are employed to drive the pumps, but though the plant has recently been extended, the whole power available is only 250 h.p. In Liverpool the central station has five engines of 200 i.h.p. each, and a second station which is being erected is laid out for a further 1600 i.h.p. The working pressure in Liverpool is 850 ℔ per square inch. There are 23 miles of mains, and between 700 and 800 machines at work. In Manchester and Glasgow the pressure adopted is 1100 ℔ per square inch. In Manchester this pressure was selected principally in view of the large number of hydraulic packing presses used in the city, and the result has been altogether satisfactory. The works were established by the corporation in 1894, the central station being designed for 1200 i.h.p. Another station has since been built of equal capacity, and 3 to 4 million gallons per week are being supplied to work about 1400 machines. About 17 miles of mains are laid. In Geneva there is a distribution of hydraulic power at the moderate pressure of 200 ℔ per square inch, the pumps being driven by turbines which are worked by the water of the Rhône. 3000 h.p. is supplied to work 268 machines, principally turbines, at a cost of £3 per brake h.p. per annum for 3000 hours' work, and about half the total is used for creating electric current for lighting and traction. Public supplies of hydraulic power exist also in Melbourne and Sydney.

In Antwerp a regular system of high-pressure hydraulic power transmission was established in 1894, specially to provide electric light for the city. The scheme was due to the late Professor von Rysslеburgh, an electrical engineer of Ghent, who came to the conclusion that the most economical way of installing the electric light was to have a central hydraulic station, and from it transmit the power through pipes to various sub-stations in the town, where it could be converted by means of turbines and dynamos into electric energy. The coal cost of the electricity supplied —0·88d. per kw. hour—compares favourably with most central electric supply stations, although the efficiency of the turbines and dynamos used for the conversion does not exceed 40 per cent. Von Rysslеburgh argued that hydraulic pumping engines would be more economical than steam engines and dynamos, and that the loss in transmission from the central station to the consumer would be less with hydraulic converters than if the current were distributed directly. The loss in conversion, however, proved to be twice as great as had been anticipated, owing largely to defective apparatus and to under-estimation of the expense of maintaining the converting stations; and the net result was commercially unsatisfactory. The system, therefore, is not likely to be extended, but the facts regarding the coal consumption are a striking testimony to the great economy of hydraulic power transmission.

At Buenos Aires hydraulic mains are laid in the streets, not for a general power supply, but solely for drainage purposes. Each of the sumps, which are provided at intervals, contains two hydraulic pumps which automatically pump the sewage from a small section of the town into an outfall sewer at a higher level. The districts where this system is at work lie below the general drainage level of Buenos Aires. The average efficiency (pump h.p. to i.h.p.) is 41 per cent., which is high, having regard to the low heads against which the pumps work. In this application all the conditions are favourable to hydraulic power transmission. The work is intermittent, there is direct action of the hydraulic pressure in the machines, and the load at each stroke of the pumps is constant. The same system has been adopted for the drainage of Woking and district, and a somewhat similar installation is in use at Margate.

The minimum cost at which hydraulic power is supplied from the hydraulic mains in London at present is 1s. 6d. per 1000 gallons, made up approximately as follows:—

	s.	d.
Coal, wages, repairs, &c., at central station .	0	3½
Distribution and general charges . . .	0	2½
Rates and interest on capital at 6 per cent. .	1	0
	1	6

The average cost is much higher (cp. Fig. 2). In 1000 gallons at 750 ℔ per square inch there is an energy of $\frac{10,000 \times 1730}{33,000 \times 60}$ $= 8{\cdot}74$ horse power hours; thus 1s. 6d. per 1000 gallons $= 2$d. per h.p. hour nearly. It is evident that the capital charge is the dominating factor, and that the influence of the load-factor on this charge is far more important than it is on the station cost. The capital employed in building and equipping the central stations bears a nearly fixed ratio to the supply, but the relative cost of mains may be expected to decrease as the supply is augmented. It does not, however, appear probable that hydraulic power at 750 ℔ per square inch can be supplied from central stations in towns on a commercial basis over any considerable areas at less than 1s. per 1000 gallons. Allowing 75 per cent. as the efficiency of the motor through which the power is utilized, this rate would give 1·83d. per brake or effective h.p. hour. This cost seems high, and it is difficult to believe that it is the best hydraulic power transmission can accomplish, having regard to the well-established fact that the mechanical efficiency of a steam pumping engine is greater than any other application of a steam engine, and that the power can be conveyed through mains without any material loss for considerable distances. Still no other system of power transmission except gas seems to be better off, and there is no method of transmission by which power could, at the present time, be supplied in towns with commercial success at such an average rate when steam is employed as the prime mover. The average rate (2s. 6d. to 3s. per 1000 gallons) charged for hydraulic power in London and other towns agrees, in fact, very closely with the average rate charged for the supply of electrical energy. Gas is undoubtedly cheaper, but in a large number of cases is mechanically inconvenient in its application. Hydraulic pressure, electrical energy, and compressed air (with reheating) can all be transmitted throughout towns with approximately the same losses and at the same cost, because the power is obtained in each system from coal, boilers, and steam engines, and the actual loss in transmission can be kept down to a small percentage. The use of any particular system of power does not, however, primarily depend upon the cost of running the central station and distributing the power, but mainly upon the mechanical convenience of the system for the purpose to which it is applied. One form of energy is, in practice, found most useful for one purpose, another form for another, and no one can command the whole field.

Cost of power.

When water is employed as the fluid in hydraulic transmission, the effects of frost must usually be provided against. In London and other towns, the water, before being pumped into the mains, is passed through the surface condensers of the engines, so as to raise its temperature. The mains are laid 3 feet below the surface of the ground. Exposed pipes and cylinders are clothed, and means provided for draining them when out of use. When these simple precautions are adopted, damage from frost is very rare. In special cases oil having a low freezing point is used, and in small plants good results have been obtained by mixing glycerine and methylated spirit with the water.

Precautions against frost.

A few gas jets judiciously distributed are of value where there is a difficulty in properly protecting the machinery by clothing.

From the central station the hydraulic power must be transmitted through a system of mains to the various points at which it is to be used. In laying out a network of mains, it is first necessary to determine what velocity of flow can be allowed.

Distribution.

Owing to the weight of water, the medium usually employed for hydraulic transmission, a low velocity is necessary in order to avoid shocks. The loss of pressure due to the velocity is independent of the actual pressure employed, and at moderate velocities of 3 to 4 feet per second the loss per 1000 yards is almost a negligible quantity at a pressure of 700 ℔ per square inch. For practical purposes Box's formula is sufficiently accurate—

$$\text{Loss of head} = \frac{\text{gallons}^2 \times \text{length in yards}}{(\text{diameter of pipes in inches} \times 3)^5}.$$

There is a further loss due to obstruction caused by valves and bends, but it has been found in London that a pressure of 750 ℔ at the central accumulators is sufficient to ensure a pressure of 700 ℔ throughout the system. The greatest distance the power is conveyed from the central stations in London is about 4 miles. The higher the initial velocity, the more variable the pressure; and in order to avoid this variation in any large system of mains, it is usual to place additional accumulators at a distance from the central station. These have an important effect in maintaining regularity of pressure, as local demands are, in the first instance, supplied from them; and they act in the same way as air-vessels, giving the whole system an elasticity which would hardly be expected with such an inelastic substance as water. The largest pipes used in London are 7 inches internal diameter. In one or two places elsewhere 8-inch pipes have been used, and in Antwerp the pipes are nearly 12-inch bore. In the last case they are of steel, but as a rule the large pipes are of cast-iron, flanged, and provided with spigots and faucets. The joint (Fig. 3) is

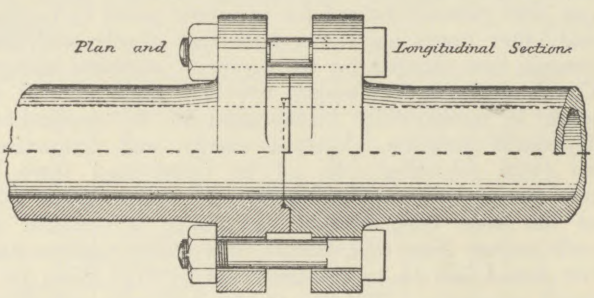

Fig. 3.

made with a gutta-percha ring, though sometimes asbestos and leather packing rings are used. The mains should be laid in circuit, and valves placed at intervals, so that any section can be isolated for repairs or for making connexions without affecting the supply at other points. The main valves adopted in London are shown in Fig. 4. Valves are also fixed to control all branch pipes, while relief valves, washouts, and air valves are fixed as required.

In public supplies the power used is in all cases registered by meters, and since 1887 automatic instruments have been used at the central stations to record the amount supplied at each instant during the day and night. The ratio between the power registered at the consumers' machines and the power sent into the mains is the commercial efficiency of the whole system. The loss may be due to leakage from the mains or to defects in the meters; or if, as is often the case, the exhaust from the machines is registered, to waste on the consumers' premises. The automatic recorders give the maximum and minimum supplies during 24 hours every day, the maximum record showing the power required for a given

Registration.

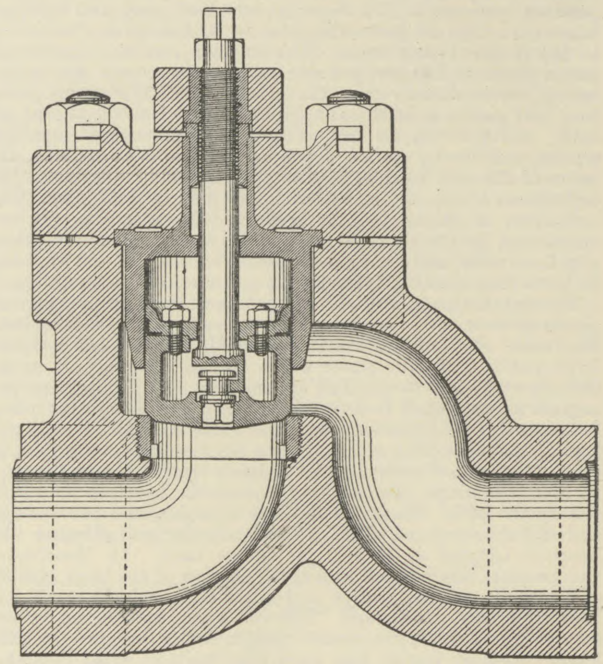

Fig. 4.

number and capacity of machines, and the minimum giving an indication of the leakage. It has been found practicable to obtain an efficiency of 95 per cent. in most public power transmission plants over a series of years, but great care and watchfulness are required to produce so good a result. In some years 98 per cent. has been registered. Up to a few years ago no meter was available for registering so high a pressure as 700 ℔ per square inch, and hence all that could be done was to register the water after it had passed through the machines and lost its pressure. This method is still largely adopted; but seeing that high-pressure meters have lately been perfected to give excellent results, it will doubtless be superseded to a considerable extent by the more satisfactory arrangement of registering the power on its entry into the consumers' premises, as is done with gas, water, and electricity. In Manchester Kent's high-pressure meters are now used exclusively. The water, after the pressure has been eliminated by passage through the machines, may run to a drain or be led back to the central station in return mains; the method adopted is a question of relative cost and convenience.

The subject of the transmission of hydraulic power cannot be regarded as in any way complete without reference to the machines which are actuated by it, for it is only by a comparison of the useful work done by them with the work done by the engines and boilers at the central station that the mechanical efficiency of the system as a whole can be gauged. At the central station and in the distribution there is no great difficulty in determining the efficiency within narrow limits; it should be 80 per cent. at the point of entry to the machine in which the pressure is used. But there a great uncertainty arises; the character of the machines and the nature of the conditions are so variable, that a really accurate general statement is impossible. In most cases the losses in the machine are constant for a given size and speed of working; consequently, the efficiency of a given machine may vary within very wide limits, according to the work it has to do. For instance, a hydraulic pump of a given

Machinery.

capacity, delivering the water to an elevation of 100 feet, will have an efficiency of 80 per cent.; but if the elevation of discharge is reduced to 15 feet, even though the hydraulic-pressure rams may be proportioned to the reduced head, the efficiency falls below 50 per cent. The ultimate efficiency of the system, or $\frac{\text{pump h.p.}}{\text{i.h.p.}}$, in the one case is 64 per cent., and in the other under 40 per cent. In crane or lift work the efficiency varies with the size of the apparatus, with the load, and with the speed. Efficiency in this sense is a most uncertain guide. Some of the most useful and successful applications of hydraulic power—as, for instance, hydraulic capstans for hauling waggons in railway goods yards—have a very low efficiency expressed on the ratio of work done to power expended. Hydraulic cranes for coal or grain hoisting have a high efficiency when well designed, but it is now very usual to employ grabs to save the labour of filling the buckets, and their use lowers the efficiency, expressed in tons of coal or grain raised, by 33 per cent. or even 50 per cent. When hydraulic machines are fully loaded, 50 per cent. to 60 per cent. of the indicated power of the central station engine is often utilized in useful work done within a radius of two or three miles from the station. In very favourable circumstances the efficiency may rise to over 70 per cent., and in a great many cases in practice it no doubt falls below 25 per cent. If, however, energy in any form can be obtained ready for use at a moderate rate, the actual efficiency of the machines (*i.e.*, the ratio of the useful work done to the energy absorbed in the process) is not of very great importance where the use is intermittent.

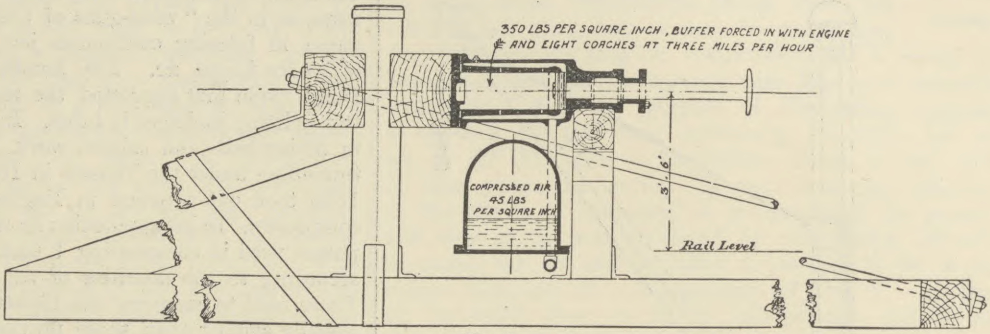

Fig. 5.

Hydraulic pressure is more particularly advantageous in cases where the incompressibility of the fluid employed can be utilized, as in hydraulic lifts, cranes, and presses. Hydraulic machines for these purposes have the peculiar and distinct advantage of direct action of the pressure on the moving rams, resulting in simplicity of construction, slow and steady movement of the working parts, absence of mechanical brakes, and greatest safety in action. When the valve regulating the admission of the pressure to the hydraulic cylinder is closed, the water is shut in, and, as it is incompressible, the machine is locked. Thus all hydraulic machines possess an inherent brake; indeed, many of them are used solely as brakes, so important is this property of fluids. The buffer-stop to be seen in terminal railway stations, and the hydraulic brakes of quick-firing guns, are examples. Mr F. W. Webb's buffer-stop is shown in Fig. 5.

Sometimes a much higher pressure than 700 ℔ or 1000 ℔ per square inch is desirable, more particularly for heavy presses and for machine tools such as are used for riveting and for punching, shearing, bending, drawing, and stamping metal. The development of these applications of hydraulic pressure has been largely due to the very complete machinery invented and perfected by the late Mr R. H. Tweddell. One of the principal installations of this kind was erected in 1876 at Toulon dockyard, where the machines are all connected with a system of mains of 2½-inch bore and about 1700 yards long, laid throughout the yard, and kept charged at a pressure of 1500 ℔ per square inch by engines of 100 h.p. with two large accumulators. M. Marc Berrier-Fontaine, the superintending engineer of the dockyard, has stated that the economy of the system over the separately-driven geared machines formerly used is very great. But while pressures so high as 3 tons per square inch (as in the 12,000-ton Armstrong-Whitworth press) have been used for forging and other presses, it is not desirable, in the distribution of hydraulic power for general purposes, that 1000 ℔ per square inch should be much exceeded; otherwise the rams, which form the principal feature in nearly all hydraulic machines, if proportioned to the work required, will often become inconveniently small, and other mechanical difficulties will arise. The cost of the machinery also tends to become greater. In particular cases the working pressure can be increased to any desired extent by means of an intensifier (Fig. 6).

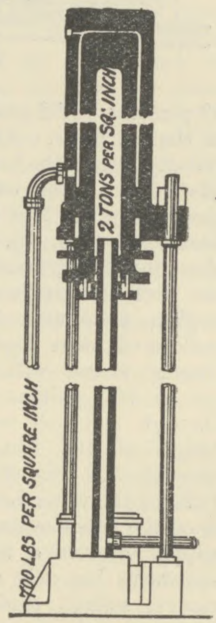

Fig. 6.

An important application of hydraulic power transmission is for ship work, the system being largely adopted both in H.M. navy and for merchant vessels. Hydraulic coal-discharging machinery was fitted by Armstrong as early as 1854 on board a small steamer, and in 1868 some hopper barges on the Tyne were supplied with hydraulic cranes. Mr A. Betts Brown of Edinburgh applied hydraulic power to ship work in 1873, and in the same year the first use of this power for gunnery work was effected by Mr G. M. Rendel on H.M.S. *Thunderer*. In 1883 the P. and O. steamer *Massilia* was fitted with hydraulic cranes, and since then all the large P. and O. boats have been supplied with hydraulic power (Fig. 7). The pressure usually employed in H.M. navy is 1000 ℔ per square inch. Accumulators are not used, and the engines have to be fully equal to supply directly the whole demand. The distance through which the power has to be transmitted is of course very short, and the high velocity of 20 feet per second is allowed in the main pipes. The maximum engine-power required under these conditions on the larger ships is very considerable. In the case of H.M.S. *Royal Sovereign* the pumping engines are capable of delivering 1340 gallons per minute.

In hydraulic transmission of power it is usually the pressure which is employed, but there are one or two important cases in which the velocity of flow due to the pressure is utilized in the machine. Reference has already been made to the use of turbines working at 750 ℔ per square inch at Antwerp. The Pelton wheel has also been found to be admirably adapted for use with such high pressures; in converting hydraulic power into electric by means of this device and a dynamo, the losses vary from

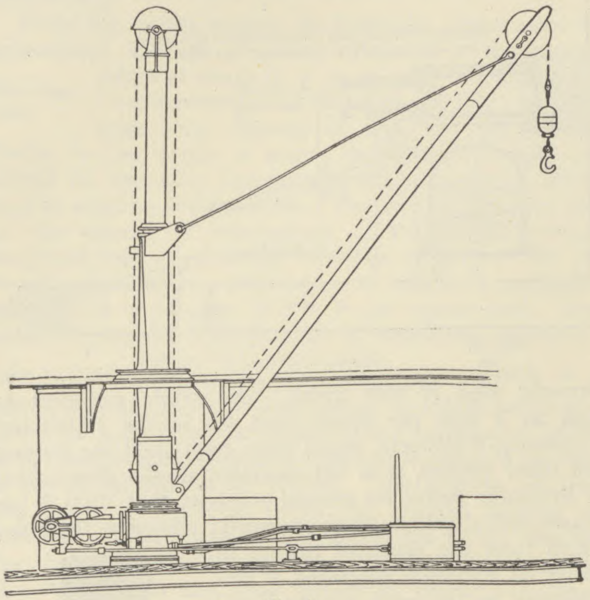

Fig. 7.

33 per cent. to 50 per cent., depending mainly on the sizes of the machines. Another very useful application of the velocity due to the head in hydraulic transmission is in an adaptation of the well-known jet pump to fire hydrants devised by the late Mr J. H. Greathead (Fig. 8). One of these injector hydrants will do the work of a single steam fire engine, and, with 30 to 40 gallons of water from the hydraulic mains, will deliver a jet of 150 gallons of water through a 1-inch nozzle to a height of 100 feet or more through 200 feet of hose, the bulk of the water being drawn from the low-pressure domestic supply or from a tank. The apparatus has only a low efficiency, seldom exceeding 25 per cent. At the present time there are about 120 of these hydrants at work from the mains in London.

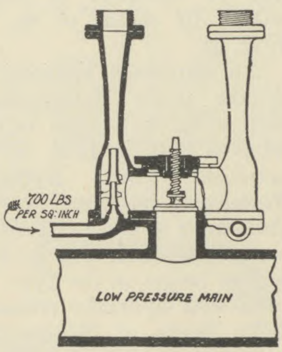

Fig. 8.

Improvements in hydraulic machinery since 1875 have been mainly in the direction of the perfecting of details, and in the adaptation of older and well-known apparatus to new requirements; but though many of these improvements have been of a highly interesting and important character, it would be outside the scope of this article to make further reference to them.

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(E. B. E.)

III. PNEUMATIC.

Probably the earliest recorded air-compressor is that found on the walls of a tomb in Egypt, in which two men standing on leather bags of air alternately press them down with their feet, to produce a blast for a furnace. The ancients employed compressed air in various ways, as in the "wind-guns of Ctesibus" (blow-guns), in forming continuous jets for their fountains, in blasts for forges, &c. Two hundred years ago, in France, Denis Papin first suggested the use of compressed air for transmitting packages in tubes. In later times it was used in diving-bells and caisson work, Brunel employing it in tunnelling under the Thames in 1825. William Mann in 1829 took out a patent in England for a compound air-compressor. In his application he states: "The condensing-pumps used in compressing I make of different capacities, according to the densities of the fluid to be compressed. Those used to compress the higher densities being proportionally smaller than those previously used to compress it at the first or lower densities," &c. This is a very exact description of the best methods of compressing air to-day, omitting the important intercooling. Baron Van Rathen in 1849 proposed compressing air in stages, and using intercoolers between each stage to get 750 lb pressure, for use in locomotives. For the next forty years inventors and engineers tried without success all manner of devices and complicated mechanism for cooling air during compression by the use of water, either injected into the cylinder or circulated around it, and finally, with few exceptions, settled down to direct compression with no cooling worthy of mention. Only in the last ten years of the 19th century were the fundamental principles of economical air-compression put into general practice, though all of them are contained in the patent of William Mann and the suggestion of Van Rathen.

History.

The first successful application of compressed air to the transmission of power as we know it, was at the Mont Cenis Tunnel in 1861. The form of compressor used was a system of water-rams—several of them in succession—in which the water was the piston, compressing the air upwards in the cylinder and forcing it out. Although the air came in contact with the water, it was not cooled, except slightly at the surface of the water and around the walls of the cylinders. Rotary drills for penetrating the rock were tried first, but were soon replaced by a percussion drill adapted from drawings in the United States Patent Office, copied by a French and Italian Commission from the patent of Fowle of Philadelphia. Drinker states positively that the first percussion drill ever made to work successfully was patented by J. J. Couch of Philadelphia in 1849. Shortly afterwards Fowle patented his drill, in which the direct-acting and self-rotating principle was used as we use it now. The first successful drill in the Hoosac Tunnel was patented 6th March 1866, by Brooks, Gates, and Burleigh, but after a few months was replaced by one made by Burleigh, who had bought Fowle's patent and improved it. The successful work in the Mont Cenis and Hoosac Tunnels with the percussion drilling machine caused the use of compressed air to spread rapidly, and it was soon found that there were many other purposes for which it could be employed with advantage, especially after economical compression was adopted. About 1870 there was started in Paris a pneumatic clock system, by which public and private clocks were run by compressed air from a central station. This soon developed into an immense system of distributing compressed air for power purposes, until Paris now has two great compressor plants and more than fifty miles of distributing pipes, furnishing air at 75 lb pressure to thousands of customers, who use it for every imaginable purpose, from cooling beer or dusting furniture to running electric light dynamos. The smaller motors are often of the rotary type and are not very efficient, though each has its little stove in which is a common kerosene lamp to heat the air before use. Compressed air is being largely and successfully introduced on tramways, in competition with electric and wire-rope traction systems. It was first tried in 1875 by Scott-Moncrieff, but failed owing to financial difficulties. Hardie, who was an assistant under him, made a success of it, and his system is now working on a very large scale in New York. The reheating is done with a tank of hot water. Mekarski uses hot water and steam. In his system, which was tried on tramways in the north of London, and is largely used in France, the air, under a high pressure, is passed over water at a temperature of 330° F., forming a combination of air and steam for use in the motor. For underground traction compressed air has been introduced in the coal mines of the Eastern states of America, and also to some extent in the metal mines of the West, but the difficulty of heating underground has not been overcome, though it might be, partially, by using compound engines and warming the air between the cylinders by the mine water, as in compound pumps.

Dr Pohle of Arizona, U.S.A., has patented and introduced extensively since 1890 the use of compressed air for lifting water directly, by admitting it into the water column. His plan is principally adopted in artesian wells, and is so arranged that the air-supply has a back pressure of water equal to half the lift. In the case of the artesian well, if it is desired to lift the water 30 feet, the air is admitted to the water column at least 30 feet below the water surface. The air admitted being so much lighter than the water it displaces, the column 60 feet high becomes lighter than that 30 feet high, and is constantly raised and flows out at the top. The efficiency of this method is only from 20 to 60 per cent., according to the height, but its adaptation to artesian wells renders it very valuable in some localities.

A remarkable compressed-air system was installed in 1890 by Priestly in the Snake River Desert, Idaho, U.S.A. On the north side of the river is a cliff, nearly perpendicular, about 300 feet high. One hundred and ninety feet above the river, for a considerable distance along the cliff, streams of water gush out from between the bottom of the great lava bed and the hardened clay of the old lake bottom. Priestly, without knowledge of Pohle's system, built a pipe line down the cliff, and trained the water into it in such a way that it carried a very considerable quantity of air in the form of bubbles along with it down the pipe, and compressed it on the way. The air was collected at the bottom in a covered reservoir, and taken up the cliff again to the lower part of an inverted siphon pipe, one side of which reached down from the water-supply about 60 feet, and the other side reached up and over the cliff. Allowing the water to fill both sides of the pipe to the level of the water-supply, he admitted his compressed air at about 75 ℔ pressure into the long side of the pipe near the bottom, and soon had the water flowing upwards over the cliff and irrigating a large tract of rich lava land. Here, then, was a power transmission and motor plant, without a moving part. A similar compressor was installed near Montreal, Canada, in 1896 (and patented), and another larger one at Ainsworth, British Columbia, Canada, in 1898, by the Taylor Hydraulic Air Compressing Co. of Montreal. Tests on the first compressor showed an efficiency of from 50 to 62 per cent., and it is thought that a few obvious improvements would bring the second one up to 75 per cent.

Saunders defines compressed air as "air under pressure." "It is usual," he continues, "to define compressed air as air increased in density by pressure, but we may produce compressed air by heat alone, as illustrated by the discharge of the cork from a bottle of air when heated." The laws of compression and expansion of gases may be found under PNEUMATICS (*Ency. Brit.*, 9th edition, vol. xix.), but it may be stated here that air develops heat on compression and is cooled on expansion, and that it expands with heat and contracts with cold. For the purpose of illustration, suppose a cylinder 10 feet long containing 10 cubic feet of air at 60° F., with a frictionless piston at one end. If this piston be moved $7\frac{1}{2}$ feet into the cylinder, so that the air is compressed to one-quarter of its volume, and none of the heat developed by compression allowed to escape, the air will be under a pressure of 90 ℔ per square inch and at a temperature of 460° F. If this air be cooled down to 60° F., the pressure will be reduced to 45 ℔ per square inch, showing that the heat produced in the air itself during compression gives it an additional expansive force of 45 ℔ per square inch. The average force or pressure in compressing this air without loss of heat is 21 ℔ per square inch, whereas if all the heat developed during compression had been removed as rapidly as developed, the average pressure on the piston would have been only 11 ℔ per square inch, showing that the heat developed in the air during compression, when not removed as fast as developed, caused in this case an extra force of 10 ℔ per square inch to be used on the piston. If this heated air could be transmitted and used without any loss of heat, the extra force used in compressing it could be utilized; but in practice this is impossible, as the heat is lost in transmission. If the piston holding the $2\frac{1}{2}$ cubic feet of air at 45 ℔ pressure per square inch and at 60° F. be released, the air expanding without receiving any heat would move it back to within $3\frac{1}{3}$ feet of the end only, and the temperature of the air would be lowered 170° F., or 110° F. below zero. If the air were then warmed to 60° F. again, it would move the piston back the remaining $3\frac{1}{3}$ feet to its starting-point, thus showing that air in expansion becomes cooled in the same manner as in compression it develops heat.

Theory.

From the foregoing it may be seen that the ideal air-compressing machine is one which will take all heat from the air as rapidly as it is developed during compression. This is called *Isothermal Compression*, and is never reached in practice, the best work yet done lacking 10 per cent. of it. It follows that the most inefficient compressing machine is one which takes away no heat during compression. This is called *Adiabatic Compression*, and in practice has been much more nearly approached than the ideal. It also follows that the ideal motor for using compressed air is one which will supply heat to the air as it is required in expanding. This is called *Isothermal Expansion*, and is often attained, and sometimes exceeded, in practice by supplying heat artificially. Finally, the most inefficient motor for using compressed air is one which supplies no heat to the air during its expansion. This is called *Adiabatic Expansion*, and has been very closely approached by most air motors until recent years. In practice isothermal compression is approached by compressing the air slightly, then cooling it, compressing it slightly again and again cooling it, until the desired compression is completed. This is called compression in stages, or compound compression. Isothermal expansion is approximately accomplished by allowing the air to do a part of its work (as expanding slightly in a cylinder) and then warming it, then allowing it to do a little more and then warming it again, and so continuing until expansion is complete.

A description of the actual performance may make the matter clearer. At the North Star Mines, in California, air is compressed by an ordinary pressure blower to about 5 lb pressure per square inch, its temperature rising from 60° to 100° F. It is then cooled again to 60° F. by a system of cooling-pipes placed in the tail-race of the water-wheel that runs the blower; then it is taken to the first cylinders of the compressor and compressed to 25 lb, its temperature being thus raised to nearly 200° F.; then it is passed through a system of cooling-pipes placed in the tail-race of the water-wheel that runs the compressor, and its temperature again reduced to 60° F.; thence it is passed to the second cylinders and compressed to 90 lb, and delivered to the transmission pipes conveying it to the mines. On reaching the motors at the mines, in some cases nearly 2 miles distant, the temperature, which had been raised by the last compression to over 200° F., has been reduced to about 70° F. Here, for the principal motors, the air, by being passed through a system of pipes heated by burning crude oil, has its temperature raised to 350° F., and is then taken by the first cylinder of the motor, where it is expanded down to 25 lb pressure per square inch and reduced to 75° temperature. It is then taken to the heater again, and after its temperature has been raised to 250° F., it is used in the second cylinders and exhausted at a temperature somewhat above that of the surrounding air.

Practice.

It will be seen that the air is carefully cooled during compression to prevent the heat it develops from working against compression, and even more carefully heated during expansion to prevent loss from the cold developed during expansion. More stages of compression, of course, give a higher efficiency, but the cost of machinery and friction losses have to be considered in practice. The reheating of the air is often considered a serious disadvantage, especially in mining, where there are great objections to having any kind of combustion underground. In the foregoing instance only one gallon of crude oil per hour is required to heat to 350° F. the air for a 300 horse-power hoisting engine. As Professor Unwin says: "For the amount of heat supplied the economy realized in the weight of air used is surprising. The reason for this is, the heat supplied to the air is used nearly five times as efficiently as an equal amount of heat employed in generating steam." Practically there is a hot-air engine, using a medium much more effective than common air, in addition to a compressed-air engine, making the efficiency of the whole system extremely high, probably over 90 per cent.

For underground work Rix has employed compound or triple expansion motors on pumps, using the pump-water in the tank as a reheater. The air enters the first cylinder at the normal temperature of the mine, the exhaust passes from that cylinder into a system of circulating pipes placed in the pump-tank, which warms the chilled air up to the temperature of the water; thence the air passes to the second cylinder, does its work there, and is again sent into a second system of circulating pipes in the tank, where it is again warmed to the temperature of the water; then it is used in the third cylinder, and exhausted. In this manner the heat that is lost in compressing the air is recovered without expense. This method has proved very successful, and as the heat costs absolutely nothing, it makes the system very economical. On account of the very considerable amount of heat taken from the water, the efficiency is high. A similar arrangement might be employed wherever there is cheap circulating water on the surface, to avoid any difficulty or complications arising from the use of fuel.

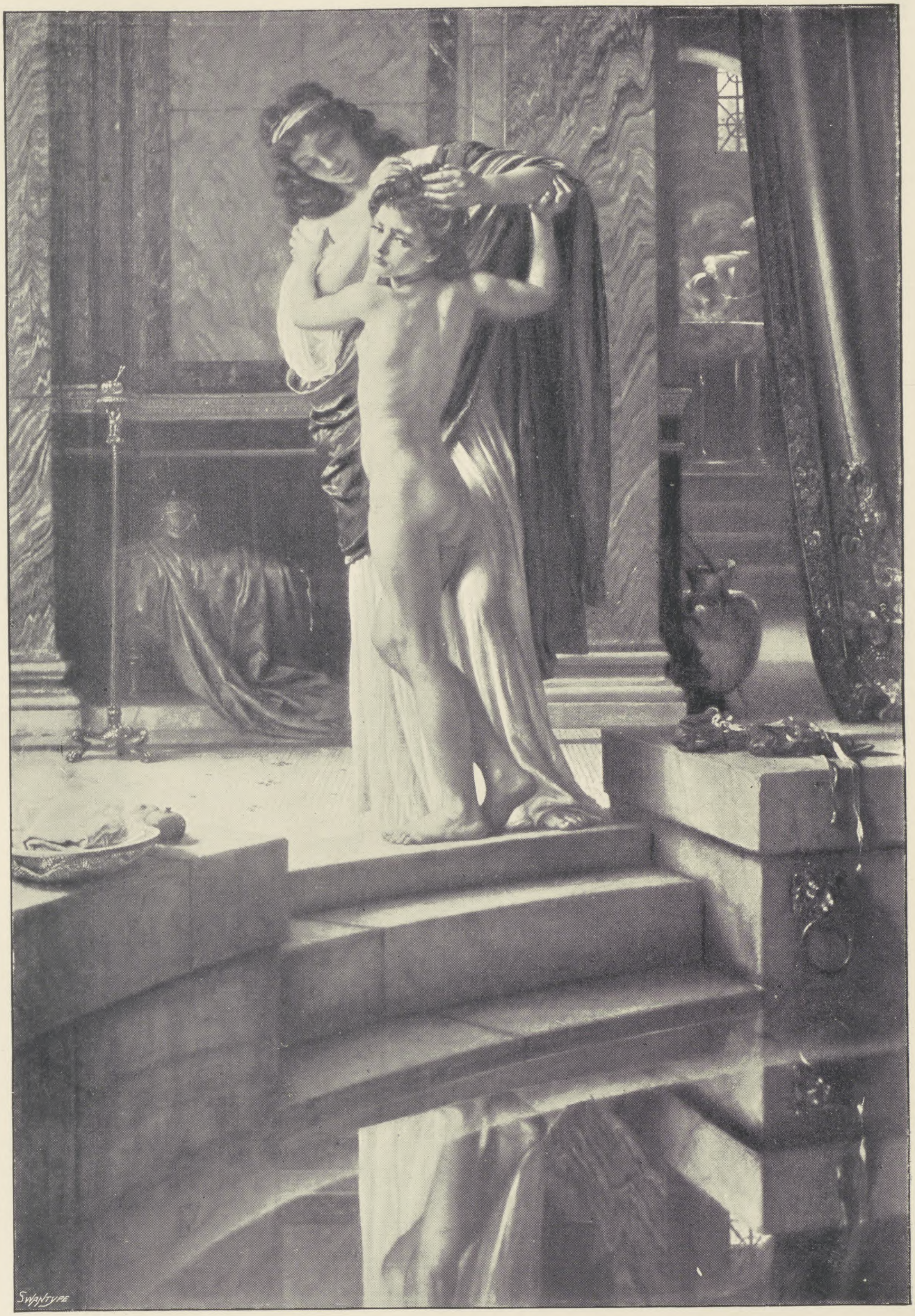
The use of compressed air without reheating should never be considered practical except in temporary emergencies, or where the cold exhausted air is of value, as is sometimes the case in sinking pumps or rock drills. An efficiency of less than 25 per cent. may be expected in such cases, where the motors are what might be called piston-displacement machines; that is, the compressed air is admitted at one end of the cylinder and moves the piston the length of the stroke at full pressure, and discharges without getting anything of the expansive force of the air. There are a great many of this class of motors in use.

The transmission of air from the compressor to the motor is much more simple and effective than is usually supposed. The air admits of a velocity of 15 to 20 feet per second through pipes, with very slight loss of friction, and therefore there is no necessity for an expensive pipe system in proportion to the power transmitted. It is found in practice that, allowing a velocity as given above, there is no noticeable difference in pressure between the compressor and the motor several miles away. Common oil well-tubing is largely used for the pipes, and if it is properly put in there is very slight loss from leakage, which, moreover, can be easily detected and stopped. In practice, a sponge with soap-suds, passed around a joint, furnishes a detective agency, the escaping air blowing soap-bubbles. In good practice there need not be more than 1 per cent. loss through leakage, and 1 per cent. possibly through friction, in the transmission of air. (See also PNEUMATIC TOOLS.) (A. DE W. F.)

Poynter, Sir Edward John, BART. (1836–——), President of the Royal Academy and Director of the National Gallery, son of Ambrose Poynter, architect, was born in Paris on 20th March 1836. He pursued his art studies in England and in Paris (under Gleyre, 1856–59), and exhibited his first picture at the Royal Academy in 1861. In 1869, after the exhibition of "Israel in Egypt" and "The Catapult," he was elected an Associate of the Royal Academy, and in 1876, the year of "Atalanta's Race," full Academician. From the beginning of his career Sir Edward Poynter was academical in his art—that is to say, he sought to base it on a profound and reverent study of the old masters, more particularly those of Italy. It has been objected, with much truth, that with all their learning and evidence of power, the greater number of his more important pictures display violent action which is not real so much as arrested movement. The true answer is not, as some have held, that this is the price paid for conscientious and deeply-studied drawing and complex composition laboriously overcome. It is that the artist's aim has been essentially decorative, and that by concession to the laws of decoration some sacrifice of realism and spontaneity is required. On the death of Sir John Millais in 1896, Sir Edward was elected to the Presidency of the Royal Academy—and to all the semi-official posts and duties, professional and social, it carries with it—and on that occasion he received his knighthood. He was made a baronet in 1902.

When the art teaching centre of South Kensington was assuming the importance it has since attained, Mr Poynter was appointed Director for Art in the Science and Art Department, and Principal of the National Art Training Schools (now the Royal College of Art), and by virtue of his vigorous and successful administration he invested his office with a distinction which, after his resignation in 1881, it soon notoriously lacked.

In the decorative arts Sir Edward practised freely as a designer in fresco, mosaic, stained glass, pottery, tile-work, and the like. While still quite a young man, he was encouraged by the architect William Burges, A.R.A., to design panels for his quaint Gothic cabinets; Messrs Powell obtained from him cartoons of designs for stained glass; for the decoration of Waltham Abbey church he was employed on a series of thirty important designs. Attracted by these, Dalziel Brothers commissioned a number of full-page drawings on wood for the illustration of their celebrated "Bible



"IDLE FEARS." By Sir E. J. POYNTER, P.R.A.

(By permission of Lord Hillingdon.)

Gallery." The cartoons for "St George" and "St David," the mosaic panels now embellishing the Outer Lobby of the Palace of Westminster, were produced in 1870, and they were followed by the "Apelles" and "Phidias," in the same method of reproduction, in the Victoria and Albert Museum; by the important series of frescoes in St Stephen's, Dulwich—scenes from the life of the saint; by the decoration of the Grill Room at the Museum at South Kensington, with the tiles *en camaïeu*—an achievement strikingly successful and pregnant with results. Sir Edward Poynter, always a lover of water-colour drawing and of the art of landscape painting, was elected to the Royal Society of Painters in Water Colours in 1883. In 1874 Sir Edward designed the Ashantee medal; and in 1892, for the coinage of that year, the reverse of the shilling and florin, to the obverse of Mr Thomas Brock, R.A.

The Directorship of the National Gallery became vacant in 1894, and Sir Edward, profoundly versed in the works of the Old Masters, especially of the Italian schools, was appointed to the post. From that date to the end of 1901 the collection largely increased in numbers, while in general arrangements, in hanging, &c., great improvements were introduced. Under Sir Edward's rule the National Gallery of British Art, at Millbank, presented by the late Sir Henry Tate, became a department of the National Gallery, and thither were removed many pictures formerly in the British rooms at Trafalgar Square, as well as the Chantrey Collection from South Kensington, &c. One of the most important services by the Director was the editing of the great *Illustrated Catalogue of the National Gallery* (1889–1900), in which every picture in the collection is reproduced—an unprecedented achievement in the annals of art-publishing.

PAINTINGS.—Sir Edward Poynter's most notable pictures have been the following: "Israel in Egypt" (1867); "The Catapult" (1868); "Perseus and Andromeda" (1872); "Atalanta's Race" (1876); "The Fortune-Teller" (1877); "Nausicaa and Her Maidens" (1879); "Visit to Æsculapius" (1880), now in the Chantrey Collection, in the Tate Gallery; "The Ides of March" (1883); "Diadumenè" (1885), now destroyed; "On the Terrace" (1889); "The Meeting of Solomon and the Queen of Sheba (1891); "Horæ Serenæ" and "Idle Fears" (1894; see Plate), and numerous portraits and water-colour drawings.

LECTURES.—The presidential discourses of Sir Edward Poynter have been of a purely academic character, dwelling on the necessity of conscientious labour and the study of tradition, in opposition to the modern tendency to avoid such study and to trust to genius. In his series of Slade Lectures, delivered from 1875 to 1879, and first published in 1879 (republished, with additions, in 1897), Sir Edward Poynter deals more fully with the whole subject of art education, considering in turn Decorative Art, Old and New Art, Systems of Art Education, Hints on the Formation of a Style, Training of Art Students, The Study of Nature, The Value of Things, Objects of Study, Professor Ruskin on Michelangelo (hotly controversial in tone), Influence of Art in Social Life, and Ancient Decorative Art.

See also COSMO MONKHOUSE. "Sir E. J. Poynter, P.R.A.: His Life and Work," *Art Annual*, 1897.—M. H. SPIELMANN. "Sir E. J. Poynter, P.R.A., and his Studies," *The Magazine of Art*, 1897.

Požarevatz, a town in Servia, situated in the Morava valley, 4 miles to the east of the Morava river and 8 miles south of the Danube. The station for steamers, Dubravitza, with its custom-house, standing on the banks of the latter river, forms practically the harbour of Požarevatz. The town has no special industry, but is the principal market of a very extensive and fruitful plain between the rivers Morava, Mlava, and Danube. It is the seat of the district prefecture, a tribunal of justice, a college, and several national or normal schools. It has a large modern penitentiary, with a department for political offenders and a prison for women. Two miles to the west, towards Morava, is situated Lubichevo, a model farm and stud belonging to the Government. The shady park and flower gardens are a popular resort of the people of Požarevatz. It is known in the history of international treaties as the place at which the famous "Požarevatz Peace" between Austria and Turkey was concluded in 1718. Population (1900), 12,957.

Pozoblanco, a town of Spain, province of Cordoba, to the south-west of Pedroche, with a little stream, De los Alamos, running through it. Its population was 11,522 in 1887, and 11,682 in 1897. It has clean, regular streets and some fine public buildings—the parish church, the town hall, the hospital, and numerous schools. The fairs are famed for their exhibit of live stock and agricultural products. There are argentiferous lead mines in the neighbourhood, and manufactures of cloth and leather in the town itself.

Pozsony (German, *Pressburg*), a municipal town, Hungary, the capital of the county of the same name, on the left bank of the Danube, 35 miles east of Vienna. Its dynamite factory produces yearly above one million kilograms of explosive material, and there is, besides, a well-known industry of fine brushes. The Danube here is spanned by a beautiful iron bridge, serving both for the railway and as a public road. In 1897 an equestrian statue in white marble of Queen Maria Theresa was erected, the work of the Hungarian sculptor Fadrusz. Population (1891), 56,048; (1901), 65,867.

Pozzuoli, a town and bishop's see of the province of Naples, Campania, Italy, on the north shore of the Bay of Naples, 6 miles west of Naples. A branch of the firm of Armstrong & Co. of Newcastle-upon-Tyne has been established here for, amongst other things, the making of guns for the Italian navy. A cement made from the volcanic earth of the neighbourhood (*pozzuolana*) is extensively used in building. The mineral baths attract numerous visitors in the summer. The Serapeum is by some authorities considered to have been a market, and —contrary to the common theory—they explain the holes made in the pillars by molluscs as due to the fact that the pillars formed part of a large tank for marine animals. In 1899 the Italian Government voted £32,000 for building a breakwater and improving the harbour. Population (1881), 14,703; (1899), 16,000.

Prachatitz, a town in Bohemia, Austria, at the foot of the Libin, on a tributary of the Blanitz river. It has a Gothic church of the 14th century, and remains of its old fortifications, together with a town hall and numerous castellated houses with mural decorations in colour. The manufactures produce hosiery, starch, matches, and electrical plant, beer and spirits. It is a favourite summer resort. Population (1890), 4141; (1900), 4338, mostly German.

Prague (German, *Prag*; Czech, *Praha*), the capital of Bohemia. The adjoining suburbs of Weinberge, Zizkoff, Karolinenthal, and Smichoff now practically form part of the town. Population (1880) 162,323, or including suburbs, about 250,000; (1890) with the garrison, 182,530 (of whom 27,125 were German), or with suburbs, 323,563; all Roman Catholic, with the exception of 17,635 Jews and 3288 Protestants, both religions showing a slight decline. In 1900 the population was 204,478, including the garrison of 7120 men, or with suburbs, 385,238 (estimated at 87 per cent. Czech, 13 per cent. German, 91 per cent. Roman Catholic, 7 per cent. Jews, and 2 per cent. Protestants). The relative diminution of the German element continues at an accelerated pace, mainly owing to the attraction of higher wages to the Czech rural population, but fostered by political causes. A token of the change that has converted Prague from a town in which German influence was paramount into a Czech stronghold, is the reduction in the decade 1880–90 of 3150 in the number of the German-speaking inhabitants, and an increase of the Czechs by 24,400. This progressive change is not exclusively due to the Czech immigration, however. In Prague, as elsewhere in the Czech provinces, the adoption of one or the other language is frequently a political confession of faith, so that a part of the Czech increase must be attributed to the conversion of former Germans. Another visible sign of the change is the removal of the German street names in the Hapsburg black and yellow, which have been replaced by the Bohemian language and colours. There are now two universities, one German and the other Czech (the latter a recent concession to Bohemian national sentiment), two polytechnics, a theological seminary, three upper and ten ordinary gymnasia, two commercial academies, an academy of arts, and a conservatory of music, together with five other special high schools, twelve intermediate and thirty-four elementary schools. Education is in an advanced state, being promoted not merely by the industrial progress and prosperity of the town and province, but by the rivalry of the two races. The boast of the Germans that they represent not merely the capital but also the culture of the city, is being steadily deprived of its justification, not through German decline but through Czech progress. In 1894 the German university was attended by 1287 and the Czech university by 2410; in 1901 the figures were 1314 and 3188 respectively. In 1894 the German polytechnic was attended by 244 students and the Czech by 417, the corresponding totals for 1901 being 585 and 1262. Twelve of the intermediate schools are Czech and six German, and of the elementary schools 39 are Czech and 18 German. Of the other educational institutions, the Czechs maintain 16 and the Germans 12. The same rivalry and separation are maintained in all grades and forms of instruction, even down to cookery, for which there are special German and Czech schools. In this struggle the Czechs have a decided advantage in their control of the municipal and provincial funds. The creation and the recognition by the State of a Czech Academy of Science are regarded as an important achievement by the dominant nationality. The addition (1878) of a new bridge, named after Palacky, the Bohemian historian, raised the number crossing the Moldau within the city to eight, and since then a ninth has been built. The Karls bridge, partially destroyed by floods in 1890, was restored in 1892. Prague now possesses fifty-seven Roman Catholic and four Protestant churches and one Russian church, together with ten synagogues. Among the public collections should be mentioned the Nostitz Picture Gallery, the Rudolphinum, and the Bohemian National Museum, in a building erected in 1889–93. In April 1901 the Emperor Francis Joseph founded, and endowed out of his privy purse, a gallery of modern painting, sculpture, and architecture, intended to contain representative works of Bohemian artists of both nationalities. There is a large and increasing number of scientific, literary, artistic, social, and benevolent institutions. The new towers of the cathedral, and the campanile, the Straha Ritter Academy, the new central market, and the Nostitz Palace constitute fresh architectural features. A second Czech national theatre was begun in 1900.

Prague has more than maintained its position as the leading centre of Bohemian industry and trade, and indeed as one of the most important places in the monarchy. Its progress has been greatly promoted by the development of communications. It is now the junction of seven railway lines, as well as of the extensive roads of the crown-land. It has also benefited by the growth of the sugar industry, of which it is the chief Austrian market, and by the efforts that have been made to promote inland navigation. In 1895 the shipping service on the Moldau numbered 56 steamers and 163 barges. The principal industries are milling, brewing, the production of cast iron, the manufacture of all kinds of metal wares and chemicals, cotton-spinning, calico-printing, tanning, and glove-making. Among the new industries is the construction of railway waggons and carriages. In Prague the struggle between the two races has of late years been marked by many vicissitudes, by ostentatious disaffection, rioting, plunder, incendiarism, bloodshed, revolutionary plots, and even murder, followed by the suspension of constitutional rights and severe measures of military repression. The upshot, thus far, has been the practical triumph of Czech aspirations in the Bohemian capital. (See BOHEMIA.)

(Æ. O'N.)

Prato, a town and episcopal see of the province of Florence, Tuscany, Italy, 11 miles by rail north-west of Florence, dominated by a mediæval castle and surrounded by walls. It has a picture gallery (in the town hall), a scientific, and a musical academy. Its varied industries embrace the manufacture of woollens (the most important), straw-plaiting, biscuits, hats, macaroni, candles, silk, olive oil, clothing, and furniture, also copper and iron works, and printing. Population (1881), 26,156; (1899), 27,000.

Prayers for the Dead.—Wherever there is a belief in the continued existence of man's personality through and after death, religion naturally concerns itself with the relations between the living and the dead; indeed, some philosophers have attributed the origin of all religion to the *cultus* of ghosts. Be that as it may, the existing conceptions of our relations to the dead vary widely. Sometimes they are worshipped, as in China. Sometimes they are consulted, as by necromancers. Sometimes the living think to furnish them with the means of enjoyment in the other world by slaying horses, &c., at their graves. Sometimes the dead are dreaded and propitiated. And, lastly, where the idea of a future judgment obtains, prayers are often offered on their behalf to the Higher Powers. Prayers for the dead are mentioned in 2 Maccabees xii. 43–45, where the writer is uncertain whether to regard the sacrifice offered by Judas as a propitiatory sin-offering or as a memorial thank-offering, a distinction of great importance in the later history of the practice. Prayers for the dead form part of the authorized Jewish services. The form in use in England contains the following passage: "Have mercy upon him; pardon all his transgressions . . . Shelter his soul in the shadow of Thy wings. Make known to him the path of life." The only passage in the New Testament which is held to bear directly on the subject is 2 Tim. i. 18, where, however, it is not certain that Onesiphorus, for whom St Paul prayed, was dead. Outside the Bible the proof of the early use of prayers for the dead has been carried a step further by Professor Ramsay's discoveries, for it is now impossible to doubt the genuineness of the copy (contained in the spurious acts of the saint) of the inscription on the tomb of Abercius of Hieropolis in Phrygia (see Lightfoot, *Apostolic Fathers*, part ii. vol. i. p. 492 ff.). The 19th line of the inscription runs thus: "Let every friend who observeth this pray for me," *i.e.*, Abercius, who throughout speaks in the first person: he died in the latter part of the 2nd century. The inscriptions in the Roman catacombs bear similar witness to the practice, by the occurrence of such phrases as "Mayst thou live among the saints" (3rd century); "May God refresh the soul of . . . "; "Peace be with them." Among Church writers Tertullian is the first to mention prayers for the dead, and that not as a concession to natural sentiment, but as a duty: "The widow who does not pray for her dead husband has as good as divorced him." This passage occurs in one of his later Montanistic writings, dating from the beginning of the 3rd century. Subsequent writers similarly make incidental mention of the practice as prevalent, but not as unlawful or even disputed (until Aerius challenged it towards the end of the 4th century). The most famous instance is St Augustine's prayer for his mother, Monica, at the end of the 9th book of his *Confessions.*

An important element in the liturgies of the various Churches consisted of the diptychs or lists of names of living and dead who were to be commemorated at the Eucharist. To be inserted in these lists was an honour, and out of the practice grew the canonization of saints; on the other hand, to be excluded was a condemnation. In the middle of the 3rd century we find Cyprian enjoining that there should be no oblation or public prayer made for a deceased layman who had broken a Church rule by appointing a cleric trustee under his will: "He ought not to be named in the priests' prayer who has done his best to detain the clergy from the altar." Although it is not possible, as a rule, to name dates for the exact words used in the ancient liturgies, yet the universal occurrence of these diptychs and of definite prayers for the dead in all parts of the Church in the 4th and 5th centuries tends to show how primitive such prayers were. The underlying principles of these recitations of names seem to have been, first, that the Eucharistic offering was the act of the whole Church, of those absent as much as of those present: "We offer on behalf of A and B"; and, secondly, that those who are asleep in Christ are as truly members of the Church as those who are alive. Hence there is in the earliest forms no sharp distinction, such as grew up later, between those who are commemorated with thanksgiving and those for whom prayers are made. The offering and the petitions embrace all alike, from the Blessed Virgin and the Twelve Apostles down to the sick and sorrowful on earth. God is further asked to hear the intercessions of the holy dead on behalf of the living. The language used in the prayers for the departed is very reserved, and contains no suggestion of a place or state of pain. We may cite the following from the so-called liturgy of St James:—

"Remember, O Lord, the God of Spirits and of all Flesh, those whom we have remembered and those whom we have not remembered, men of the true faith, from righteous Abel unto to-day; do Thou Thyself give them rest there in the land of the living, in Thy kingdom, in the delight of Paradise, in the bosom of Abraham, Isaac, and Jacob, our holy fathers, from whence pain and sorrow and sighing have fled away, where the light of Thy countenance visiteth them and always shineth upon them."

Public prayers were only offered for those who were believed to have died as faithful members of Christ. But Perpetua, who was martyred in 202, believed herself to have been encouraged by a vision to pray for her brother, who had died in his eighth year, almost certainly unbaptized; and a later vision assured her that her prayer had been answered and he translated from punishment. St Augustine thought it needful to point out that the narrative was not canonical Scripture, and contended that the child had perhaps been baptized. Similarly, a mediæval legend relates that Gregory the Great was so struck with the justice of the Emperor Trajan, that he prayed for him, and in consequence he was admitted to Paradise (cf. Dante, *Purg.* x., *Parad.* xx.).

As time went on, further developments took place. Petitions to God that He would hear the intercessions of the departed became direct requests to them to pray (*Ora pro nobis*); and finally, the saints were asked themselves to grant grace and help. Again, men felt difficulty in supposing that one who repented at the close of a wicked life could at once enjoy the fellowship of the saints in Paradise (St Luke xxiii. 43), and it seemed unfair that they should be made equal with those who had borne the burden and heat of the day (St Matt. xx. 12). And so the simple severance between good and bad indicated in St Luke xvi. 26, became the threefold division made familiar by Dante. First there were the saints in Paradise, awaiting their final glory, but already above the need of human prayers, and able to help men. Next came the forgiven sinners, who would ultimately pass on to Paradise, and were being prepared for it in Purgatory, and might be helped forward by the prayers of their friends on earth. And lastly, the impenitent wicked, whose destiny was Hell. These speculations were further fixed by the growth of the theory of satisfaction and of Indulgences: each forgiven soul was supposed to have to endure an amount of suffering in proportion to the guilt of its sins, and the prayers and pious acts of the living availed to shorten this penance time in Purgatory (see *Ency. Brit.*, 9th ed., art. INDULGENCES). It thus came about that prayers for the dead were regarded only as aiming at the deliverance of souls from purgatorial fires; and that application of the Eucharist seems to have overshadowed all others. The Council of Trent attempted certain reforms in the matter, with more or less success; but, broadly speaking, the system still remains in the Roman Church, and masses for the dead are a very important part of its acts of worship.

The Reformation took its rise in a righteous protest against the sale of Indulgences; and by a natural reaction the Protestants, in rejecting the Romish doctrine of Purgatory, were inclined to disuse all prayers for the dead. They tended to divide men sharply into two classes, the good and the bad; to speak as if judgment followed immediately on death, and as if the soul passed at once to Heaven. Prayers for the dead therefore seemed useless, if not presumptuous; though if the fact that a man's fate is already decided makes it vain to pray for him, it is difficult to see how a strict Calvinist could permit intercession even for the living. The formularies of the English Church speak plainly of an intermediate state, where disembodied spirits await their "perfect consummation and bliss," resting in Christ until "the general resurrection at the last day" (Burial Service); but they as clearly condemn the Romish doctrine of Purgatory. Important changes have been made, in the successive revisions of the Prayer-Book, in the commemorations of the dead at the Eucharist and in the Burial Service.

In the Communion Service of 1549, after praise and thanks were offered for all the saints, chiefly the Blessed Virgin, came the following: "We commend unto Thy mercy all other Thy servants, which are departed hence from us with the sign of faith and now do rest in the sleep of peace: grant unto them, we beseech Thee, Thy mercy and everlasting peace." The Burial Service of the same date contained explicit prayers for the deceased, and Introit, Collect, Epistle, and Gospel were provided for "the Celebration of the Holy Communion when there is a Burial of the Dead." In 1552, under the influence of Bucer, all mention of the dead, whether commemorative or intercessory, was cut out of the Eucharist; the prayers in the Burial Service were brought into their present form; and the provision for Holy Communion at a Burial was omitted. The thankful commemoration of the dead in the Eucharist was restored in 1661, but prayers for them remained, if they remained at all, veiled in ambiguous phrases.

The Church of England has never forbidden prayers for the dead, however little she has used them in her public services. It was proposed in 1552 to condemn the scholastic doctrine *de precatione pro defunctis* in what is now the 22nd of the Thirty-nine Articles, but the proposal was rejected. And these intercessions have been used in private by a long list of English divines, among whom Andrewes, Cosin, Ken, Wesley, and Keble form an almost complete chain down to the present day. On the tomb of Bishop Barrow (1680) stands a request to passers-by to pray for their fellow-servant. And in a suit (1838) as to the lawfulness of an inscription, "Pray for the soul of . . .," the Court decided that "no authority or canon has been pointed out by which the practice of praying for the dead has been expressly prohibited." As Jeremy Taylor put it (*Dissuasive from Popery*, I. I. iv.), "General prayers for the dead the Church of England never did condemn by any express articles, but left it in the middle."

In conclusion, we may quote the views of a writer who represents Eastern Christendom: "We pray . . . for the dead that they may become worthy of the vision of God's face. We know nothing of an intermediate state of souls which have neither been received into the kingdom of God, nor condemned to torture; for of such a state we have received no teaching, either from the apostles or from Christ. We do not acknowledge Purgatory—that is, the purification of souls by sufferings from which they may be redeemed by their own works or those of others; for the Church knows nothing of salvation by outward means, nor any sufferings, whatever they may be, except those of Christ; nor of bargaining with God, as in the case of a man buying himself off by good works" (Khomiakoff's "Essay on the Church," in W. J. Birkbeck, *Russia and the English Church*, p. 217. London, 1895).

Luckock. *After Death.* London, 1879, &c.—Plumptre. *The Spirits in Prison.* (W. O. B.)

Prenzlau, a town of Prussia, on the Ücker river and at the north end of the Lower Ücker lake, 30 miles west-south-west of Stettin by rail. There are 4 Evangelical churches, a Reformed church, a Catholic church, a synagogue, a gymnasium, a boys' and 2 higher grade girls' schools, a seminary for teachers, and a dairy school. Population (1880), 16,933; (1900), 20,228.

Prerau (Czech, *Přerov*), an important railway junction and commercial centre in Moravia, Austria, 13 miles south-east of Olmütz. Population (1890), 12,955; (1900) 16,738, chiefly Czech and Catholic (estimated to have 9 per cent. German, 5 per cent. Jewish). It has an important cloth industry, in addition to the staple manufactures of sugar, ropes, machinery, agricultural implements, &c. It was at one time the chief seat of the Moravian Brethren.

Presbyterianism.—The extent to which the Presbyterian form of Church polity prevails throughout the world has been made manifest in recent years by the formation of a Pan-Presbyterian Alliance. At a representative conference in London in 1875, the constitution of the Alliance was agreed upon, and arrangements were made for holding, every three or four years, a Presbyterian Œcumenical Council. This "General Council of the Alliance of Reformed Churches holding the Presbyterian System" met in Edinburgh in 1877, in Philadelphia in 1880, in Belfast in 1884, in London in 1888, in Toronto in 1892, in Glasgow in 1896, and in Washington in 1899. Churches which are organized on Presbyterian principles, and hold doctrines in harmony with the Reformed Confessions, are eligible for admission to the Alliance. Its object is not to form one great Presbyterian organization, but to promote unity and fellowship among the numerous branches of Presbyterianism throughout the world. On the roll of the General Council held at Washington there were 64 Churches. The statistics of these and of 16 others not formally in the Alliance were as follows: Congregations 29,476, ministers 26,521, elders 126,607, communicants 4,852,096. The approximate amount raised during the previous year (1898) for home and foreign work was £6,999,021. Of these 80 Churches, 12 were in the United Kingdom, 20 on the continent of Europe, 16 in North America, 3 in South America, 10 in Asia, 9 in Africa, 6 in Australia, 2 in New Zealand, 1 in Jamaica, and 1 in Melanesia. The desire for union which led to the formation of the Alliance has since 1875 borne remarkable fruit. In England in 1876 two Churches united to form the Presbyterian Church of England; in the Netherlands two Churches became one in 1892; in South Africa a union of the different branches of the Presbyterian Church took place in 1897; in Scotland the "Free Church" and the "United Presbyterian" became one in 1900, under the designation of the United Free Church; in Australia and Tasmania six Churches united in 1901 to form the "Presbyterian Church of Australia"; and a few months later the two Churches in New Zealand which represented respectively the North and South Islands united to form the "Presbyterian Church of New Zealand." "In no portion of the Empire," it has been said, "does the British flag now fly over a divided Presbyterianism except in the British Isles themselves."

The United Kingdom.

The development of Presbyterianism in the United Kingdom has been marked since 1875 by some features common to all the Churches. The first of these has been a restatement of doctrinal belief. No Church has proposed to set aside the Westminster Confession of Faith, but the United Presbyterian Church (which led the way in this matter), the Free Church of Scotland, and the Presbyterian Church of England, have taken steps to define more accurately their relation to the Confession. This has been done by a Declaratory Statement, or by an alteration of the formula by which ministers and other office-bearers express their adherence to the standards, or, as in the case of the Presbyterian Church of England, by the adoption of more briefly expressed "Articles of the Faith." No change, it is alleged, has been made in regard to the substance of the Westminster doctrine, but there has been a desirable alteration of emphasis and proportion. The Church of Scotland, in consequence of her relation to the State, has not found it so easy to move in this direction; and the Presbyterian Church of Ireland, in consequence of her conservatism in matters of doctrine, has not felt the need of change.

Doctrinal belief.

Another feature of development common to Presbyterianism in the United Kingdom is the great attention devoted to the improvement of public worship. The *service* as distinguished from the *sermon* has been the subject of much thought and care. Instead of one or two long prayers, there is a tendency to have a greater number of brief prayers, definitely apportioned into acts of confession, thanksgiving, supplication, and intercession. The repetition of a creed is also provided for. All the larger churches in Great Britain have produced books of the nature of a Directory of Worship, in which the right order of service and suitable topics for prayer are indicated. This help has in most cases been rendered by a Church Service Society not directly connected with the Courts of the Church. The Synod of the Presbyterian Church of England took the matter into its own hands and prepared a "Directory for the Public Worship of God on the Basis of that agreed upon by the Assembly of Divines at Westminster, A.D. 1644." The Service of Praise, too, has received special attention in all the Churches. The adoption of the new "Church Hymnary" by the Churches in Scotland and Ireland will do much to unify Presbyterian worship, as did the exclusive use of "Psalms and Paraphrases" before hymn-books were introduced. The "Church Hymnary" was the work of a joint committee representing the three Churches in Scotland and the Church in Ireland. Since 1875 the use of instrumental music has become much more general.

Public worship.

A third feature characteristic of British Presbyterianism during the period under review is a strenuous endeavour to provide for the higher instruction of youth, not only in the Sunday-school, but also in the Bible-class and in the home. Conspicuous service in this respect has been rendered by the production of handbooks covering the whole field of biblical and doctrinal education. Written examinations are held yearly, and honours and prizes are awarded. In this way much has been done to prolong the religious instruction of young people after they have ceased to be children, and it is hoped that a fruit of the movement will be a larger supply of well-equipped teachers for Sunday-schools.

Instruction of youth.

One other feature common to the development of Presbyterianism in several of the Churches in Great Britain concerns the tenure of the pastorate. In all Presbyterian Churches of the United Kingdom it has been the invariable rule and practice that a minister holds office *ad vitam aut culpam*, *i.e.*, for life or until found guilty of an offence which merits suspension or deposition. In the United Free Church of Scotland and the Presbyterian Church of England efforts have been made to formulate a quasi-judicial method of removing a minister from his charge on the ground of apparent inefficiency or want of success. This marks a new departure in British Presbyterian polity. The following deliverance of one of the Churches indicates the line along which the new movement tends to advance :—

Tenure of the pastorate.

If the Presbytery, after exhausting all ordinary means, shall find that the ends of the ministry are still not being served ; that there is *primâ facie* ground to believe that the responsibility for this state of things rests mainly with the minister ; and that there is no reasonable hope that these ends will be served by a continuance of his ministry in that congregation ; they shall prepare a full and explicit statement of the facts and grounds upon which they have come to this conclusion, and shall hear the minister and other parties thereupon. If, after due hearing of parties, the judgment of the Presbytery shall be that there is no hope of the ends of the Christian ministry being served in that particular congregation under the existing pastorate, they may, on such pecuniary provision being made for the minister as in the circumstances of each case the Presbytery shall deem equitable, dissolve the pastoral tie ; but without prejudice to his ministerial standing, and subject to complaint and appeal in the ordinary form.

There has been little time and less practical experience to test the effect of this departure from the immemorial law and practice of the Presbyterian Church, which went far to secure, even in unendowed churches, the independence of her ministers. But it seems likely to affect unfavourably the supply of high-class candidates for a sacred office, the independence of which, even when hedged about by constitutional safeguards, is often menaced by the unscrupulous exercise of money power.

Other features in the development of Presbyterianism in the United Kingdom are more specifically associated with individual Churches.

SCOTLAND.

In the CHURCH OF SCOTLAND by far the most important change was the abolition of patronage in 1874. It exercised a powerful influence upon the Scottish people, for it was the uprooting of the main cause of all the alienations and secessions from the National Church. The Act of 1874 gave back to the people the right to elect and call the minister to a vacant parish. Whatever effect it may have had in other respects, there is no doubt that it restored the affections of many of the people to the mother Church and caused them to return to her fold. From that time the increase in her membership has been rapid and continuous. The number of her communicants in 1874 was 460,464; in 1890 they had increased to 593,393; in 1901 the number was 661,629, and in 1902 it was reported as 668,335. The increase from 1874 to 1902 was 207,871, a yearly average of 7424. Contemporaneous with this movement of the people back to the Church, there has been within the Church a growing earnestness in promoting deeper spiritual life and in fostering organized Christian effort. Much work has been done among the young by the formation of guilds. The work of women has been recognized and encouraged. The ancient order of deaconess has been revived, and institutions founded in which women are trained for missionary work at home and abroad. The liberality of the Church has shown decided improvement, home and foreign missions have been better supported, large sums have been raised for the endowment of new parishes and for the better endowment of poor ones, the care of the toiling masses has come close to the Church's heart, and successful efforts have been made to minister to the large migratory population which follows the fishing every season round the coasts of the British Isles. The voluntary offerings of the people for 1901, as reported to the General Assembly of 1902, amounted to £545,785. This included a munificent gift of £62,000 from Lord Mount Stephen for increasing the stipends of certain parishes in his native district. Since 1875 the Church of Scotland has had on several occasions to meet the crusade of the Dissenting churches for Disestablishment by organization for Church defence. Coupled with this, a fine spirit was manifested towards the Churches outside the Establishment, and suggestions emanated from the Church of Scotland for the inclusion of them all within the Establishment, even at the expense of sharing with them her own privileges and endowments. The statistical return to the General Assembly of 1902 gave the number of parishes as 1391, of non-parochial churches as 217, of preaching stations and missions as 207, a total of 1815. Since 1875 the church accommodation has been increased by 184,870 sittings. Since the Disruption 420 new parishes have been endowed, at a cost to the Church of £1,547,000.

The outstanding feature in the history of the FREE CHURCH and the UNITED PRESBYTERIAN CHURCH after 1875 was the desire, expressed in repeated efforts, to accomplish the incorporating union which was at length effected in October 1900. The Free Church left the Establishment in 1843 strongly holding and frequently asserting what was called the Establishment principle. In the minds of her younger ministers this principle was gradually obscured by the splendid success of her practical voluntaryism, until at last, most of the "Disruption fathers" having passed away, it became possible to subordinate it to the expediency of uniting with a Church which was voluntary not only in practice but also in principle. Under the influence of a brilliant leader, successive General Assemblies by increasing majorities declared in favour of regarding the "Establishment principle" as a non-essential doctrine of the Free Church. Eventually the union of the Free Church and the United Presbyterian Church was "brought about on the understanding that the question as to the lawfulness of State endowments should be an open one." It is impossible to predict the effect of this union upon the Churches themselves, or upon the general ecclesiastical history of Scotland. The two Churches, differing widely in historical origin, traditions, and administrative methods, may for a time have to expend their energy on consolidation, internal adjustment, and assimilation. Agitation in favour of Disestablishment may henceforward be less emphatic, hampered as it will be by the presence of many in the united Church who conscientiously hold the "Establishment principle" and long for a reconstruction of Scottish Presbyterianism within the National Church. The heroic self-sacrifice of the Free Church ministers in 1843, the splendid liberality of her people, her marvellous power of organization, and the fervour of her evangelical teaching, won the admiration of all the Churches and gave a powerful impulse to the religious life of the country. The conspicuous missionary achievements of the United Presbyterian Church and her fearless advocacy of religious equality and freedom gained for her also a place of honour among sister Churches. The union of 1900 was therefore regarded with special interest, and took place amid almost universal congratulations and benedictions. Great things are expected from it, and its spiritual fruits will be hailed with joy.

The following statistics of the United Free Church were presented to the General Assembly of 1902: Congregations 1630, preaching stations 72, communicants 495,259; raised for home missions £20,051, for foreign missions £123,055, for all purposes £1,056,347.

Two small bodies of Presbyterians in Scotland continue to maintain a separate existence. One is the remnant of the Reformed Presbyterian Church, which united with the Free Church in 1876. It consisted in 1899 of 9 congregations, 8 ministers, and 1040 communicants. The other claims to represent the United Original Secession Church, and consists of 29 congregations, 24 ministers, and 3769 communicants.

England.

The union of the Presbyterian Church in England with the English congregations of the United Presbyterian Church of Scotland, which took place in 1876, gathered all English Presbyterians (with a few exceptions) into one Church, the Presbyterian Church of England. "What kept these bodies apart was their separate historic origin and development, but especially the alienation caused by the 'Voluntary controversy,' which had its roots in the difficult problems of State law in its relation to religion, and the stumbling-block of the civil magistrate's authority in relation to the Christian conscience."[1] Since the union the growth of the Church is indicated by the following figures:—

	1876.	1901.
Congregations	259	326
Communicants	51,013	78,024
Sittings provided	134,146	167,945
Value of church buildings	£973,485	£1,378,525

Presbyterianism is comparatively strong in three districts of England, namely, Northumberland, Lancashire, and London. Elsewhere it is either weak or non-existent. As yet it is largely an exotic. The membership is mainly Scottish, and the ministers have been imported principally from Scotland. Hence a distinctly Scottish accent and a Scottish type of theological thought in the pulpit; Scottish methods in church arrangements, and Scottish manners in religious worship. To the English people, therefore, the Presbyterian Church is "the Scottish Church," and they are slow to connect themselves with it. Though they see much in it to admire and approve, they look upon it as meant for the Scots rather than for themselves. Here and there a different state of things prevails, but this is the attitude of the English people as a whole. Earnest efforts have been made to counteract this feeling by making the Church more distinctively English. Hymns and organs were introduced earlier than elsewhere. The technical nomenclature of Presbyterian procedure is being modernized so as to be better understood in England. For a similar reason, Presbyterian procedure itself is sometimes modified. This readiness to make changes in her polity is regarded by some as a dangerous symptom; by others it is hailed as the indication of an open mind and a desire to make progress by adaptation to environment. Following the lead of the Independents, who set up Mansfield College at Oxford, the Presbyterian Church has founded Westminster College at Cambridge. It was opened in 1899. It is hoped that it will do much to ensure a home-bred and home-trained ministry more conversant with English academic life and thought.

The most notable feature of the Church's work is her foreign missions. The field is mainly China, and the results attained are remarkable, as the following statistics will show:—

	1876.	1901.
Ordained European missionaries	12	21
Medical missionaries	3	13
Lady missionaries (including two medical)	...	27
Native pastors supported by their own congregations	...	34
Native Evangelists	49	260
Organized congregations	14	87
Preaching stations	52	123
Communicants	1974	7560

There are also in England 14 congregations in connexion with the Church of Scotland, namely, 5 in Berwick and Northumberland, 1 in Carlisle, 2 in Liverpool, and 6 in London. The number of communicants in 1900 was 3799.

Many Unitarians in England call themselves Presbyterians. This is a misnomer, for though descended from the old English Presbyterians, they retain nothing of their distinctive doctrine or polity—nothing of Presbyterianism, indeed, but the name. This is retained on account of ancient Presbyterian endowments which they continue to hold.

Ireland.

The Presbyterian Church in Ireland, most conservative of the great Presbyterian Churches in the United Kingdom, has during recent years passed through some phases of development which the others reached considerably earlier. After heated discussions in her General Assembly for many years, she has come abreast of the sister Churches in regard to the use of hymns and organs in public worship. Her attitude is one of sturdy adherence to the old paths of Evangelical doctrine and Presbyterian polity. She zealously supports the Irish system of national education, which may be briefly defined as "united secular and separate religious instruction," and she declines to be bribed by the offer of a Presbyterian university in Belfast to consent to the formation of a Roman Catholic university in Dublin. The Church Act of Mr Gladstone which disestablished the Episcopal Church took away the Presbyterian *Regium Donum*. Her ministers, with all but entire unanimity, decided "to commute in the interests of the Church." The Commutation Fund thus formed is a permanent memorial of a generous and disinterested act on the part of her ministry. It amounted in 1902 to £588,028. The interest accruing from it is added to the yearly Sustentation Fund contributions to form a strong central fund for ministerial support. Since the State endowment ceased, the average income of her ministers has increased by about £30 a year.

Statistics show that whilst Ireland lost about a quarter of a million of its people during the decade 1890–1900, the Presbyterian Church is numerically almost the same as in 1891. Returns presented to the General Assembly in 1902 give the following particulars: Congregations 574, ministers and missionaries 655, communicants 106,121, amount raised in congregations and Sunday schools £229,307, collections for missions £18,892. Outside Ulster the number of strong, self-supporting congregations is small, but hearty support is given to weak congregations and mission stations in the south and west of Ireland. The Presbyterian Orphan Society was founded for the purpose of undertaking the support of every poor orphan child throughout the Church. No Presbyterian orphan now needs to seek workhouse relief. The orphans are boarded in the homes of respectable poor people, who thus also benefit by the Society. A training home for girls forms part of the scheme.

Three small bodies of Presbyterians maintain a separate existence, namely, the Reformed Presbyterian Church, with 36 congregations and 4040 communicants; the Eastern Reformed, with 6 congregations and 700 communicants; and the Secession Church, with 10 congregations and 1230 communicants.

Wales.

The Presbyterian Church of Wales, formerly better known as "The Calvinistic Methodists," had its origin in the great Evangelical revival of the 18th century. Its polity has been of gradual growth. In 1811 its preachers were first Presbyterially ordained and authorized to administer the sacraments. In 1823 a "Confession of Faith" was adopted. In 1864 the two Associations (or Synods) of North and South Wales were united in a "General Assembly." The progress and present strength of the Church are indicated by the following figures:—

	1850.	1882.	1901.
Ministers	172	616	834
Communicants	58,678	122,167	160,333
Churches and preaching stations	848	1372	1579

[1] Drysdale's *History of the Presbyterians in England*, p. 625.

In 1901 the Church raised for all purposes £305,745. Of this sum, £14,407 went to missions, £9041 to Sunday schools, £2899 to the poor, and £67,494 to reduce the debt on church buildings. (W. Y.)

UNITED STATES.

Although Presbyterians are closely united in America, twelve distinct organizations exist. The total number of Presbyterians at the beginning of the 20th century was 1,945,106. The Sunday-school teachers and scholars numbered 1,829,336. The largest body, known as *The Presbyterian Church in the United States of America*, had a membership in 1900 of 1,007,689. In 1880 the whole number of members reported was 578,671. *The Presbyterian Church in the United States*, commonly called the Church South, which separated from the main body during the Civil War in 1861, reported in 1900, 225,890 members. These two bodies differ only regarding civil relations, and the separation is simply an expression of disagreement concerning relations to the Government. When the happy reunion of the Old School and New School Churches was accomplished in 1869, it was the hope of many that the spirit of union would bring together again those who had been separated by the bitterness of war. Conferences have been proposed by the Northern Church frequently since the division, but up to 1902 these had not led to union. There is, however, a growing desire for fraternal federation, and it is the conviction of very many that the near future will bring to Presbyterianism the power of such federation. This federation, it is believed, will include all the organizations known as Presbyterian. *The United Presbyterian Church*, the result of the union of the Associate and Associate Reformed Churches, accomplished in 1858, numbered 128,836.. This Church represents a fine type of Presbyterians, the descendants of the Scottish and Irish loyalists who did not count their lives dear when truth was to be defended. The United Presbyterians are much closer to other bodies bearing the Presbyterian name than they were in 1875. New versions of the Psalms, instrumental music, and less vigorous protest against secret societies, together with a frequent exchange of ministers and members, are all significant signs of closer fellowship in work, if not actually signs of organic union. *The Cumberland Presbyterian Church* reported a membership in 1900 of 180,192. This organization flourishes chiefly in the South. It is not strictly Calvinistic in doctrine, but is Presbyterian in polity. Whether the revision movement in the Presbyterian Church may win the Cumberland Presbyterians into closer union, remains to be seen. But it is not likely that there will be any such modification of the Calvinistic faith as could satisfy the more liberal belief of this body of Presbyterians. There were thirteen thousand *Welsh Presbyterians*, and nearly thirty thousand other Presbyterians divided into half a dozen smaller organizations. There were also more than three hundred and sixty thousand Church members belonging to the Reformed Churches, which are closely associated with Presbyterians in faith and in government. They stand together in the defence of a common system of doctrine, and the government of the Churches is very similar. These organizations, Presbyterian and Reformed, comprise the Alliance of the Reformed Churches, which was formed in 1875, and has since held several general councils. Two of these councils have been held in the United States, four in Great Britain, and one in Canada. Ninety separate Churches or denominations comprised this great Reformed Presbyterian Alliance. These Churches represented five continents and twenty-five millions of adherents.

The Presbyterian Church in the United States of America has since 1880 enjoyed signal prosperity. In 1880 it included 177 presbyteries; in 1900, 232. There were 600 candidates for the ministry in 1880; in 1900, 973. There were 5044 ministers in 1880; in 1900, 7467. In 1880 there were 5489 churches; in 1900, 7750. Over 57,000 members were added to the Church in 1900 by examination and 40,000 by church letters. The whole membership in 1900 was 1,007,689, whereas in 1880 the number was 578,671. The Sunday-school membership in 1880 was 631,952; in 1900, 1,058,051. $429,769 was given for home missions in 1880, and $1,088,367 in 1900; $420,427 for foreign missions in 1880, and in 1900, $822,811. $6,098,150 was contributed for congregational purposes in 1880, and in 1900, $11,372,383. The total contributions of the Church in 1880 were $8,361,028, as compared with $15,054,301 in 1900. These contributions do not include the personal gifts of members of the Church to charitable and educational institutions. 1371 missionaries were employed in the home field during 1900, and 728 missionaries, with over 2000 native helpers, in foreign countries. The Board of Church Erection has secured church property valued at $14,500,000. The Board of Relief has under its care 363 ministers and 483 widows of ministers. The Board of Missions for Freedmen, which was organized in 1865, is represented by 340 churches and 20,000 members. 10,000 scholars are instructed in 80 day schools. This Board has also under its care 18 boarding schools, and supports 231 teachers. The Biddle University in Charlotte, North Carolina, is intended for coloured students, and eleven of its twelve professors are coloured men. Lincoln University, near Oxford, Pa., which is independent of the Board but connected with the Presbyterian Church, has an able faculty, is liberally endowed, and is concerned specially with the education and elevation of the coloured race. Through the Board of Aid for Colleges and Academies, old colleges have been strengthened, and new colleges and academies have been planted, particularly in the newer parts of the country, and the work of higher education has been fostered. Nearly $200,000 was so distributed in 1900 by this Board. There are 14 theological seminaries in connexion with the Presbyterian Church. Three large and prosperous hospitals have been established by the Church—one in New York, one in Philadelphia, and one in Chicago. There is a disposition in other cities to provide Church hospitals for the benefit of the poor. The charity of the Church is expressed also by homes and asylums of various kinds, and by many forms of mission work. The Presbyterian Church resolved to mark the advent of the 20th century by a great forward movement. While the synods are giving special attention to the increased endowment of colleges and theological seminaries, the Presbyteries are encouraging the churches to pay off their debts and to contribute money for the organization of new churches. Already gifts amounting to several millions of dollars have been received. This forward movement is both the cause and the result of a spirit of unity in the Church. Twenty years of discussion have ended in a harmonious and hopeful determination to find a satisfactory solution of the question that has so long disturbed the Church. Three-fourths of the Presbyteries having indicated a desire that there should be some revision, the General Assembly of 1901, by a vote of three to one—and finally by a unanimous vote—determined to have prepared (1) a Short Statement of doctrine for popular use and information, and (2) a Declaratory Statement, which might remove misapprehension regarding a few confessional statements; or, if necessary, revision by a change of text. These statements, however, could not be adopted without the prior approval of the General Assembly, and, this being given, the adhesion afterwards of two-thirds of the Presbyteries—that is, by more than 150 Presbyteries. (C. A. D.)

Prescot, a market-town in the Ormskirk parliamentary division of Lancashire, England, 8 miles east of Liverpool by rail. The streets are lighted both by electric light and gas, and the town has been connected by tramway with St Helens. A large factory has been built for the complete making of watches. There is also a manufacture of electric cables. Population (1891), 6745: (1901), 7855.

Preserved Fruits. See CANNING.

Pressburg. See POZSONY.

Preston, a municipal, county, and parliamentary borough, seaport and market-town of Lancashire, England, on the Ribble, 209 miles north-west of London by rail. Since 1880 the municipal borough has been successively extended. In 1894 the townships and parts of townships within the limits of the county borough were consolidated into one civil parish. The parliamentary borough returns two members. St Stephen's church was erected in 1888, and St Jude's in 1893. A new Harris Free Public Library and Museum was opened in 1893, and to this building was transferred in 1894 the free library of 1879. £40,000 has been given by the Harris trustees towards establishing a technical school, and part of this sum has been spent on a Victoria Jubilee Technical School (1897). A school for the education of the deaf and dumb was opened in 1894. There is one daily newspaper. The construction of spacious docks, in conjunction with the deepening of the river from the quays of Preston to its outfall in the Irish Sea, a distance of 16 miles, begun in 1884, has been carried out at a cost of over one million sterling. The main wet dock, opened in 1892, is 3240 feet long and 600 feet wide. The total quayage is over 8500 lineal feet. The channel of the river has been made straighter, and from docks to sea deepened, so that the dock is now accessible for vessels of 17 feet draught on ordinary spring tides. The waterworks are now the town property. Vessels entering port in 1888 numbered 198 of 15,362 tons; clearances, 198 of 15,462 tons. In 1900 entrances numbered 1223 vessels of 153,903 tons; clearances, 1183 of 151,298 tons. Imports of foreign and colonial produce in 1888 were valued at £7211; in 1900, £446,934; exports in 1888 at £207; in 1900, £14,812. Area, 4089 acres. Population (1881), 96,537; (1891), 107,573; (1901), 112,982.

Prestonpans, a police burgh and coast village of Haddington, Scotland, on the shore of the Firth of Forth, nine miles east of Edinburgh, with a station on the North British Railway. It was formerly the principal seat of the salt trade in Scotland, but has now only one salt work. There are a fire-brick and tile work, a brewery, a soap work, and a pottery. There is also an extensive coalfield in the vicinity. An oyster bed, once famous for its Pandore oysters (an esteemed variety), is now scarcely as productive. The cross of the Barony of Preston dates from 1617. The churches are Established and United Free. The public school had an average attendance of 540 in 1898–99. Prince Charles inflicted a severe defeat here upon the Hanoverian forces, under Sir John Cope, on the 21st of September 1745. An obelisk was erected to the memory of Colonel Gardiner, who fell in the battle. Population (1881), 2265; (1891), 2224; (1901), 1721.

Prestwich, Sir Joseph (1812–1896), English geologist, was born at Clapham on 12th March 1812, and was educated at Reading and at University College, London, where, under Dr Lardner, he paid special attention to scientific studies, particularly mineralogy and geology. Up to the age of 60 he was actively engaged in his business, which was that of a wine merchant, and therefore was only able to devote his leisure time to his favourite scientific pursuits. But the journeys he was obliged to make to various parts of Great Britain and the Continent afforded him opportunities of becoming acquainted with the geological conditions of many localities, and he was thus able to combine business and science so effectively that he won for himself a high place among the geologists of the 19th century. He began original work early in his career, publishing in 1836 a remarkable memoir on the structure of the Coalbrookdale coalfield, which embodied the results of observations made during visits there in 1831 and 1832. His name is especially known in connexion with his studies on the Tertiary deposits of the London Basin, which he systematically classified and correlated with similar deposits in other parts of the world. He was further led to investigate their water-bearing characteristics, and his extensive knowledge in that respect procured him a seat on the Metropolitan Water Commission in 1867. From about 1858 the question of the antiquity of man specially engaged his attention. On various occasions statements had been made as to the association of flint implements formed by man with the bones of extinct mammals which belonged to more remote periods than those generally assigned for the appearance of the human race on this earth, but the evidence adduced had usually been disregarded by geologists as not affording sufficient proof of the point. Prestwich, however, saw the desirability of a closer examination of the facts, particularly in regard to the implements discovered by Boucher de Perthes in the gravels of the Somme valley, and his investigation yielded evidence which was generally regarded as proving that man existed contemporaneously with the Pleistocene mammoth. In 1866 Prestwich became a member of the Coal Commission, the report of which in 1871 contained a paper by him suggesting the probability that a range of coalfields extended from Somerset to south-eastern England. He was inclined, however, to consider that the coal-trough would be found to lie in Essex and Hertfordshire, rather than on the more southerly line favoured by Godwin-Austen and actually verified by subsequent borings. After retiring from business in 1872, he was elected to the chair of geology at Oxford, and retained it till 1888. His two volumes on *Geology: Chemical, Physical, and Stratigraphical*, were the product of this period. He was knighted in 1896, and died on 23rd June of the same year at Shoreham, Kent.

Pretoria, city of the Transvaal Colony, British South Africa. It was the capital of the South African Republic since 1855, the seat of government being transferred from Potchefstroom after the death of Pretorius, in whose memory Pretoria was founded and named. It is pleasantly situated about 4500 feet above sea-level, near the southern slope of the Magaliesberg Range, which is here pierced by the Aapies headstream of the Limpopo. Like most of the Boer settlements, it was laid out on a regular and somewhat ambitious plan, with broad streets and boulevards disposed at right angles to each other, and ample enough to accommodate some 100,000 inhabitants. But Pretoria, which suffers from the rivalry of the neighbouring Johannesburg, has remained a small place, with a population estimated in 1899 at not more than 10,000 whites and perhaps half that number of natives. As a railway centre it is the converging point of the main lines from Delagoa Bay, Natal, and Orange River Colony, with extensions running north to Pietersburg and south-west to Potchefstroom and the Klerksdorp goldfields. In Church Street, the chief thoroughfare, stand several fine blocks, notably the former Raadzaal (Parliament House), an imposing structure, the "architectural glory" of Pretoria, crowned by the statue of Liberty, rising 120 feet above the pavement. In the northern outskirts is the perennial spring, where still flourishes the *Wonderboom* ("Wonder Tree") which first attracted the voortrekkers to the spot; and a little farther north is the Waterval station on the Pietersburg Railway, where were laagered the British prisoners captured during the war. All were released soon after 31st May 1900, when the capital surrendered to General Roberts without resistance, despite the formidable-looking encircling forts, now dismantled,—Wonderboom, Daspoort, Schanzkop, and Klapperkop—which, however, were so elaborately designed that they were never effectively armed.

Prevesa, the capital of a sanjak, in the vilayet of Janina, European Turkey, at the entrance to the Gulf of Arta. The houses are for the most part embosomed in gardens, and magnificent olive plantations surround the town. The chief exports are wool, butter, cheese (to the yearly value of about £14,000), olive oil and olives, valonea, skins, and coal. The total value of the exports in 1900 was £35,243, as compared with £31,100 in 1898; the value of the imports in the same years being £45,567 and £46,600 respectively. A hindrance to the commercial prosperity of the port is the impossibility of large steamers entering the harbour owing to a bar of sand, which reduces the depth of the gulf to 10 feet. The number of vessels that entered the port in 1900 was 1374 of 100,296 tons, as compared with 1785 of 98,761 tons in 1898. The population is estimated at 11,000, of whom about one-fifth are Moslems, the remainder being Greeks and Christian Albanians.

END OF SEVENTH VOLUME.

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A PARTIAL LIST OF THE CONTRIBUTORS

TO

THE NEW VOLUMES

OF

THE ENCYCLOPÆDIA BRITANNICA

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A

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ABNEY, Sir William de Wiveleslie, K.C.B., D.Sc., D.C.L., F.R.S.; Principal Assist. Sec., Board of Education, South Kensington, since 1899; President, Royal Astronomical Society, 1893-95; President, Physical Society, 1895-97; author of 'Photography' in Ninth Edition of the 'Ency. Brit.,' 'Instruction in Photography,' 'Treatise on Photography,' 'Colour Vision,' 'Colour-Measurement and Mixture,' 'Thebes and its Five Great Temples,' in part of 'The Pioneers of the Alps.' (W. de W. A.)

ADAMS, B. B.; associate-editor of the 'Railroad Gazette' (New York). (B. B. A.)

AIRY, Wilfred, B.A., M.I.C.E.; Examiner of Inspectors of Weights and Measures, Board of Trade; author of 'Levelling and Geodesy,' 'Weighing Machines,' etc. (W. Ay.)

AKERS, C. E.; author of 'Argentine, Patagonian, and Chilian Sketches,' etc. (C. E. A.)

ALCOCK, Charles William; Secretary Surrey County Cricket Club since 1872; Hon. Sec. Football Association, 1867-90; author of 'Football our Winter Game,' 1867; editor of 'Cricket Newspaper,' 1882-1900, 'Football Annual,' 'Cricketer's Annual' (Lillywhite's), etc. (C. W. A.)

ALEXANDER, Gen. Edward Porter; General of Ordnance; and later Brigadier-General of Artillery and Chief of Artillery in Gen. Longstreet's Corps, Confederate Army. (E. P. A.)

ALEXANDER, W. D., Honolulu; author of 'A Brief History of the Hawaiian People.' (W. D. A.)

ALLBUTT, Thomas Clifford, M.A., M.D., LL.D., D.Sc., F.R.S.; Regius Professor of Physic, Camb., since 1892; Commissioner in Lunacy, 1889-92; author of 'The Ophthalmoscope in Medicine,' 'Goulstonian Lectures (On Visceral Neuroses),' 'On Scrofula,' 'Science and Medical Thought'; editor of 'System of Medicine and Gynæcology,' etc.; inventor of short clinical thermometer. (T. C. A.)

ALLDRIDGE, T. J., F.R.G.S., F.Z.S.; for many years Travelling Commissioner of Sierra Leone; District Commissioner of Sherbro District, Sierra Leone; author of 'Sherbro and its Hinterland.' (T. J. A.)

ANDERSON, Miss A. M.; Principal Lady Inspector of Factories, Home Office. (A. M. An.)

ANDERSON, W., F.R.C.S., the late; Comp. of the Order of the Rising Sun (Japan); Professor at Royal Academy; Chairman of Council of the Japan Society; Medical Director, Imperial Naval Medical College, Tokio; author of 'The Pictorial Arts of Japan,' 'Japanese Wood Engravings,' 'Cat. of Chinese and Japanese Pictures in British Museum.' (W. An.)

ANDERSON, Lt.-Col. W. P.; Chief Engineer and Superintendent of Lights, Department of Marine and Fisheries, Ottawa, Canada. (W. P. A.)

ANDREWS, Hon. Elisha Benjamin, LL.D.; Chancellor of the University of Nebraska; late Superintendent of Schools of the City of Chicago; formerly President of Brown University; author of 'Institutes of General History,' 'Institutes of Economics,' 'History of the United States,' etc. (E. B. A.)

ANSTRUTHER-THOMSON, Major W., F.G.S., F.S.A.; Inspector of Concentration Camps, S.A. (W. A.-T.)

ARCHER, William; dramatic critic of 'World' (London), 1884 onwards; edited and translated Ibsen's 'Prose Dramas'; author of 'Life of Macready,' 'Masks or Faces,' 'The Theatrical World,' 'Study and Stage,' 'America To-day, 1900,' 'Poets of the Younger Generation,' etc. (W. A.)

ARMSTRONG, Edmund Archibald, Barrister-at-Law, Inner Temple. (E. A. Ar.)

ARMSTRONG, Henry Edward, Ph.D., LL.D., F.R.S.; Professor of Chemistry at the City and Guilds of London Central Institute, South Kensington; author of 'Carbon,' etc., in Ninth Edition of 'Ency. Brit.,' 'Introduction to the Study of Organic Chemistry.' (H. E. A.)

ARMSTRONG, Sir Walter; Director of the National Gallery of Ireland; author of 'Sir Joshua Reynolds,' 'Thomas Gainsborough,' 'Sir Henry Raeburn,' 'Alfred Stevens,' 'Peter de Wint,' 'Velasquez,' 'Scottish Painters,' 'J. M. W. Turner,' etc., and co-editor of 'Bryan's Dictionary of Painters.' (W. Ar.)

ASHWORTH, Philip A., Dr. Juris, of the Inner Temple, Barrister-at-Law; associate-editor of the new volumes of the 'Encyclopædia Britannica'; editor of Taswell-Langmead's 'Constitutional History of England,' translator of Gneist's 'History of the English Constitution,' etc. (P. A. A.)

ASKWITH, Rev. Edward Harrison, M.A., D.D.; Chaplain of Trinity College, Cambridge; author of 'Christian Conception of Holiness,' 'Epistle to the Galatians,' etc. (E. H. A.)

ASTON, Lt.-Col. George Grey, R.M.A., C.B.; late Professor of Fortification, Royal Naval College, Greenwich. (G. G. A.)

ASTON, William George, M.A., Hon. D.Lit., C.M.G.; student interpreter in Japan, 1864; interpreter and translator to British Legation at Yedo, 1870; assistant Japanese Secretary, Yedo, 1875-82; acting Consul, Hiogo, 1880-83; Consul-General for Corea, 1884; Japanese Secretary, Tokio, 1886; author of 'A Grammar of the Japanese Spoken Language,' 'A Grammar of the Japanese Written Language,' 'A Translation of the Nihongi, or Annals of Ancient Japan,' 'History of Japanese Literature,' etc. (W. G. As.)

ATWATER, Wilbur Olin, Ph.D.; Professor of Chemistry, Wesleyan University, U.S.A.; Special Agent of the U.S. Department of Agriculture in charge of Nutrition investigations. (W. O. A.)

AVES, Ernest, M.A.; formerly Sub-Warden of Toynbee Hall; author of papers on sociology and economics. (E. A*.)

AXON, William Edward Armitage, LL.D.; late Dep. Librarian Manchester Free Libraries; author of 'Manchester' in Ninth Edition of 'Ency. Brit.,' 'The Annals of Manchester,' 'Manchester a Hundred Years Ago,' 'Lancashire Gleanings,' 'Stray Chapters in Literature,' 'Folk-lore and Archæology,' etc. (W. E. A. A.)

B

BACON, Edwin Monroe, M.A.; editor of 'Time and the Hour' (Boston, U.S.A.); sometime editor-in-chief of the 'Boston Globe,' the 'Boston Advertiser,' and the 'Boston Post'; author of 'Boston Illustrated,' 'Bacon's Dictionary of Boston,' 'Boston of To-day,' etc. (E. M. B.)

BADEN-POWELL, Maj. Baden F. S.; inventor of man-lifting kites; late President Aëronautical Society; author of 'In Savage Isles and Settled Lands,' many articles on ballooning, etc. (B. F. S. B.-P.)

BAGWELL, Richard, M.A., D.L., J.P.; author of 'Ireland' in the Ninth Edition of the 'Ency. Brit.,' 'Ireland under the Tudors,' and of numerous Irish biographical articles in the 'Dictionary of National Biography.' (R. Ba.)

BAIN, Robert Nisbet; Assistant Librarian, British Museum; author of 'Peter III., Emperor of Russ[illegible],' 'Gustavus III. and his Contempo[illegible]aries[illegible]' (R. N. B.)

BA[illegible]NE[illegible], Jervoise Athelstane, C.S.I.; Hon. S[illegible] (gold medallist) and Vice-President Royal S[illegible]tistical Society; Census Commissioner u[illegible]er Government of India, 1889-93; employed at India Office and as secretary to Royal Commission on Opium, 1894-95; author of Official Reports on Provincial Administration, on Indian Census Operations, 1881-91, on Indian Progress, 1894, many papers, ethnographic and statistical, for London societies. (J. A. B.)

BAKER, Henry Frederick, M.A., F.R.S.; Fellow and Lecturer of St John's College, Cambridge; University Lecturer in Mathematics. (H. F. BA.)

BALCARRES, Lord, M.P., F.S.A., F.S.A.S.; Trustee of National Portrait Gallery, London; Hon. Sec. Society for Protection of Ancient Buildings; Vice-Chairman of National Trust. (B.)

BALDRY, Alfred Lys, artist; author of 'Albert Moore: his Life and Works,' 'The Life and Works of Marcus Stone, R.A.,' 'Sir John Everett Millais,' 'Hubert von Herkomer,' etc. (A. L. B.)

BALDWIN, Hon. Simeon Eben, A.M., LL.D.; Judge of the Supreme Court of Errors of Connecticut; Professor of Constitutional and Mercantile Law, Corporations, and Wills, Yale University; sometime President of the American Bar Association and American Social Science Association; author of 'Baldwin's Connecticut Digest,' 'Cases on R.R. Law,' 'Modern Political Institutions,' etc. (S. E. B.)

BALDWIN, W. H., Jr.; President of the Loug Island R.R. Co., U.S.A.; Chairman of 'The General Education Board' (an organization for promoting education in the Southern states of the U.S.A.) (W. H. B.)

BALE, Edwin, R.I.; Art Director, Cassell and Company; Hon. Sec. Artists' Committee for Promoting Art Copyright Bill, etc. (E. BA.)

BALFOUR, Isaac Bayley, M.D., D.Sc., M.A., F.R.S., F.L.S.; Regius Keeper of Royal Botanic Garden, Edinburgh; Professor of Botany, University of Edinburgh; Transit of Venus Expedition to Rodriguez, 1874; Regius Professor of Botany, University of Glasgow, 1879-84; explored island of Socotra, 1880; Sherardian Professor of Botany, University of Oxford, and Fellow of Magdalen College, 1884-88; author of 'Botany of Rodriguez,' 'Botany of Socotra,' editor of 'Annals of Botany.' (I. B. B.)

BANCROFT, Frederic, Ph.D.; Chief of Bureau of Rolls and Library, U.S. Department of State; author of 'Life of William H. Seward,' etc. (F. BA.)

BANISTER, G. H., M.I.C.E., M.I.M.E.; late Assistant to Superintendent of the Royal Carriage Department, Woolwich; Whitworth Scholar. (G. H. BA.)

BARCLAY, Thomas, LL.B., Ph.D.; member of the Institute of International Law; Vice-President of the International Law Association; Examiner in Jurisprudence and International Public and Private Law to the University of Oxford, 1900; member of the Supreme Council of the Congo Free State; Vice-President of the Franco-Scottish Society; President of the British Chamber of Commerce in Paris, 1899-1900; Knight of the Legion of Honour and of the Order of Leopold; author of 'Companies in France,' and other law books, all the articles on International Law in the 'Encyclopædia of the Law of England,' etc. (T. BA.)

BARING, The Hon. Maurice; Attaché to the British Embassy, Paris, 1899; Third Secretary to the British Embassy, Rome, 1902. (M. BA.)

BARLOW, Major H. W., R.A.; Secretary to Chief Superintendent, Royal Ordnance Factories, Woolwich. (H. W. B.)

BARNES, William Emery, D.D.; Fellow of Peterhouse, Cambridge; Hulsean Professor of Divinity, Cambridge; assist. editor of 'Journal of Theological Studies'; Lecturer in Hebrew at Clare Coll. Camb., 1885-94; in Hebrew and Divinity at Peterhouse, 1889-1901; author of 'The Genuineness of Isaiah xxiv.-xxvii.,' 'Canonical and Uncanonical Gospels, 'The Peshitta Text of Chronicles,' I. II. Chronicles, with Introduction and Notes (Cambridge Bible). Isaiah (Churchman's Bible). (W. E. B.)

BARNETT, Rev. Samuel Augustus, M.A.; Canon of Bristol; Founder and Warden of Toynbee Hall, Whitechapel; President of the Sunday Society; Chairman Whitechapel Board of Guardians, 1894; Chairman of Children's Country Holiday Fund; Chairman Pupil Teachers' Scholarship Fund; author of 'Practicable Socialism' with Mrs Barnett, 'Service of God.' (S. A. B.)

BARRETT, F. N., editor of the 'American Grocer' (New York). (F. N. B.)

BARTLET, Rev. J. Vernon, M.A.; Professor of Church History, Mansfield College, Oxford; author of 'Early Church History,' 'The Apostolic Age,' etc. (J. V. B.)

BARTLEY, George Christopher Trout, M.P.; Assistant-Director of Science Division of Science and Art Department, London, till 1880; established National Penny Bank, 1875; author of 'A Square Mile in the East of London,' 'Schools for the People,' 'Provident Knowledge Papers,' 'The Seven Ages of a Village Pauper,' 'The Parish Net.' (G. C. T. B.)

BARWICK, G. F., B.A.; Assistant Keeper of Printed Books and Superintendent of Reading-room, British Museum; author of 'International Exhibitions,' 'The Laws Regulating Printing and Publishing in Spain,' and translator of various works of travel, etc. (G. F. B.)

BASSETT, John Spencer, Ph.D.; Professor of History, Trinity College, N.C.; author of 'Constitutional Beginnings of North Carolina,' 'Slavery and Servitude of the Colony of North Carolina,' 'Anti-Slavery Leaders of North Carolina,' 'Slavery in the State of North Carolina.' (J. S. BA.)

BASTABLE, C. F., M.A., LL.D.; Professor of Political Economy, Dublin University, 1882; author of 'Money' in Ninth Edition of 'Ency. Brit.,' 'Theory of International Trade,' 'Commerce of Nations,' 'Public Finance,' 'Dictionary of Political Economy,' and 'Economic Journal. (C. F. B.)

BATHER, Francis Arthur, M.A., D.Sc., F.G.S.; Asst. Keeper of the Geological Department of the British Museum (South Kensington); Hon. Member Soc. Linnéenne de Normandie; author of 'Concise Knowledge of Natural History,' 'The Genera and Species of Blastoidea,' 'Echinoderma' (in Lankester's 'Zoology'), 'The Crinoidea of Gothland,' etc. (F. A. B.)

BAUERMAN, H., F.G.S.; Lecturer on Metallurgy, Ordnance College, Woolwich; author of 'Bismuth,' 'Coal,' 'Fuel,' 'Furnace,' etc., in Ninth Edition of 'Ency. Brit.,' 'A Treatise on the Metallurgy of Iron,' 'Text-book of Systematic Mineralogy,' etc. (H. B.)

BEALBY, J. T., B.A.; sometime acting editor of 'Scottish Geographical Magazine'; author of 'A Daughter of the Fen,' and numerous geographical magazine articles; joint author of 'Stanford's Compendium: Europe'; translator of Sven Hedin's 'Through Asia.' (J. T. BE.)

BEDDARD, Frank Evers, M.A., F.R.S.; Prosector of Zoological Soc. of England since 1884, and Vice-Sec. since 1898; formerly Lecturer on Biology at Guy's Hospital; has been Examiner in Zoology and Comparative Anatomy, University of London, and of Morphology at Oxford; now Examiner in the University of New Zealand; naturalist to 'Challenger' Expedition Commission, 1882-84; author of 'Worm' in Ninth Edition of 'Ency. Brit.,' 'Animal Coloration,' 'Text-book of Zoogeography,' 'A Monograph of the Oligochæta,' 'Structure and Classification of Birds'; and 'Mammalia' ('Cambridge Natural History'). (F. E. B.)

BELL, Charles Frederic Moberly; asst. manager of 'The Times'; formerly correspondent of 'The Times' in Egypt; author of 'Khedives and Pashas,' 'Egyptian Finance,' 'From Pharaoh to Fellah,' etc. (C. F. M. B.)

BELL, Dr Louis, Boston, U.S.A.; author of 'The Elements of Practical Electricity,' 'Power Distribution for Electric Railroads,' 'Electric Power Transmission,' etc. (L. BL.)

BELL, Malcolm; author of 'Rembrandt,' 'Sir E. Burne-Jones,' etc. (M. BE.)

BELLAIRS, Carlyon W.; Lieut. R.N., retired; writer of articles on naval subjects; Lecturer to the War Course of Captains and Commanders at the R. N. College, Greenwich; Medallist of the Society of Arts (for paper on the Coal Problem, 1901). (C. W. BE.)

BELLINGER, Hon. Charles Byron; Judge of the U.S. District Court, District of Oregon. (C. B. B*.)

BELTRAMI, Luca; architect; author of 'Storia della facciata di St Maria del Fiore in Firenza,' 'La Basilica Ambrosiana primitiva e la ricostruzione compiuta nel secolo IX,' etc. (L. BI.)

BÉNÉDITE, Léonce; Conservator, Musée du Luxembourg, Paris; author of 'Alphonse Legros'; editor of 'Bulletin des Musées,' etc. (L. BE.)

BENSON, Arthur Christopher, M.A., F.R.Hist. Soc.; Master at Eton College since 1885; author of 'Memoirs of Arthur Hamilton,' 'Archbishop Laud: a Study,' 'Poems,' 'Lyrics,' 'Essays,' 'Lord Vyet and other Poems,' 'Fasti Etonenses,' 'Life of Archbishop Benson,' 'The Professor, and other Poems.' (A. C. BE.)

BERG, Sigvard Johnson, A.M.I.C.E., Switzerland. (S. J. B.)

BERNARD, Rev. John Henry, D.D.; Fellow of Trin. Coll., Dublin; Archbishop King's Lecturer in Divinity, University of Dublin; member of University Council, 1892; Vice-Warden, Alexandra Coll., Dublin, for higher education of women, 1894; Secretary of Royal Irish Academy, 1899; Commissioner of National Education, Ireland, 1897; part-editor of 'Kant's Critical Philosophy for English Readers,' translator of 'Kant's Kritik of Judgment, joint-author of 'The Literature of the Second Century,' editor of 'The Pilgrimage of St Silvia of Aquitania,' 'The Pastoral Epistles of St Paul,' 'The Works of Bishop Butler,' etc. (J. H. BE.)

BERNSTEIN, Eduard; German Socialistic politician and writer; late editor of the 'Social Democrat'; author of 'On the History and Theory of Socialism,' 'The Communistic and Democratic-Socialistic Movements in England during the 17th Century,' etc. (E. BN.)

BERRY, George Andreas, M.B., F.R.C.S., F.R.S. Edin.; Vice-Pres. Ophthalmological Soc.; author of 'Diseases of the Eye,' 'The Elements of Ophthalmoscopic Diagnosis,' 'Subjective Symptoms in Eye Diseases,' etc. (G. A. BE.)

BESANT, Sir Walter, M.A., F.S.A., the late; Secretary Palestine Exploration Fund, 1868-85; Hon. Sec. Palestine Exp. Fund; First Chairman Society of Authors, 1884-85; Chairman Society of Authors, 1887-1892; author of 'Froissart' in Ninth Edition of 'Ency. Brit.,' 'Studies in Early French Poetry,' 'Rabelais,' Lives of 'Coligny,' 'Whittington,' 'Edward Palmer,' and 'Richard Jefferies,' 'London,' 'Westminster,' 'South London,' many Novels with the late James Rice. Novels alone: 'The Revolt of Man,' 'All Sorts and Conditions of Men,' 'Beyond the Dreams of Avarice,' 'The Orange Girl,' etc. (W. BE.)

BHOWNAGREE, Sir Mancherjee Merwanjee, K.C.I.E., M.P.; State Agent, Bombay, for the territory of Bhavnagar, 1873; author of 'History of the Constitution of the East India Company,' Gujerati translation of 'Her Majesty's Life in the Highlands,' etc. (M. M. BH.)

'BICKERDYKE, John' (Charles Henry Cook), M.A.; writer on angling and sporting subjects; President of Thames Re-stocking Association, and the Fly-Fishers' Club, 1899-1900; editor of the angling department of the 'Field'; author of 'Angling in Salt Water,' 'The Book of the All Round Angler,' 'Thames Rights and Thames Wrongs,' 'Days in Thule with Rod, Gun, and Camera,' 'Sea-Fishing,' 'Days of My Life in Water, Fresh and Salt,' 'Wild Sports in Ireland,' 'Letters to Young Sea-Fishers,' etc. ('J. B.')

BIDWELL, Shelford, M.A., Sc.D., F.R.S.; barrister; President of Physical Society, England, 1897-99; author of 'Curiosities of Light and Sight,' and numerous memoirs on physical subjects. (S. BI.)

BINDLOSS, Harold; Secretary Royal Mersey Yacht Club. (H. BS.)

BINYON, Laurence; assistant in the British Museum, Department of Printed Books, 1893; transferred to Department of Prints and Drawings, 1895; author of 'Lyric Poems,' 'Poems,' 'London Visions,' 'The Praise of Life, 'Porphyrion and other Poems,' 'Western Flanders,' 'Odes,' 'Catalogue of English Drawings in the British Museum.' (L. B.)

BIRD, Christopher John, C.M.G.; Principal Under Secretary of the Colony of Natal, and a Member of the Civil Service Board. (C. J. BI.)

BIRDWOOD, Sir George Christopher Molesworth, M.D., K.C.I.E., C.S.I., LL.D.; special assistant in Revenue and Statistics Department India Office, 1871-99; author of 'Incense' in Ninth Edition of 'Ency. Brit.,' 'Economic Vegetable Products of the Bombay Presidency,' 'The Industrial Arts of India,' 'Report on Old Records of the India Office,' 'First Letter Book of East India Company,' Appendix on the Aryan Fauna and Flora to Max-Müller's 'Biography of Words,' etc. (G. B.)

BIRKBECK, William John, M.A., F.S.A.; author of 'Russia and the English Church.' (W. J. BI.)

BIRKINBINE, John, M.E.; President of the Franklin Institute and the Pennsylvania Forestry Association; sometime President American Institute of Mining Engineers, and editor 'Journal of Iron Workers.' (J. BI*.)

BIRRELL, Augustine, K.C.; Hon. Fellow, Trinity Hall, Cambridge; LL.D. St Andrews (Honorary); Quain Professor of Law, University Coll. London, 1896; M.P. (L.) Fifeshire W., 1889-1900; author of Obiter Dicta, 1884, 1887; Life of Charlotte Brontë, 1885; Res Judicatae, 1892; Men, Women, and Books, 1894; Lectures on the Duties and Liabilities of Trustees, 1896; editor of Boswell's Life of Johnson, 1897; Sir Frank Lockwood, 1898; Collected Essays, 1900. (A. BI.)

BISHOP, Mrs Isabella L. (Miss Isabella Bird), F.R.G.S., Hon. F.R.S.G.S.; Hon. Member of Oriental Society, Pekin; first lady Fellow of the Royal Geographical Society; author of 'The Englishwoman in America,' 'Six Months in the Sandwich Islands,' 'A Lady's Life in the Rocky Mountains,' 'Unbeaten Tracks in Japan,' 'The Golden Chersonese,' 'Journeys in Persia and Kurdistan,' 'Among the Tibetans,' 'Korea and her Neighbours,' 'The Yangtze

Valley and Beyond,' 'Pictures from China,' etc. (I. L. B.)

BLACK, John A.; press reader of the New Volumes of the 'Ency. Brit.' (J. A. Bl.)

BLAIN, W.; of the Treasury, Whitehall. (W. Bl.)

BLAIR, Andrew A.; chief chemist of the U.S. Geological Survey, Division of Mining and Geology, Tenth Census of the United States; author of 'The Chemical Analysis of Iron,' etc. (A. A. B.)

BLAKE, Rev. John Frederick, M.A., F.R.S.; sometime Professor of Natural Science, University College, Nottingham; author of 'British Fossil Cephalopoda,' 'The Geological Society of London,' 'Astronomical Myths,' 'Yorkshire Lias,' etc. (J. F. Bl.)

BLAKE, Prof. William Phipps, Ph.B.; Director School of Mines, University of Arizona, and territorial geologist of Arizona; author of 'Geological Reconnaissance of California,' 'Silver Ores and Silver Mines,' etc. (W. P. B.)

BLŎNDAL, Sigfús, of the University Library, Copenhagen. (S. Bl.)

BLOUNT, Bertram, F.C.S., F.I.C.; consulting chemist to the Crown Agents for the Colonies; Hon. President Cement Section of International Assoc. for Testing Materials, Buda-Pesth. (B. Bl.)

BLOWITZ, Henri Georges Stephane Adolphe Opper de; 'The Times' correspondent in Paris; Professor of German at Tours, Limoges, Poitiers, and Marseilles; entered on service of 'The Times,' July 1871; inaugurated constant telegraphic communications and obtained the concession from 9 P.M. to 3 A.M. of a special wire for 'The Times' from 9 May 1874; officer of the Legion of Honour; Doctor of Philosophy; officer of the Institute of France; author of 'Feuilles Volantes,' 'L'Allemagne et la Provence,' 'Le Mariage royal d'Espagne,' 'Une Course à Constantinople.' (de B.)

BLUNT, Capt. Charles Jasper, R.A.; Chief Ordnance Officer, Guernsey; served in the Chitral campaign, etc. (C. J. B.)

BODLEY, John Edward Courtenay, M.A.; private secretary to President of Local Government Board, 1882-85; secretary to Royal Commission on Housing of the Working Classes, 1884-85; author of 'France': vol. i. 'The Revolution and Modern France,' vol. ii. 'The Parliamentary System,' (French ed. 1901), 'L'Anglomanie et les traditions françaises.' (J. E. C. B.)

BOLTZMANN, Ludwig; Professor of Theoretical Physics, University of Vienna; Hon. Member Royal Academy of Sciences, Berlin; author of 'Lectures on the Theory of Gas,' 'Lectures on Maxwell's Theory of Electricity and Light'; editor of 'Maxwell's Physical Forces.' (L. Bo.)

BONAR, James, M.A., LL.D.; senior Examiner Civil Service Commission, Westminster; junior Examiner in H.M. Civil Service Commission, 1881; senior Examiner, *ibidem*, end of 1895; President of Section F of British Association, 1898; author of 'Malthus and his Work,' 'Ricardo's Letters to Malthus,' 'Philosophy and Political Economy,' 'Catalogue of Adam Smith's Library' (part), 'Ricardo's Letters to Trower.' (J. B*.)

BONNEY, Rev. Thomas George, D.Sc., LL.D., F.R.S.; late Professor of Geology, University Coll. London; Hon. Canon of Manchester; Fellow of St John's Coll. Camb.; Hulsean Lecturer (Camb.), 1884; President Geological Society, 1884-86; Boyle Lecturer, 1890-92; Rede Lecturer (Camb.), 1892; Vice-President Royal Society, 1899; author of 'The Alpine Regions,' 'The Story of our Planet,' 'Charles Lyell and Modern Geology,' 'Ice-Work,' 'Volcanoes,' etc. (T. G. B.)

BONUS, Ernest Melvill, B.A.; Barrister-at-Law, Lincoln's Inn, and Deputy Judge Advocate. (E. M. Bs.)

BOSCO, Augustus; Professor of Statistics, University of Rome. (A. Bo.)

BOULENGER, George A., F.R.S., F.Z.S.; assistant, Dept. of Zoology, Brit. Museum, since 1882; author of numerous works on Zoology. (G. A. B.)

BOURCHIER, James David, M.A.; sometime Scholar of King's College, Cambridge; Correspondent of 'The Times' at Athens. (J. D. B.)

BOURGET, Paul, poet, critic, and novelist; member of French Academy since 1894; officer of the Legion of Honour, 1895; author of La Vie inquiète, 1874; Edel, 1878; Les Aveux, 1882; Essais de Psychologie, 1883; Nouveaux Essais de Psychologie, 1885; Études et Portraits, 1887; Pastels, 1889; Physiologie de l'Amour moderne, 1890; Sensations d'Italie, 1891; Nouveaux Pastels, 1891; Outre Mer, 1895; L'Irréparable, 1884; Cruelle Enigme, 1885; Un Crime d'Amour, 1886; André Cornélis, 1887; Mensonges, 1887; Le Disciple, 1889; Un cœnr de femme, 1890; La Terre Promise, 1892; Cosmopolis, 1892; Un Scrupule, 1894; Un Idylle Tragique, 1896; Voyageuses, 1897; Recommencements, 1897; Complications Sentimentales, 1898; La Duchesse Bleue, 1898; Drames de Famille, 1900; Un Homme d'Affaires, 1900; Le Fantôme. (P. B*.)

BOURNE, Gilbert Charles, M.A., D.Sc., F.L.S.; Fellow and Tutor of New Coll. Oxford; assistant to Linacre Professor of Comparative Anatomy, Oxford, 1887-88; Director, Marine Biological Association, United Kingdom, 1889-1890; assistant to Linacre Professor at Oxford, 1892-1900; University Lecturer in Comparative Anatomy, 1898; author of various memoirs on Comparative Anatomy, an 'Introduction to Study of Comp. Anatomy of Animals,' articles Anthozoa and Ctenophora, in Lankester's 'Zoology,' etc. (G. C. B.)

BOURNE, Henry Eldridge; Professor of History, College for Women, Western Reserve University, U.S. (H. E. B.)

BOWER, Frederick Orpen, Sc.D., F.R.S., F.L.S.; Regius Professor of Botany, University of Glasgow, since 1885; author of 'A Course of Practical Instruction in Botany,' 'Practical Botany for Beginners,' etc. (F. O. B.)

BOWLEY, A. L.; author of 'Elements of Statistics,' 'Wages in the United Kingdom in the Nineteenth Century,' etc. (A. L. Bo.)

BOYD, Charles Walter, B.A. (Edin.); journalist; sometime private secretary in South Africa to Dr Jameson and Mr Cecil Rhodes. (C. W. B*.)

BRABROOK, Edward William, C.B., F.S.A., V.P.S.S., V.P.R.S.L.; V.P. Royal Archæological Institute since 1900; Chief Registrar of Friendly Societies since 1891; President Anthropological Institute, 1895-97; President Folk-Lore Society, 1901; Foreign Associate, Society of Anthropology of Paris, 1901; author of 'Building Societies,' 'Friendly Societies,' 'Savings Banks' in Ninth Edition of 'Ency. Brit.,' 'Provident Societies and Industrial Welfare,' 'History of Royal Society of Literature.' (E. W. B.)

BRADFORD, John R., M.D., D.Sc., F.R.C.P., F.R.S.; member of Senate of University of London; physician to University Coll. Hospital London; Professor of Materia Medica and Therapeutics, University College, London; Professor Supt. of the Brown Institution; author of papers on medical and scientific subjects in Proc. Roy. Soc. and in Transactions of medical societies, etc. (J. R. B.)

BRÆKSTAD, H. L.; Anglo-Norwegian journalist; translator of standard Norwegian works. (H. L. B.)

BRAMWELL, Capt. G. A.; School of Signalling, Aldershot; Deputy-Assistant-Adjutant-General for signalling. (G. A. Br.)

BRANNER, John Casper, Prof., Ph.D., LL.D.; Geologist, Imperial Geolog. Commission, Brazil, 1875-1877; Agent U.S. Department of Agriculture in Brazil, 1882-83; acting President, Stanford University, U.S.A., 1898-99; Fellow of Geolog. Soc. of London and Société Géologique de France; member of various scientific societies of North and South America; author of numerous publications on Brazil. (J. C. Br.)

BRANTLY, William Theophilus; reporter of the Maryland Court of Appeals; ex-secretary of State of Maryland; author of 'Maryland' in Ninth Edition of 'Ency. Brit.,' 'Law of Personal Property.' (W. T. B.)

BRASSEY, Lord, 1st Baron, K.C.B., D.C.L.; Knight of St John of Jerusalem; Commander of Legion of Honour, 1889; President Statistical Society, 1879-80; Civil Lord of Admiralty, 1880-83; Secretary to Admiralty, 1883-85; Chairman of Opium Commission; President of the Institution of Naval Architects, 1893-95; Governor of Victoria, 1895-1900; author of 'Work and Wages,' 'Naval Annual,' 'British Navy,' 'British Seamen,' 'British Work and Foreign Wages,' etc. (Br.)

BRETT, Michael, Barrister, Middle Temple. (M. Bt.)

BRICKDALE, C. Fortescue, Barrister, Lincoln's Inn; author of 'The Law and Practice regarding the Registration of Deeds in the County of Middlesex,' 'Notes on Land Transfer,' 'Registration of Title to Land,' part author of 'The Land Transfer Acts, 1875 and 1897,' etc. (C. F. Br.)

BRIDGE, Vice-Admiral Sir Cyprian Arthur George, K.C.B.; Commander-in-Chief, China station; member of Committee on Heavy Guns, 1878; of War Office Committee on Machine Guns, 1879; of Ordnance Committee, 1881; Director of Naval Intelligence, 1889-94; Commander-in-Chief Australian station, 1895-98; author of 'Signals' in Ninth Edition of 'Ency. Brit.' (C. A. G. B.)

BRIGHTMAN, Rev. Frank Edward, M.A.; Pusey Librarian, Oxford, since 1884; Chaplain Univ. Coll. Oxford, 1884-87; author of 'What Objections have been made to English Orders?'; editor of 'Liturgies Eastern and Western,' 'The Oxford Library of Practical Knowledge,' etc. (F. E. Br.)

BRINKLEY, Capt. F., R.A.; proprietor and editor of the 'Japan Mail,' Yokohama; edited 'Japan'; translated 'The History of Japan'; compiled 'An Unabridged Japanese and English Dictionary,' etc. (F. By.)

BROADFOOT, Major William, R.E.; author of the Badminton 'Billiards'; edited 'Career of Major George Broadfoot, C.B., in Afghanistan and the Punjaub,' etc. (W. Br.)

BROOME, Lady, widow of the late Sir F. Napier Broome, Governor of West Australia; author of 'Station Life in New Zealand,' etc. (M. A. B.)

BROOMHALL, G. J. S., editor of 'Corn Trade Year-Book,' etc. (G. J. S. B.)

BROWNE, Edward Granville, M.A., M.B.; Fellow of Pembroke College, Cambridge, and Professor of Persian; editor of 'The Episode of the Bab,' etc. (E. G. B.)

BROWNLOW, Rt. Rev. William Robert [the late], M.A., D.D., R.C. Bishop of Clifton; provost, and domestic prelate to Pope Leo XIII.; co-editor of 'English Roma Sotterranea'; author of 'Early Christian Symbolism'; Memoirs of Melise Brownlow, Sir James Marshall, and Mother Rose Columba Adams, O.P.; Lectures on Slavery and Serfdom, on Church History, on Sacerdotalism, on the Catacombs, and other Archæological subjects; translation of 'Cur Deus Homo,' and 'Vitis Mystica.' (✠ W. R. B.)

BRUNTON, Sir Thomas Lauder, M.D., Sc.D., LL.D. (Edin. and Aberd.), F.R.S.; physician to St Bartholomew's Hospital, London; author of 'The Bible and Science,' 'Text-Book of Pharmacology, Therapeutics, and Materia Medica,' 'Disorders of Digestion,' 'Lectures on the Action of Medicines.' (T. L. B.)

BRYAN, George Hartley, Sc.D., F.R.S.; Professor of Pure and Applied Mathematics in the University College of North Wales; Fellow of Peterhouse, 1889-95; gold medal Inst. Naval Architects, 1901. (G. H. Br.)

BRYANT, Hon. Edgar E., LL.D.; Justice of the Circuit Court of Arkansas, 1890-97; author of 'Speeches and Addresses,' etc. (E. E. B.)

BRYCE, Rt. Hon. James, P.C., D.C.L., LL.D., F.R.S., M.P.; Regius Professor of Civil Law at Oxford, 1870; Under-Secretary of State for Foreign Affairs, 1886; Chancellor of Duchy of Lancaster (with seat in Cabinet), 1892; President of Board of Trade, 1894; Chairman of Royal Commission on Secondary Education, 1894; member of Senate of London University, 1893; corresponding member of Institute of France, 1891; foreign member of Royal Academies of Turin and Brussels, 1896; corresponding member of Società Romana di Storia Patria, 1885; honorary Fellow of Trinity and Oriel Colleges, Oxford; president of the Alpine Club; author of 'Emperor and Empire,' 'Justinian,' 'Procopius,' 'Theodora,' in Ninth Edition of 'Ency. Brit.,' 'The Holy Roman Empire,' 'The Trade Marks Registration Act,' 'Transcaucasia and Ararat,' 'The American Commonwealth,' 'Impressions of South Africa,' etc. (J. Br.)

BRYDON, J. M., the late; architect; designed various Government Offices, Chelsea Town Hall and Polytechnic, Bath Municipal Buildings, etc. (J. M. By.)

BUCHANAN, John Young, M.A., F.R.S.; chemist and physicist of the 'Challenger' Expedition; later, Lecturer in Geography, University of Cambridge; author of 'Lake,' 'Mediterranean,' in Ninth Edition of 'Ency. Brit.' (J. Y. B.)

BUCKLEY, Rev. James Monroe, D.D., LL.D.; editor of 'The Christian Advocate' (New York); author of 'Travels in three Continents,' 'Faith Healing,' 'Christian Science and Kindred Phenomena,' 'Supposed Miracles,' etc. (J. M. Bu.)

BÜRDE, Lieut. Johannes, late of the German army, 51st Infantry Regiment; author of 'Problems of Applied Tactics, with Solutions,' 'Tactical Problems,' etc. (J. Be.)

BURDETT, Sir Henry, K.C.B.; founder and editor of the 'Hospital'; late superintendent of the Queen's Hospital, Birmingham, and of the Seamen's Hospital, Greenwich; late secretary Share and Loan Department, London Stock Exchange; author of 'Burdett's Official Intelligence of British, American, and Foreign Securities,' 'The National Debt,' 'Local Taxation in England and Wales,' 'The Patriotic Fund,' 'Hospitals and Asylums of the World,' 'The Relative Mortality of Large and Small Hospitals,' 'Burdett's Hospitals and Charities, a Year-book of Philanthropy,' 'Hospitals and the State,' 'Unhealthiness of Public Institutions,' 'A Practical Scheme for Old Age Pensions,' 'The Registration of Nurses,' 'The Nursing Profession, how and where to Train,' 'Housing of the Poor,' etc. (H. Bt.)

BURN, Rev. A. E., B.D.; Examining Chaplain to the Bishop of Lichfield; author of 'The Athanasian Creed,' 'An Introduction to the Creeds and to the Te Deum,' etc. (A. E. B.)

BURNSIDE, Rev. Frederick, M.A.; Hon. Canon St Albans; Rural Dean of Hertford; Hon. editor of the 'Official Year-Book of the Church of England'; compiler of 'The Official Parochial Register of Church Services,' etc. (F. Bu.)

BURNSIDE, William, M.A., F.R.S.; Professor of Mathematics, Royal Naval College, Greenwich. (W. Bu.)

BURROUGHS, John, author of 'Wake Robin,' 'Signs and Seasons,' 'Birds and Poets,' 'Fresh Fields,' 'Whitman: A Study,' etc. (J. Bu.)

BURROWS, Rev. Winfrid Oldfield, M.A.; Vicar of Holy Trinity, Leeds; formerly Principal of Leeds Clergy School and Tutor of Christ Church, Oxford. (W. O. B.)

BURTON, Clarence Monroe, LL.D.; author of 'Life of Cadillac, founder of Detroit,' 'Revisited Landmarks of Detroit,' etc. (C. M. B.)

BURTON, William, F.C.S.; author of Cantor Lectures on 'Material and Design in Pottery,' etc. (W. B*.)

BUTLER, Alfred Joshua, M.A.; Fellow of Brasenose College, Oxford; author of 'Tyrol' in Ninth Edition of 'Ency. Brit.' (A. J. B.)

BUTLER, Prof. Nicholas Murray, Ph.D.; Pres. Columbia University, New York; author of 'The Meaning of Education,' etc.; editor of the 'Educational Review' and of the 'Great Educators' series. (N. M. B.)

C

CABLE, George Washington, A.M., D.L.; author of 'New Orleans' in Ninth Edition of 'Ency. Brit,' 'Old Creole Days,' 'The Grandissimes,' 'Dr Sevier,' 'John March, Southerner,' etc. (G. W. Ca.)

CAILLARD, Sir Vincent Henry Penalver, K.B.; Assistant Commissioner for England on Montenegrin Frontier Commission, 1879; on Arab Tabia Commission, 1879; attached to Sir Beauchamp Seymour, Naval Demonstration, Dulcigno, 1880; service for Intelligence Department, 1882; attached Headquarters Staff Egyptian Campaign, 1882; appointed President Ottoman Public Debt Council, 1883; and Financial Representative of England, Holland, and Belgium in Constantinople; medal and bronze star, Egyptian campaign; Grand Cordons Medjidieh and Osmanieh; gold medals of Liakat and Nishan-i-Imtiaz; Grand Cordon of Ordre pour le mérite civile. (V. H. P. C.)

CALLENDAR, Hugh Longbourne, LL.D., F.R.S.; Professor of Physics, Royal Coll. of Science, London; Professor of Physics, M'Gill Coll. Montreal, 1893-98. (H. L. C.)

CAMP, Walter, Newhaven, U.S.A., author of 'Book of College Sports,' 'American Football,' etc. (W. Ca.)

CAMPBELL, J. G. D., M.A.; H.M.'s Inspector of Schools; educational adviser to the King of Siam, 1899-1901. (J. G. D. C.)

CAMPBELL, Rev. Lewis, M.A., LL.D.; emeritus Professor of Greek, University of St Andrews; Hon. Fellow of Balliol Coll. Oxford; Gifford Lecturer, St Andrews, 1894-95; author of 'Plato,' 'Sophocles' in Ninth Edition of 'Ency. Brit.,' 'The Christian Ideal,' part 'Life of James Clerk-Maxwell,' 'Sophocles in English Verse,' 'Aeschylus in English Verse,' 'Guide to Greek Tragedy'; edition of 'Plato's Republic' (with late Professor Jowett), 'Life of Benjamin Jowett' (with E. Abbott), 'Religion in Greek Literature,' 'Letters of B. Jowett' (with E. Abbott), 'The Nationalization of the Old English Universities.' (L. C.)

CANA, Frank R., F.R.G.S.; journalist and writer on African subjects; author of 'Traveller's Companion and Guide,' and 'Boers and British,' 1899; for many years on the staff of the 'St. James's Gazette.' (F. R. C.)

CARLYLE, E. I., M.A., F.R.Hist.Soc.; Fellow of Merton College, Oxford; assist. editor to the 'Dictionary of National Biography.' (E. I. C.)

CAROE, William Douglas, M.A., F.S.A.; Architect to Ecclesiastical Commission, to the Dean and Chapter of Canterbury, etc.; Fellow and Member of the Council R.I.B.A.; part author of 'Sefton.' (W. D. C.)

CARSON, Howard A., formerly chief engineer of the Metropolitan (Greater Boston, U.S.A.) Sewerage Commission and now chief engineer of the Boston Transit Commission; in charge of the building of the Boston Subway and the East Boston Tunnel; sometime President of the Boston Society of Civil Engineers. (H. A. C.)

CARTER, Albert Charles Robinson; assistant editor of 'The Year's Art,' 1887; editor, 1894; editor of 'The Year's Music,' 1898; contributor to 'The Art Journal' since 1889; art critic of 'Manchester Courier'; art critic for 'Pall Mall Gazette'; writer of 'The Art Annual, 1900, on War Artists.' (A. C. R. C.)

CARVER, Thomas Gilbert, M.A., K.C.; author of 'On the Law relating to the Carriage of Goods by Sea.' (T. G. C.)

CASE, Thomas, M.A.; Waynflete Professor of Moral and Metaphysical Philosophy, Oxford; Fellow of Magdalen; formerly Fellow and Tutor of B.N.C., and C.C.C.; author of 'Materials for History of Athenian Democracy from Solon to Pericles,' 'Realism in Morals,' 'Physical Realism,' 'St Mary's Clusters.' (T. Ca.)

CASTLE, Egerton, M.A., F.S.A.; author of 'Schools and Masters of Fence,' 'Consequences,' 'English Book-Plates,' 'The Light of Scarthey,' 'The Jerningham Letters,' 'The Pride of Jennico,' 'The Bath Comedy,' 'Young April,' 'Marshfield the Observer,' 'The Secret Orchard,' etc. (E. Ca.)

CHADWICK, Capt. French Ensor, in command of U.S. cruiser 'New York,' flagship N. Atlantic Squadron; Chief of Staff of Rear-Admiral Sampson in the Spanish-American War. (F. E. Ch.)

CHALMERS, Mackenzie Dalzell, C.S.I., M.A.; assistant parliamentary counsel to Treasury, England; counsel to Board of Trade; Judge of County Courts, 1884; acting Chief Justice, Gibraltar, 1893; Commissioner of Assize, 1895; member of the Statute Law Committee, and Board of Faculty of Law of Oxford; law member of the Viceroy's Council in India; author of contributions to 'Dictionary of Political Economy and 'Encyclopædia Britannica,' 'Digest of the Law of Bills of Exchange,' 'Digest of the Law of Sale,' etc. (M. D. Ch.)

CHAMBERLAIN, Hon. Joshua Lawrence, A.M., LL.D.; Brigadier-General in the U.S. Civil War; Governor of Maine, 1866-71, and President of Bowdoin College, 1871-83; author of 'Maine' in Ninth Edition of 'Ency. Brit.,' 'Maine: Her Place in History,' 'American Ideals,' etc. (J. L. C.)

CHANEY, Henry James, Superintendent Standards Department Board of Trade; Secretary to Royal Commission on Standards, 1867-70; represented Great Britain at International Conference on the Metric System, 1901; author of 'Treatise on Weights and Measures.' (H. J. C.)

CHANNING, Edward, Ph.D.; Professor of History, Harvard University; author of 'History of the United States,' 'Town and County Government in the English Colonies of North America,' 'Narragansett Planters,' etc.; collaborator with the late Dr Justin Winsor on the 'Narrative and Critical History of America.' (E. Ch.)

CHANUTE, Octave, late President American Society of Civil Engineers; honorary member Institution of Civil Engineers, Great Britain; author of 'Kansas City Bridges,' 'Progress in Flying Machines,' etc. (O. C.)

CHAPMAN, Alfred, M.I.C.E.; designer and constructor of sugar machinery. (A. Ch.)

CHARLES, Rev. Robert Henry, M.A., D.D.; Professor of Biblical Greek, Trin. Coll. Dublin; author of 'Book of Enoch,' translated from the Ethiopic and edited 'Ethiopic Text of Book of Jubilees, edited from four MSS.,' 'Book of the Secrets of Enoch,' 'Apocalypse of Baruch,' translated from the Syriac and edited 'The Assumption of Moses,' 'The Doctrine of a Future Life,' 'Jowett Lectures for 1898-99.' (R. H. C.)

CHATAWAY, James Vincent, M.L.A., the late; Secretary for Agriculture, Queensland. (J. V. C.)

CHIROL, Valentine; B.Lit. University of Paris; foreign editor of 'The Times'; author of 'The Far Eastern Question,' ''Twixt Greek and Turk,' etc. (V. C.)

CHISHOLM, G. G., M.A., B.Sc.; author of 'The Commerce of the British Empire,' joint-author of 'Europe' in Stanford's 'Compendium of Geography and Travel'; edited Longman's 'Gazetteer of the World.' (G. G. C.)

CHISHOLM, Hugh, B.A.; formerly scholar C.C.C., Oxford; Barrister-at-Law of the Middle Temple; assistant editor of the 'St James's Gazette,' 1892-97; editor, 1897-1900. Contributor to 'Fortnightly Review,' 'National Review,' 'The Times,' 'Standard,' etc.; Joint-editor of the New Volumes of the 'Encyclopædia Britannica.' (H. Ch.)

CHREE, Charles, M.A., Sc.D., LL.D., F.R.S.; late Fellow of King's College, Camb.; Superintendent Observatory Department, National Physical Laboratory. (C. Ch.)

CHRISTY, S. B., Ph.B.; Professor of Mining and Metallurgy and Dean of the Faculty of the College of Mining, University of California. (S. B. C.)

CHURCH, Arthur Herbert, M.A., D.Sc., F.R.S., F.S.A.; Professor of Chemistry, Royal Academy of Arts; Professor of Chemistry in the Royal Agricultural Coll. Cirencester; Lecturer, Cooper's Hill; President of Mineralogical Society, 1898-1901; author of 'Guano,' 'Hemp,' 'Irrigation,' in Ninth Edition of 'Ency. Brit.,' 'Precious Stones,' 'English Earthenware,' 'English Porcelain,' 'The Laboratory Guide,' 'Food Grains of India,' 'Food,' 'Josiah Wedgwood,' 'Colour,' etc. (A. H. C.)

CHURCH, Col. George Earl; Member of the Council Roy. Geog. Soc.; President of the Geog. Section, British Association, 1898; author of 'South America, an outline of its Physical Geography,' etc. (G. E. C.)

CIST, Henry Martyn, A.M., Cincinnati, U.S.A.; author of 'Army of the Cumberland,' 'Life of Major-General George H. Thomas'; editor of 20 Annual Reports of the Society of the Army of the Cumberland. (H. M. C.)

CLARK, Charles Hopkins, editor of 'Hartford Courant,' Conn., U.S.A. (C. H. Cl.)

CLARK, George A., B.L.; Secretary to the Leland Stanford Junior University, Secretary of the U.S. Fur Seal Commission, 1896-1898. (G. A. C.)

CLARKE, Colonel Sir George Sydenham, K.C.M.G., F.R.S.; Governor of Victoria, Australia, since 1901; served Egyptian expedition, 1882; Sudan expedition, 1885; Suakin, in Intelligence Department and as Assistant Political Officer; Secretary Colonial Defence Committee; Secretary to Royal Commission on Navy and Army Administration; Superintendent Royal Carriage Factory, 1894-1901; member of Committee on War Office Reorganization, 1900-1901; author of 'Practical Geometry and Engineering Drawing,' 'The Principles of Graphic Statics,' 'Plevna, 'Fortification Past, Present, and Future,' 'The Navy and the Nation,' 'Imperial Defence,' 'Russia's Sea-power,' etc. (G. S. C.)

CLAUSEN, George, A.R.A., R.W.S.; medals: Paris 1889, Chicago 1893, Brussels 1897, Paris 1900. (G. Cl.)

CLAUSON, Captain John Eugene, R.E., B.A. London; Secretary Colonial Defence Committee, War Office, London. (J. E. C.)

CLAYDEN, Peter William, the late; President Inst. Journalists, London; a President International Congress of the Press, Antwerp, 1894; English member International Bureau of Press; Treasurer, Institute of Journalists' Orphan Fund; author of 'Scientific Men and Religious Teachers,' 'England under Lord Beaconsfield,' 'Early Life of Samuel Rogers,' 'Rogers and his Contemporaries,' 'England under the Coalition,' etc. (P. W. C.)

CLERC, F. L., Denver, Colorado, U.S.A. M. Amer. Soc. of Mining Engineers. (F. L. C.)

CLERK, Dugald, M.I.C.E., F.C.S.; Consulting Engineer; Originator of the 'Clerk' type of Gas Engine; author of 'The Theory of the Gas and Oil Engine,' 'Notes on Motive Power Inventious,' etc. (D. Cl.)

CLIFFORD, Hugh Charles, C.M.G.; British Resident, Pahang; nominated by Colonial Office to post of Governor North Borneo and Labuan under Chartered Company, 1900; Resident, Pahang, 1901; Acting Resident, Negri Sembilan, Sept. 1901; author of 'In Court and Kampong, 'Studies in Brown Humanity,' 'Since the Beginning,' 'In a Corner of Asia,' joint-author with Sir Frank Swettenham of a Dictionary of the Malay Language. (H. Cl.)

CLODD, Edward; author of 'The Childhood of the World,' 'The Childhood of Religions,' 'Jesus of Nazareth,' 'Myths and Dreams,' 'Story of Creation,' 'Story of Primitive Man,' 'Primer of Evolution,' 'Pioneers of Evolution,' 'Tom Tit Tot, an Essay on Savage Philosophy in Folk-Tale,' 'Grant Allen,' 'Story of the Alphabet,' etc. (E. Cl.)

COBHAM, C. Delaval, M.A., B.C.L.; British Commissioner, Larnaca, Cyprus; editor of 'Bibliography of Cyprus,' and 'Excerpta Cypria'; translator of Mariti's 'Travels in Cyprus.' (C. D. C.)

COCKBURN, Hon. Sir John Alexander, K.C.M.G., M.D.; Fellow King's College, London; Mayor of Jamestown, S. Australia; member of House of Assembly, S. Australia; Minister of Education, 1885-87; Premier and Chief Secretary, 1889-90; Chief Secretary, 1892; Minister of Education and Agriculture, 1893-98; one of the representatives of South Australia at the Federal Conferences in 1890, 1891, 1897, and 1898; Agent-General for South Australia to 1901. (J. A. Co.)

COGHLAN, T. A., A.M.I.C.E., Hon. F.S.S.; Government Statistician of New South Wales and Registrar of Friendly Societies and Trade Unions; author of 'A Statistical Account of the Seven Colonies of Australasia,' 'Wealth and Progress of New South Wales,' etc. (T. A. C.)

COLCLOUGH, John George, B.A.; late Secretary of the British Chamber of Commerce, Paris; author of 'Ulster,' 'The Law of Contract,' 'Twenty-five Years of Anglo-French Trade,' etc. (J. G. C.)

COLE, Alan S., C.B.; Asst. Sec. (Art) Board of Education; Ex. for Art, S. Kensington; author of 'Ancient Needle Point and Pillow Lace,' 'Tapestry and Embroidery,' etc.; and editor 'Studies from the Museums,' various descriptive catalogues of Tapestry, Embroidery, Lace, and Egyptian textiles at South Kensington Museum, etc. (A. S. C.)

COLLINS, Rev. William Edward, M.A.; Professor of Ecclesiastical History, King's Coll., London; Examining Chaplain to the Bishop of St Albans; author of 'The English Reformation and its Consequences,' 'The Nature and Force of the Common Law,' 'Unity, Catholic and Papal,' etc. (W. E. Co.)

COLOMB, Sir John Charles Ready, K.C.M.G., M.P.; author of 'Protection of Commerce in War,' 'Imperial Strategy,' 'The Distribution of our War Forces,' 'Colonial Defence and Colonial Opinions,' 'The Defence of Great and Greater Britain,' 'Naval Intelligence and Protection of Commerce,' 'The Use and Application of Marine Forces,' 'Imperial Federation, Naval and Military,' 'British Defence,' etc. (J. C. R. C.)

COLVIN, Sir Auckland, K.C.S.I., K.C.M.G., C.I.E.; Grand Cordons of Osmanieh and Medjidieh; Comptroller-Gen. Egypt; Financial Adviser to Khedive; Financial member of Viceroy's Council, India; Lieut.-Gov. North-West Provinces and Oudh; author of 'John Russell Colvin,' etc. (A. Co.)

COLYAR, H. A. de; of the Middle Temple, Barrister-at-Law; author of 'Law of Guarantees and Principal and Surety'; Fellow of the Royal Colonial Institute. (H. A. de C.)

COMSTOCK, Brig.-Gen. Cyrus Ballou; U.S.A., retired; Board of Engineers for Fortifications, U.S. Army; chief engineer, Army of the Potomac, 1862-63; President of the Mississippi River Commission; author of 'Primary Triangulation of the U.S. Lake Survey.' (C. B. C.)

CONATY, Right Rev. Bishop Thomas James, S.T.D., J.C.D.; titular Bishop of Samos; Rector of the Catholic University of America. (✠ T. J. C.)

CONWAY, Sir William Martin, M.A.; Slade Professor of Fine Arts, Cambridge; Professor of Art, Univ. Coll. Liverpool, 1885-88; Hon. Sec. Art Congress, 1888-90; President of the Alpine Club; author of 'Dawn of Art in the Ancient World,' a series of Climbers' Guide-books to the Pennine and Lepontine Alps, etc., 'Climbing and Exploration in the Karakoram-Himalayas,' 'The Alps from End to End,' 'The First Crossing of Spitsbergen,' 'With Ski and Sledge over Arctic Glaciers,' 'The Bolivian Andes.' (W. M. C.)

COOK, Theodore Andrea, M.A., F.S.A.; author of 'Old Touraine,' 'Rouen,' 'A History of the English Turf,' joint-author of 'Ice-Sports.' (T. A. Co.)

COOKE, Charles Wallwyn Radcliffe, B.A.; author of 'A Treatise on the Agricultural Holdings (England) Act,' 'Four Years in Parliament with Hard Labour,' 'A Book about Cider and Perry'; President, National Association of English Cider-makers. (C. W. R. C.)

COOLIDGE, Rev. William Augustus Brevoort, M.A., F.R.G.S.; Fellow of Magdalen College, Oxford; Professor of English History, St David's College, Lampeter, 1880-81; Corresponding Member of the Swiss Hist. Society, 1891; author of 'Jura,' 'Switzerland' (History, Geography, and Statistics), 'Tell,' 'Valais,' 'Zurich' in Ninth Edition of 'Ency. Brit.'; joint author of 'Guide du Haut Dauphiné,' 'Guide to the Central Alps of the Dauphiny,' 'Guide to the Lepontine Alps,' 'The Mountains of Cogne,' 'The Adula Alps,' 'The Range of the Tödi,' 'Guide to Grindelwald,' 'Guide to Switzerland'; editor of 'Alpine Journal,' 1880-89. (W. A. B. C.)

COPEMAN, Sydney Monckton, M.A., M.D.; Medical Inspector, Local Government Board; Member of the Council Epidemiological Society; author of 'Vaccination: its Natural History and Pathology,' 'Bacteriology of Vaccine Lymph,' etc. (S. M. C.)

CORRADINI, Enrico; late editor of 'La Naziona,' Florence; author of 'La Civia Romanzo,' etc. (E. Co.)

COTTON, James Sutherland, M.A.; Hon. Secretary of the Egypt Exploration Fund; late editor of 'The Academy,' London; Fellow and Lecturer of Queen's Coll. Oxford; author of 'Warren Hastings' in Ninth Edition of 'Ency. Brit.,' 'Decennial Report on the Moral and Material Progress of India,' 'India,' 'Elphinstone,' 'Quinquennial Report on Education in India'; editor of 'Paterson's Practical Statutes,' 'The Official Gazetteer of India.' (J. S. Co.)

COX, General Jacob Dolson, LL.D., the late; Governor of the State of Ohio (1866-67); U.S. Secretary of the Interior (1869-70); Major-General U.S. Volunteers in the Civil War; Brigade-Commander under General Sherman in the Atlanta campaign; author of 'Atlanta: the March to the Sea,' 'Battle of Franklin,' etc. (J. D. Co.)

CRACKANTHORPE, Montague Hughes, K.C., D.C.L.; late member General Council of the Bar and Council of Legal Education; late Chairman Incorporated Council of Law Reporting; Honorary Fellow St John's Coll. Oxford; representative of General Council of Bar at International Congress of Advocates, Brussels, 1897; representative of the same Council at International Congress of the Société de Législation Comparée, Paris, 1900; acting Chairman of the International Commission on Criminal Sentences; author of many legal, social, and political articles. (M. H. C.)

CRAIES, William Feilden, M.A.; sometime Scholar of New College, Oxford; Barrister-at-Law, Inner Temple; editor of 'Hardcastle on Interpretation of Statutes,' 'Archbold's Criminal Pleading'; Member of the Mansion House Council on the Dwellings of the Poor, and editor of the Mansion House Council's handbook on the subject; contributor to legal journals on subjects relating to municipal government and magistrates' law. (W. F. C.)

CRANE, Walter, A.R.W.S.; silver medal, Paris, 1889; silver medal, Society of Arts; gold medal, Munich, 1895; first and present President Arts and Crafts Ex. Society (England), 1888; member of Council of Art, Board of Education, and examiner in Design; Hon. Member Dresden Academy of Fine Arts; appointed British Commissioner for the Turin International Exhibition of Decorative Art, 1902; Director of Design, Manchester Municipal School of Art, from 1893-96 (resigned); Hon. Art Director, Reading College, 1898; Principal of the Royal College of Art, South Kensington, 1898-99 (resigned); author and illustrator of 'Baby's Opera,' 'Baby's Banquet,' 'The Sirens Three,' 'Flora's Feast,' 'Queen Summer,' 'Claims of Decorative Art,' 'Renascence, 1891,' 'Decorative Illustration of Books,' 'Spenser's Fairie Queene,' 'The Shepherd's Calendar,' 'Line and Form,' 'A Masque of Days,' etc. (W. Cr.)

CRAWFORD, Francis Marion; author of many novels, including 'Mr Isaacs,' and 'Saracinesca'; and of 'Ave Roma Immortalis,' 'Life of Pope Leo XII.,' 'Constantinople,' etc. (M. Cr.)

CREAK, Capt. Ettrick William, R.N., C.B., F.R.S.; late Superintendent of Compasses, Hydrographic Department, Admiralty, London. (E. W. C.)

CREIGHTON, Charles, M.A., M.D. Aberdeen; author of 'A History of Epidemics in Britain,' 'Jenner and Vaccination,' etc. (C. C.)

CREWE, Earl of, P.C., M.A., F.S.A.; President of the Literary Fund; assist. priv. sec. to Sec. for Foreign Affairs, 1883-84; Lord-Lieut. of Ireland, 1892-95; author of 'Stray Verses,' articles on Ireland, etc. (C.)

CRIMP, Santo, M.I.C.E.; the late; author of 'Sewage Disposal Works'; joint author of 'Tables and Diagrams for use in designing sewers and water mains,' etc. (S. Cr.)

CRITCHELL, James Troubridge; London Correspondent of the 'Brisbane Courier,' 'North Queensland Herald,' etc.; author of 'Preliminary Enquiry into the Markets of the European Continent,' 'Guide to Queensland,' etc. (J.T.Cr.)

CROOKES, Sir William, F.R.S.; Past President of the Chemical Society, Great Britain; Past President of the Institution of Electrical Engineers; editor of 'Chemical News,' President of the British Association for the Advancement of Science, 1898; editor of 'Quarterly Journal of Science'; Professor of Chemistry, Training Coll., Chester, 1855; author of 'Assaying' in Ninth Edition of 'Ency. Brit.'; 'Select Methods in Chemical Analysis,' 'Manufacture of Beetroot-Sugar in England,' 'Handbook of Dyeing and Calico-Printing,' 'Dyeing and Tissue Printing,' 'Kerl's Treatise on Metallurgy,' with Ernst Rohrig, 'Wagner's Chemical Technology,' 'Auerbach's Anthracen and its Derivatives,' 'Ville's Artificial Manures,' 'A Solution of the Sewage Question,' 'The Profitable Disposal of Sewage,' 'The Wheat Problem,' etc. (W. C.)

CROSS, Charles Robert, B.Sc.; Professor of Physics and Director of Rogers Laboratory, Massachusetts Institute of Technology; Director of Rumford Committee, American Academy of Arts and Sciences. (C. R. Cr.)

CROZIER, Capt. T. H., R.A.; Professor of Artillery, Ordnance College, Woolwich. (T. H. C.)

CRUMP, Charles George, B.A.; of H.M. Record Office; editor 'The History of the Life of Thomas Ellwood,' 'The Works of Walter Savage Landor,' etc. (C. G. Cr.)

CUNDALL, F.; Sec. and Librarian, Institute of Jamaica; author of 'Studies in Jamaica History,' 'The Story of the Life of Columbus and Discovery of America'; edited 'Bibliotheca Jamaicensis,' etc. (F. Cu.)

CUNNINGHAM, J. T., M.A.; late Fellow of University Coll., Oxford; lecturer for Fisheries, Tech. Instruction Com. of Cornwall; late Asst. Professor of Natural History, Edinburgh; also Naturalist to Marine Biological Assoc. of the U.K.; author of 'Treatise on Common Sole,' 'Marketable Marine Fishes of the British Isles,' 'Sexual Dimorphism,' etc. (J. T. C.)

CURRAN, Rev. J. Milne; author of 'Geology of Sydney and the Blue Mountains,' 'A Contribution to the Geology and Petrography of Bathurst,' etc. (J. M. Cu.)

D

DABNEY, Charles William, Ph.D.; Pres. Univ. of Tennessee; assistant U.S. Secretary Agriculture, 1893-97, etc. (C. W. D.)

DABNEY, Richard Heath, A.M., Ph.D.; Professor of Historical and Economical Science, University of Virginia; author of 'The Causes of the French Revolution,' 'John Randolph: a Character Sketch.' (R. H. D.)

DALBY, W. Ernest, M.A., B.Sc., M.I.C.E., M.I.M.E., Assoc. M.I. Nav. Architects; Professor of Mechanical Engineering and Applied Mathematics, City and Guilds Technical College, Finsbury. (W. E. D.)

DALE, T. F.; author of 'The Game of Polo,' part-editor of 'Riding and Polo.' (T. F. D.)

DALL, Hon. William Healey, A.M.; naturalist, U.S. National Museum; author of 'Alaska and its Resources,' 'Tribes of the Extreme North-west,' etc. (W. H. D.)

DALLAS, J. M. M.; late Secretary of the Edinburgh Draughts Club. (J. M. M. D.)

DANNREUTHER, Edward, Professor Royal Coll. Mus.; author of 'Musical Ornamentation,' 'Liszt's Études,' 'Richard Wagner.' (E. Da.)

DARWIN, George Howard, M.A., LL.D., D.Sc., F.R.S.; Plumian Professor of Astronomy and Experimental Philosophy, Cambridge; Fellow of Trin. Coll. Camb.; author of 'Tides,' in Ninth Edition of 'Ency. Brit.' 'Reports to B.A. on Harmonic Analysis of Tidal Observations,' 'Memoirs on the Effects of Tidal Friction on the Earth and on the Moon,' Phil. Trans. Roy. Soc., 'The Tides and Kindred Phenomena in the Solar System,' etc. (G. H. D.)

DARWIN, Leonard, Major, late R.E.; Intelligence Dept. War Office, 1885-90; served on several scientific expeditions, including Transit of Venus of 1874 and 1882; author of 'Bi-metallism.' (L. D.)

DAVENPORT, Cyril James H., F.S.A.; British Museum; silver medal Society of Arts, 1900; binding editor to the Anglo-Saxon Review; author of 'The English Regalia,' 'Royal English Bookbindings,' 'Cantor Lectures on Decorative Bookbindings,' 'English Embroidered Bookbindings,' 'Life of T. Berthelet.' (C. D.)

DAVEY of Fernhurst, Lord, D.C.L., F.R.S.; Lord of Appeal in Ordinary; Solicitor-General, 1886; Lord Justice of Appeal, 1893. (D.)

DAVIDS, T. W. Rhys, LL.D., Ph.D.; Secretary and Librarian Royal Asiatic Society; Professor of Pali and Buddhist Literature, Univ. Coll. London; author of 'Buddhism,' 'Jains,' 'Lamaism,' in Ninth Edition of 'Ency. Brit.,' 'Buddhism,' 'Buddhist Birth Stories,' 'Buddhist Suttas from the Pali,' 'Hibbert Lectures,' 1881, etc. (T. W. R. D.)

DAVIDSON, William Leslie, M.A., LL.D.; Professor of Logic and Metaphysics, Aberdeen University; author of 'English Words Explained,' 'Theism as grounded in Human Nature,' 'A Philosophical Centenary: Reid and Campbell,' 'Christian Ethics.' (W. L. D.)

DAVIES, A. Llewelyn, B.A.; Barrister, Inner Temple; Assistant Reader in Common Law under the Council of Legal Education. (A. Ll. D.)

DAVIES, Henry Walford, Mus. Doc. (Camb.), A.R.C.M. (Lond.); organist and director of the choir, Temple Church, London; formerly organist and choirmaster, St Anne's, Soho; teacher of counterpoint, R.C.M., 1895. (H. W. D.)

DAVIS, John Patterson, Ph.D., A.M.; assistant in History and Economics, University of Michigan, 1894-1895; now Attorney-at-Law, Nampa, Idaho; author of 'The Union Pacific Railway,' etc. (J. P. D.)

DAVIS, William Morris, Professor Physical Geography, Harvard University; author of 'Physical Geography' and numerous scientific publications. (W. M. D.)

DAWKINS, William Boyd, M.A., D.Sc., F.R.S., F.S.A., F.G.S., A.M.I.C.E.; Professor of Geol. and Palæontology in Owens College, Manchester; geologist on Geological Survey of

Great Britain, 1861-69; author of 'Cave' in Ninth Edition of 'Ency. Brit.,' 'Cave Hunting,' 'Early Man in Britain,' 'British Pleistocene Mammalia.' (W. B. D.)

DAWSON, George Mercer, LL.D., F.R.S., the late; Director Geological Survey of Canada; Geologist and Naturalist to H.M. North American Boundary Commission, 1873-75; one of H.M. Bering Sea Commissioners, 1891, and under the Behring Sea Joint Commission Agreement, 1892; author of numerous scientific and technical reports printed by the Canadian Government, and scientific and other papers. (G. M. D.)

DAY, Lewis F.; English Designer and Art Lecturer; Med. Paris Exhibition (1900); Examiner for Art, Board of Education; author of 'Windows—Stained and Painted Glass,' 'The Anatomy of Pattern,' 'The Distribution of Ornamental Design,' 'Art in Needlework: A Book about Embroidery,' etc. (L. F. D.)

DAYOT, Armand; Inspector of Fine Arts, Ministry of Fine Arts, France; author of 'Un siècle d'art,' 'La Révolution Française, d'après des peintures, sculptures, etc.,' 'Les maîtres de la caricature Française au XIXe siècle,' etc. (A. DA.)

DEACON, George Frederick, M.I.M.E.; Member of Council of Institution of Civil Engineers, London; investigated schemes for water-supply of Liverpool; projected the Vyrnwy scheme, and subsequently carried it out (the first half in conjunction with the late Thomas Hawksley); President Association of Municipal and County Engineers, 1878; President Engineering Section Sanitary Institute, 1894; President Mechanical Science Section, British Association, Toronto, 1897. (G. F. D.)

DEANS, Richard Storry, LL.B.; Barrister-at-Law, Gray's Inn. (R. S. D.)

DENNING, W. F., F.R.A.S.; Gold Medal, R.A.S.; President Liverpool Ast. Society, 1877-78; author of 'Telescopic Work for Starlight Evenings,' 'The Great Meteoric Shower,' etc. (W. F. D.)

DE VILLIERS, John Abraham J.; British Museum. (J. A. J. DE V.)

DE VINNE, Theodore Low, printer and typographist, New York; head of the firm of Theodore L. de Vinne and Co.; author of 'Printers' Price List,' 'Invention of Printing,' 'Historic Types,' etc. (T. L. DE V.)

DEWAR, James, M.A., Hon. LL.D. (Glasgow, St Andrews, Edin.), D.Sc. (Victoria), F.R.S., F.R.S.Ed., F.I.C., F.C.S.; Professorial Fellow of Peterhouse, Camb.; Jacksonian Professor of Experimental Philosophy, Cambridge; Fullerian Professor of Chemistry, Royal Institution, London; Vice-President of the Royal Society; a Director of the Davy-Faraday Research Laboratory; President British Association for 1902; co-inventor with Sir Frederick Abel of cordite; late member of the Government Explosives Committee; author of 'Alum,' etc. in Ninth Edition of 'Ency. Brit.,' numerous papers contributed to the proceedings of the Royal Societies of London and Edinburgh, the Royal Institution, the British Association, the Chemical Society, etc. (J. DR.)

DIBDIN, Charles, F.R.G.S., A.V.I.; Knight of St John of Jerusalem in England; Hon. Corresponding Member of Institutions de Prévoyance, France; Secy. of the Royal National Lifeboat Institution, England; Hon. Secy. of the Civil Service Lifeboat Fund. (C. Di.)

DIBDIN, Lewis Tonna, K.C., D.C.L. (Durham), F.S.A.; author of 'Church Courts,' 'City Livery Companies,' 'Brewer's Endowment and Establishment,' 'Monasticism in England,' 'Hanson's Death Duties.' (L. T. D.)

DICEY, Edward, C.B., B.A.; editor of 'The Observer' (London), 1870-89; author of 'Rome in 1860,' 'Cavour,' 'The Morning Land,' 'England and Egypt,' 'Victor Emmanuel,' 'Bulgaria, the Peasant State,' 'The Story of the Khedivate,' etc. (E. D.)

DICKEY, Rev. Charles A., D.D.; President of the Presbyterian Hospital in Philadelphia; Moderator of the General Assembly of the Presbyterian Church in the U.S., 1900. (C. A. D.)

DICKSON, Henry Newton, B.Sc., F.R.S.E., F.R.G.S.; late Vice-President Royal Meteorological Society; Lecturer in Physical Geography, Oxford; author of 'Meteorology: the Elements of Weather and Climate,' etc. (H. N. D.)

DIXON, Capt. J. Whitly, R.N.; conservator of the river Humber; late Staff Commander of the Medway Fleet Reserve; author of 'Mariner's Compass in an Iron Ship,' etc. (J. W. D.)

DOBSON, George; Petersburg; author of 'Russia's Railway Advance and Central Asia,' etc. (G. D.)

DOBSON, Henry Austin, Principal, H.M. Board of Trade, to 1901; author of 'Hogarth' in Ninth Edition of 'Ency. Brit.'; 'Proverbs in Porcelain,' 'Old-World Idylls,' 'At the Sign of the Lyre,' 'Collected Poems,' 'Thomas Bewick and his Pupils,' Lives of Fielding, Steele, Goldsmith, Horace Walpole, William Hogarth, 'Four Frenchwomen,' 'Eighteenth Century Vignettes,' 'A Paladin of Philanthropy,' etc. (A. D.)

DODD, Lieut.-Col. John Richard, M.B., F.R.C.S., R.A.M.C.; Medical Officer, Royal Arsenal, Woolwich. (J. R. D.)

DOUGLAS, James, LL.D.; member and Vice-President Am. Inst. of Mining Engineers; member Am. Philosoph. Soc., Am. Geolog. Soc., Society of Arts, London, etc.; formerly Professor of Chemistry, Morrin College, Quebec; author of 'Canadian Independence,' 'Imperial Federation and Annexation,' numerous technical articles and reports, etc. (J. Ds.)

DOUGLAS, Robert Kennaway, Keeper of Oriental Printed Books and MSS. at the British Museum; Professor of Chinese, King's Coll. London; appointed China Consular Service, 1858; retired, and appointed assistant in charge of Chinese Library, British Museum, 1865; author of 'Canton,' 'China,' 'Jenghiz Khan,' 'Manchuria,' etc., in Ninth Edition of 'Ency. Brit.,' 'The Language and Literature of China,' 'Confucianism and Taoism,' 'China,' 'A Chinese Manual,' 'The Life of Li Hung-Chang,' 'China.' (R. K. D.)

DOUGLASS, William Tregarthen, M.I.C.E., M.I.M.E., M.I.E.E.; late Consulting Engineer to the Trinity House; Con. Eng. to Govts. of W. Australia, N. S. Wales, Victoria, Cape of Good Hope, etc.; erected the Eddystone, Bishop Rock Lighthouses, etc.; author of 'The New Eddystone Lighthouse,' 'On the More Efficient Lighting of Estuaries and Rivers,' etc. (W. T. D.)

DOWSON, J. Emerson, M.I.C.E., M.I.M.E.; Inventor of the Dowson Gas Plant; part author of 'Tramways,' 'Decimal Coinage,' etc., etc. (J. E. Do.)

DREYER, John Louis Emil, Director Armagh Observatory; assist. Astronomer at Dublin University Observatory, 1878-82; author of 'Observatory,' 'Sextant,' 'Time,' 'Transit Circle,' in Ninth Edition 'Ency. Brit.,' 'Second Armagh Catalogue of 3300 Stars,' 1886, 'New General Catalogue of Nebulæ and Clusters of Stars,' 'Tycho Brahe'; co-editor 'Copernicus: an International Journal of Astronomy,' 1881-84. (J. L. E. D.)

DRIESCH, Hans A. E., Ph.D. Jena; Stazione Zoologica, Naples; author of 'Analytical Theory of Organic Development,' 'Biology,' etc. (H. A. E. D.)

DRIVER, Rev. Samuel Rolles, D.D., D.Litt.; Regius Professor of Hebrew, and Canon of Christ Church, Oxford; member of Old Testament Revision Company; author of 'Isaiah,' 'Notes on the Hebrew Text of the Books of Samuel,' 'An Introduction to the Literature of the Old Testament,' various commentaries; joint-editor of the 'Holy Bible, with various renderings and readings from the best authorities,' 'A Hebrew and English Lexicon of the Old Testament.' (S. R. D.)

DUFF, Rt. Hon. Sir Mountstuart Elphinstone Grant, P.C., M.A., D.L., G.C.S.I., F.R.S.; Under-Secretary of State for India, 1868-74; Under-Secretary for the Colonies, 1880-81; Governor of Madras, 1881-86; Member of Senate University of London, 1891; President Royal Geographical Society, 1889-93; President Royal Historical Society, 1892-99; author of 'Miscellanies, Political and Literary,' 'Memoir of Sir H. S. Maine,' 'Ernest Renan,' 'Memoir of Lord de Tabley,' 'Notes from a Diary.' (M. G. D.)

DUFFIELD, William Bartleet; of the Inner Temple, Barrister-at-Law. (W. B. DU.)

DU FIEF, J.; Secrétaire, Société Royale Belge de Géographie, Bruxelles; author of 'Atlas du Belgique,' 'Les decouvertes maritimes des Portugais au XVe siècle,' 'Les Expeditions Belges au Katenga,' etc. (J. DU F.)

DUNCAN, Louis, Ph.D.; sometime President of the American Institute of Electrical Engineers, and Associate Professor of Electricity, Johns Hopkins University, Baltimore. (L. DU.)

DUNCAN, P.; Treasurer of the Transvaal Colony; formerly of the Secretary's Department, Inland Revenue Office, London. (P. D.)

DUNNING, William Archibald, Ph.D.; Professor of History, Columbia University, New York; member of the American Historical Association; author of 'Essays in Reconstruction,' etc.; editor 'Political Science Quarterly.' (W. A. D.)

DUTT, Romesh Chunder, C.I.E.; Lecturer Indian History, Univ. Coll. London; Fellow of the Calcutta Univ.; Divisional Commissioner, 1894 and 1895, being the only native of India who attained that position in the last century; author of a series of historical and social novels in Bengali, and a translation of the Rig Veda and other Sanscrit religious works into that language; in English, 'Civilization in Ancient India,' 'Lays of Ancient India,' 'Maha-bharata' and 'Ramayana,' condensed into English verse; 'England and India, 1785-1885'; 'Famines in India'; and 'The Economic History of British India.' (R. C. D.)

DYER, Sir William Turner Thiselton-, M.A., B.Sc., LL.D., Ph.D., K.C.M.G., C.M.G., C.I.E., F.R.S.; Director, Royal Gardens, Kew; Fellow, University of London, 1887-90; V.P.R.S. 1896-97; joint-author of 'Biology' in Ninth Edition of 'Ency. Brit.,' 'Flora of Middlesex,' edited English edition of Sachs' 'Text-book of Botany,' 'Flora Capensis,' etc. (W. T. T.-D.)

E

EARDLEY-WILMOT, Rear-Admiral Sydney M., R.N.; author of 'The British Navy, Past and Present,' 'The Next Naval War,' 'Our Flags: Their Origin, Use, and Traditions,' 'The Development of Navies during the Last Half Century,' etc. (S. M. E.-W.)

EATON, Fred. A.; Secretary to the Royal Academy, London; edited Thausing's 'Albert Dürer: His Life and Works.' (F. A. E.)

ECCLES, Dorset; assistant, British Museum. (D. E.)

EDGINGTON, Charles, M.A.; President Oxford University Speed Skating Club; holder since 1898 of the world's speed record for the hour (19 m. 348 yds.). (C. E.)

EDGEWORTH, Francis Ysidro, M.A.; D.C.L.; Professor of Political Economy, Oxford, Fellow of All Souls' Coll. Oxford; Fellow of King's Coll. London; editor of the 'Economic Journal'; author of 'Mathematical Psychics,' etc. (F. Y. E.)

EDWARDS, William Seymour, Attorney and Counsellor-at-law, U.S.A.; author of 'Coals and Cokes in West Virginia.' (W. S. E.)

EGERTON, H. E., M.A.; author of 'A Short History of British Colonial Policy,' 'Sir Stamford Raffles,' 'Essays on Christ's Hospital,' etc. (H. E. EG.)

ELIOT, Charles William, LL.D., D.C.L.; President of Harvard University; author of 'American Contributions to Civilization,' 'Educational Reform,' etc. (C. W. E.)

ELIOT, Whately, M.I.C.E.; conducted survey of the coast of New Zealand; late Engineer to Peterhead Harbour Board; Resident Engineer Eastham section of the Manchester Ship Canal; Superintendent Civil Engineer, Keyham Dockyard Extension, etc. (W. E.)

ELLINGTON, E. B., M.I.C.E.; Member of the Council M.E.; Member of the Société des Ingénieurs Civils de France; Chief Engineer London and Liverpool Hydraulic Power Companies, etc.; inventor of numerous improvements in hydraulic machinery. (E. B. E.)

ERNST, Gen. Oswald Herbert; Brigadier-General U.S.A.; member of the U.S. Isthmian Canal Commission; Engineer in charge of Western River Improvements, 1878-86, and of Harbour Improvements on Texas Coast, 1886-89; Superintendent U.S. Military Academy, 1893-98; author of 'Manual of Practical Military Engineering,' etc. (O. H. E.)

EVANS, Hon. Henry Clay; U.S. Commissioner of Pensions, Washington. (H. C. E.)

EVERETT, Commander Allan F., R.N.; Signal School, H.M.S. 'Victory,' Portsmouth. (A. F. E.)

EVERETT, Joseph David, M.A., D.C.L., D.Sc., F.R.S.; late Professor of Natural Philosophy, Queen's Coll. Belfast; Assist. to Professor of Mathematics, Glasgow, 1864-67; author of 'Centimètre-Gramme-Second System of Units,' English edition of 'Deschanel's Physics,' 'Elementary Text-Book of Physics,' 'Outlines of Natural Philosophy.' (J. D. E.)

EWART, James Cossar, M.D., F.R.S.; Regius Professor of Natural History, Edinburgh; Professor Natural History, Aberdeen, 1878-82; member Fishery Board for Scotland; author of 'The Locomotor System of the Echinoderms' (with the late G. J. Romanes), 'On the Progress of Fish Culture in America,' 'On Whitebait,' 'On the Preservation of Fish,' 'The Development of the Limbs of the Horse.' (J. C. E.)

EWING, James Alfred, M.A., B.Sc., F.R.S., M.I.C.E.; Professor of Mechanism and Applied Mechanics, Cambridge; Fellow of King's College, Cambridge; Professor of Mechanical Engineering at the Imperial University, Tokyo, Japan, 1878-83; author of 'Pneumatic Despatch,' 'Seismometer,' 'Sewerage,' 'Siemens,' 'Steam Engine,' 'Strength of Materials' in Ninth Edition of 'Ency. Brit.,' 'Treatise on Earthquake Measurement,' 'Magnetic Induction in Iron and other Metals,' 'The Steam Engine and other Heat Engines,' etc. (J. A. E.)

EXETER, Bishop of, Right Rev. Herbert Edward Ryle, D.D., B.A.; Warburton Lecturer 1899-1903; Fellow King's

College, Cambridge, 1881; Divinity Lecturer at Emmanuel College, Cambridge, 1881-84; at King's College, 1882-86; Principal of St David's College, Lampeter, 1886-88; Professorial Fellow of King's College, Cambridge, 1888; examining chaplain to late Bishop of St Asaph, 1887-89, and to Bishop of Ripon, 1889; Hon. Canon of Ripon, 1895; Chaplain to the Queen, 1898-1901; Hulsean Professor of Divinity, Cambridge University, 1887-1901, and President of Queens' College, Cambridge, 1896-1901; author of 'The Canon of the Old Testament,' 'The Early Narratives of Genesis,' 'Commentary on Ezra and Nehemiah,' 'Philo and Holy Scripture,' etc. (H. E. E.)

F

FAIRBAIRN, Andrew Martin, M.A., D.D., LL.D.; Principal Mansfield Coll. Oxford; Principal of Airedale Coll. 1877-1886; Chairman of Congregational Union of England and Wales, 1883; Member of Royal Commission on Secondary Education, 1894-95; author of 'Arminius,' 'Independents,' in Ninth Edition of 'Ency. Brit.,' 'Studies in the Life of Christ,' 'The City of God,' 'Religion in History and in Modern Life,' 'Catholicism, Roman and Anglican,' 'The Philosophy of the Christian Religion,' etc. (A. M. F.)

FAIRBROTHER, William Henry, M.A., Lecturer in Philosophy, Lincoln College, Oxford; author of 'Philosophy of Thomas Hill Green.' (W. H. F*.)

FAIRLIE, John A., Ph.D.; Asst. Prof. of Administrative Law, Univ. of Michigan; author of 'Municipal Government.' (J. A. Fa.)

FARRAR, Very Rev. Frederic William, D.D., F.R.S.; Dean of Canterbury; Hulsean Lecturer at Cambridge; Bampton Lecturer at Oxford; Chaplain to the Speaker of the House of Commons, 1890-95; author of 'Jesus Christ' in Ninth Edition of 'Ency. Brit.,' 'The Life of Christ,' 'The Life of St Paul,' 'The Early Days of Christianity,' 'Darkness and Dawn,' 'The Bible, its Meaning and Supremacy,' etc. (F. W. F.)

FAUNCE, W. H. P., A.M., D.D.; President of Brown University, Providence, R.I. (W. H. P. F.)

FAUR, G., of the Egyptian Hall, London. (G. Fa.)

FERGUSON, J.; editor of the 'Ceylon Observer,' 'Tropical Agriculturist,' etc.; author of 'Handbook to Ceylon,' manuals on Coffee, Tea, Gold, Gems, etc. (J. F.)

FERRERO, Baron Augusto; editor of 'La Tribuna,' Rome; author of 'Nostalgie d'Amore'; edited 'From Florence to Rome: A Political Diary of 1870-71,' etc. (A. Fe.)

FFOULKES, Miss C. Jocelyn; translator of Morelli's 'Italian Painters,' etc. (C. J. F*.)

FIDLER, H.; Civil Engineer, head of Technical Staff Department of Civil Engineer-in-Chief, Admiralty; editor of 'A Manual of Construction,' etc. (H. F.)

FIELD, Capt. A. Mostyn, R.N.; F.R.A.S., F.R.G.S., F.R.Met.S.; has worked for the Hydrographic Survey in various parts of the world. (A. M. F*.)

FILON, Pierre Marie Augustin; agrégé ès lettres; French Critic; tutor to the late Prince Imperial; literary editor of the 'Revue Bleue'; author of 'Le Mariage de Londres,' 'Histoire de la Littérature Anglais,' 'English Profiles,' and works on the French and English drama. (A. Fi.)

FISHER, Alexander; English teacher and specialist in the art of enamelling; author of technical articles in the 'Magazine of Art,' the 'Studio,' etc. (A. Fi*.)

FISHER, George Park, D.D., LL.D.; Professor of Ecclesiastical History, Yale; author of 'The Reformation,' 'History of the Christian Church,' 'The Colonial Era,' etc. (G. P. F.)

FISHER, W. E. Garrett, M.A.; author of 'The Transvaal and the Boers.' (W. E. G. F.)

FISKE, John, LL.D., the late; author of 'Discovery of America,' 'American Revolution,' 'The Mississippi Valley in the Civil War,' 'Cosmic Philosophy,' etc. (J. Fi.)

FITCH, Charles H., in charge of the Indian Territory Section, U.S. Geological Survey. (C. H. F.)

FITCH, Sir Joshua Girling, M.A., LL.D.; Chief Inspector of Training Colleges, retired 1894; H.M. Inspector of Schools, 1863; Chevalier of the Legion of Honour; Governor of St Paul's School, London, and Girton College, Cambridge; author of 'Lectures on Teaching,' 'The Arnolds and their Influence on English Education,' 'Educational Aims and Methods.' (J. G. F.)

FITZGERALD, Vice-Adml. Charles Cooper Penrose; Superintendent, Pembroke Dockyard; second in command of the China Station, 1898-1899; author of 'Boat Sailing,' 'Life of Sir George Tryon.' (C. C. P. F.)

FITZGERALD, J. D.; Barrister-at-Law of N.S.W., Journalist, and Alderman of the Corporation of the City of Sydney. (J. D. F.)

FITZMAURICE-KELLY, James; corresponding member of the Spanish Academy; author of 'A History of Spanish Literature,' 'The Life of Miguel de Cervantes Saavedra,' etc. (J. F.-K.)

FLANNERY, Sir Fortescue, M.P., M.Inst. C.E., M. Inst. Marine Engineers; Consulting Engineer; sometime President of the Institution of Marine Engineers. (F. F*.)

FLEMING, C. J. N., B.A.; Scottish International Football Player; member of Committee of Scottish Rugby Football Union. (C. J. N. F.)

FLEMING, John Ambrose, M.A., D.Sc., F.R.S.; Pender Professor of Electrical Engineering, Univ. College, London; Fellow of Univ. Coll. London; author of 'Treatise on the Alternate Current Transformer,' 'Electric Lamps and Electric Lighting,' 'Magnets and Electric Currents,' 'A Handbook for the Electrical Laboratory and Testing Room.' (J. A. F.)

FOOTE, Arthur De Wint; Superintendent of North Star Mining Company, California; Member of the American Society of Civil Engineers. (A. De W. F.)

FORBES, Dr H. O., LL.D., F.R.G.S.; Director of Museums, Liverpool; author of 'A Naturalist's Wanderings in the Eastern Archipelago,' etc. (H. O. F.)

FORD, Worthington Chauncey, Public Library, Boston, U.S.A.; Chief of Bureau of Statistics, U.S. Department of State, 1885-89, and of Bureau of Statistics, U.S. Treasury Department, 1893-98; author of 'American Citizen's Manual,' etc. (W. C. F.)

FORD, W. J., M.A.; author of 'A Cricketer on Cricket.' (W. J. F.)

FOREMAN John, F.R.G.S.; author of 'The Philippine Islands.' (J. F*.)

FORTIER, Alcée, Litt.D.; Professor of Romance Language, Tulane University, New Orleans; sometime President of the Modern Language Association of America, and of the American Folk-Lore Society; President of the Louisiana Historical Society since 1894; author of 'Louisiana Studies,' 'Louisiana Folk Tales,' etc. (A. Fo.)

FOSTER, Clement Le Neve, B.A., D.Sc., F.R.S.; Professor of Mining at Royal School of Mines, London; Examiner in Mining for the Board of Education; Geological Survey of Great Britain, 1860-65; H.M. Inspector of Mines, 1873-1901; author of 'Mining' in Ninth Edition of 'Ency. Brit.,' 'Ore and Stone Mining,' etc. (C. L. N. F.)

FOSTER, Hon. John Watson, LL.D.; ex-U.S. Minister to Mexico, Russia, and Spain; U.S. Secretary of State 1892-93, and Agent of the United States in the Behring Sea Arbitration. (J. W. Fo.)

FOSTER, Sir Michael, D.C.L., D.Sc., LL.D., K.C.B., F.R.S., M.P.; Professor of Physiology, Cambridge; secretary R.S.; President British Ass., 1899; author of 'Physiology' in Ninth Edition of 'Ency. Brit.,' 'Text-Book of Physiology,' 'Lectures on History of Physiology'; joint-editor of 'Scientific Memoirs of Thomas Henry Huxley,' etc. (M. F.)

FOWLER, George Herbert, B.A., Ph.D., F.Z.S.; Berkeley Fellow of Owens College, 1884-87; Secretary Marine Biological Association, 1891-95; Assistant and Assistant Professor of Zoology, University College, London, 1891-99; author of various memoirs on zoological subjects, articles 'Hydromedusæ' and 'Scyphomedusæ' in Lankester's 'Zoology,' etc. (G. H. Fo.)

FOX, Francis, M.I.C.E.; author of 'On the Results of Trials of Varieties of Iron Permanent Way,' and various papers on 'Ventilation, Tunnelling,' etc. (F. Fo.)

FOX, Major Charles James; head of London Salvage Corps. (C. J. F.)

FRANKLIN, Fabian, Ph.D.; editor of 'Baltimore News,' Baltimore, U.S.A.; formerly Professor of Mathematics, Johns Hopkins University. (F. Fr.)

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HILL, Robert Thomas, U.S. Geological Survey; formerly Professor of Geology, University of Texas; author of 'Texas' in Ninth Edition of 'Ency. Brit.,' 'Cuba, Porto Rico, and other Islands of the West Indies.' (R. T. H.)

HILLIER, Alfred Peter, M.D., B.A., C.M.; one of the Reform Prisoners at Pretoria, 1896; author of 'South African Studies,' etc. (A. P. H.)

HIME, Lieut.-Col. H. W. L.; Gold Medal Roy. Artillery Inst., and Roy. United Service Inst.; Secretary Roy. Artillery Inst., 1880-86; author of 'Outlines of Quaternions,' 'Stray Military Papers,' 'Lucian, the Syrian Satirist,' etc. (H. W. L. H.)

HINTON, A. Horsley, editor of 'The Amateur Photographer'; author of 'A Handbook of Illustration,' 'Practical Pictorial Photography,' etc. (A. H. H.)

HIPKINS, Alfred James, F.S.A.; member of Council and Hon. Curator of R. C. of Music; engaged in Messrs Broadwood's pianoforte business since 1840; Member of Committee of the Inventions and Music Exhibition, 1885, of the Vienna Exhibition, 1892, and of the Paris Exhibition, 1900; author of 'Harp,' 'Lyre,' 'Pianoforte,' in Ninth Edition of 'Ency. Brit.,' 'Musical Instruments,' 'A Description and History of the Pianoforte,' etc. (A. J. H.)

'HOBBES, John Oliver' (Pearl Mary Teresa Craigie); author of 'Some Emotions and a Moral,' 'A Study in Temptations,' 'The Gods, Some Mortals, and Lord Wickenham,' 'School for Saints,' 'Robert Orange,' 'The Serious Wooing,' 'The Ambassador,' 'The Wisdom of the Wise,' etc. (P. M. T. C.)

HOBSON, Ernest W., D.Sc., F.R.S.; Fellow of Christ's Coll. Cambridge; University Lecturer in Mathematics. (E. W. H.)

HODGE, Frederick Webb, Bureau of American Ethnology, Smithsonian Institution; managing editor 'American Anthropologist.' (F. W. H.)

HODGES, Major Harry F., Corps of Engineers, U.S. Army; during Spanish-American War, Lieut.-Col. of Engineers, U.S. Volunteers. (H. F. H.)

HODGKINSON, W. R. E., F.R.S. Edin., F.C.S., F.R.G.S., Ph.D. Würzburg; Professor of Chemistry and Physics, Ordnance Coll., Woolwich; late Professor of Chemistry and Physics, R.M.A., Woolwich; part-author of Valentin-Hodgkinson's 'Practical Chemistry,' etc. (W. R. E. H.)

HOFFER, Leopold; chess editor of the 'Standard' (*London*); author of 'Chess,' etc. (L. H.)

HOFMAN, Heinrich O., E.M., Ph.D.; Professor of Metallurgy, Massachusetts Institute of Technology. (H. O. H.)

HOGARTH, David George, M.A., Fellow of Magdalen College, Oxford; explored Asia Minor, 1887, 1890, 1891, 1894; excavated at Paphos in Cyprus, 1888; appointed by Egypt Exploration Fund, 1893; Special Correspondent for 'The Times' in Crete and Thessaly, 1897; Director, British School at Athens, 1897-1900; Director, Cretan Exploration Fund, 1899; author of 'A Wandering Scholar in the Levant,' 'Philip and Alexander of Macedon,' 'The Nearer East,' etc. (D. G. H.)

HOLDEN, Prof. Edward Singleton, Sc.D., LL.D.; Director of the Lick Observatory, 1887-97; Member National Academy of Sciences; Associate Royal Astronomical Society of London, Astronomical Society of France, etc.; author of 'Astronomy for Students,' 'Life of Sir Wm. Herschel,' 'Nebula of Orion,' etc. (E. S. H.)

HOLDICH, Col. Sir Thomas Hungerford, R.E. (retired), K.C.I.E., C.B.; Abyssinia, 1867; Afghan War, 1878-80; also served on political duty with Afghan Boundary Commission, 1884-86; Supt. Frontier Surveys, India, 1892-98; Asmar Boundary Commission, 1894; Pamir Commission, 1895; as H.M. Commissioner for Perso-Beluch Boundary in 1896; author of 'Kandahar,' in Ninth Edition of 'Ency. Brit.,' 'The Indian Borderland,' various papers on military surveying, etc. (T. H. H*.)

HOLLAND, F. C., M.A.; Assistant Clerk, House of Commons. (F. C. H.)

HOLLAND, Hon. Sydney, LL.D.; President of the Life Saving Society of England; Chairman of the London Hospital; Knight of Grace of the Order of St John of Jerusalem. (S. H*.)

HOLLINGSHEAD, John, staff of 'Household Words,' under Charles Dickens; staff of 'Cornhill Magazine,' under W. M. Thackeray, 'Good Words,' under Dr Norman Macleod, 'Daily News,' etc.; founded Gaiety Theatre, 1868; Theatrical Licensing Reform, 1866 and 1892; Copyright Reform, 1874; author of 'Plain English,' 'Underground London,' 'Ragged London,' 'According to My Lights,' etc. (J. Hd.)

HOLROYD, Charles, F.R. Soc. Painter Etchers; Keeper National Gallery of British Art (Tate Gallery); assistant to Professor Legros, Slade School of Art, for four years; author of 'Michael Angelo and His Works,' 'Etchings,' etc. (C. Hd.)

HOOPER, Franklin H., A.B.; associate-editor of the New Volumes of the 'Encyclopædia Britannica'; assistant editor of 'The Century Dictionary.' (F. H. H.)

HOOPER, Wynnard, M.A., author of 'Population,' 'Statistics,' 'Suicide,' in the Ninth Edition of the 'Ency. Brit.' (W. Ho.)

HOPKINSON, S. D. (S. D. H.)

HOSE, C., LL.D., D.Sc.; Resident in the Boram District, Sarawak; author of 'A Descriptive Account of the Mammals of Borneo,' etc. (C. H.)

HOUGHTON, A. E., B.A., L.C.L.; Correspondent of the 'Standard' in Spain; author of 'Restoration of the Bourbons in Spain.' (A. E. H.)

HOUSMAN, Laurence, author of 'The Writings of William Blake,' 'Arthur Boyd Houghton,' 'Green Arras,' etc.; illustrated 'Goblin Market,' 'The End of Elfintown,' 'The Were Wolf,' '"Jump to Glory" Jane,' 'The Sensitive Plant.' (L. Ho.)

HOUTUM-SCHINDLER, Gen. A., C.I.E.; general in the Persian army; has resided, as Persian official, and travelled for many years in Persia; author of 'Eastern Persian Irak,' etc. (A. H.-S.)

HOWE, Henry Marion, A.M.; Professor of Metallurgy, Columbia University, New York; Past President Am. Institute of Mining Engineers; President Jury of Mines and Mining, World's Columbian Exposition; Bessemer Medallist, British Iron and Steel Inst., and Gold Medallist, Franklin Inst. of Philadelphia, 1895; author of 'Metallurgy of Steel,' 'Copper Smelting,' etc. (H. M. H.)

HOWELL, Hon. Clark; editor of 'The Constitution,' Atlanta, Georgia. (C. Ho.)

HOWELL, William H., Ph.D., M.D.; Dean of the Medical Faculty and Professor of Physiology, Johns Hopkins University. (W. H. H.)

HUBBARD, Wilfranc. (W. Hd.)

HUDSON, James Fairchild, editor of the 'Pittsburg Dispatch'; author of 'Railways of the Republic,' etc. (J. F. H.)

HUGHES, Rev. Hugh Price, M.A.; Pres. Wesleyan Conference, 1898-99; editor of 'Methodist Times'; Past Pres. of National Council of Evangelical Free Churches; author of 'Social Christianity,' 'Ethical Christianity,' etc. (H. P. H.)

HUGHES, Rupert, A.M.; formerly assistant editor of the 'Criterion,' New York; author of 'American Composers,' 'Gyges Ring,' etc. (R. Hu.)

HULL, Commander Thomas A., R.N., F.R.G.S.; employed in the search for Sir John Franklin, survey of Palestine, Corfu, etc.; late Superintendent of Admiralty charts; author of 'Practical Nautical Surveying'; editor and reviser 'The Pilot's Handbook for the English Channel,' and 'The Practice of Navigation and Nautical Astronomy,' etc. (T. A. H.)

HUMMEL, J. J., F.I.C.; Professor of Dyeing, Yorkshire Coll., Leeds; author of 'The Dyeing of Textile Fabrics.' (J. J. H.)

HUNT, Rev. William, M.A.; examiner in History, 1877 to 1880, Oxford; author of 'The English Church, 597 to 1066,' 'The Church of England in the Middle Ages'; editor with E. A. Freeman of 'Historic Towns,' etc. (W. Hu.)

HUNT, Hon. William H., Governor of Porto Rico; sometime Justice of the Supreme Court of Montana. (W. H. H*.)

HUNTER, Sir Robert, M.A.; Solicitor to the Post Office; author of 'The Preservation of Open Spaces and of Footpaths and Other Rights of Way.' (R. H*.)

HUNTER, Walter, M.I.C.E., M.I.M.E.; engineering director of the Grand Junction Water Works Co., and joint engineer of the Staines Reservoir Joint Committee. (W. H*.)

HUTCHINSON, Horatio Gordon, B.A.; amateur golf champion, 1886-87; author of 'Golf' in Badminton Library, 'Creatures of Circumstance,' 'The Book of Golf and Golfers,' 1899. (H. G. H.)

HUTTON, Rev. Arthur Wollaston, M.A.; Rector of Spridlington, 1873-76; received into Roman Catholic Church by Dr Newman, 1876; resumed clerical functions in the Church of England, 1898; author of 'Our Position as Catholics in the Church of England,' 'The Anglican Ministry,' 'Cardinal Manning'; edited Arthur Young's 'Tour in Ireland,' 1892, Maitland's 'Essays on the Reformation,' Newman's 'Lives of the English Saints,' etc. (A. W. Hu.)

I

IDE, Hon. Henry Clay, Member of U.S. Philippine Commission; formerly U.S. Commissioner to Samoa, and later Chief Justice of Samoa. (H. C. I.)

ILBERT, Sir Courtenay Peregrine, K.C.S.I., C.I.E.; Clerk of the House of Commons; formerly Parl. Counsel to the Treasury, 1899-1902; Legal Member of Council of Governor-General of India, 1882-86; Assistant Parl. Counsel to the Treasury, 1886-99; Member of Statute Law Committee; author of 'The Government of India,' 'Legislative Method and Forms.' (C. P. I.)

INAMA-STERNEGG, Karl Theodor von; Professor of Political Science, Vienna; President of the Austrian Royal Statistical Central Commission; author of 'Outlines of Germanic Philology,' 'Economy,' etc. (K. T. I.-S.)

IRVINE, William Fergusson; Hon. Sec. Record Society of Lanc. and Chesh., author of 'Notes on the Ancient Parish of Bidston'; editor 'Liverpool in King Charles II.'s Time,' etc. (W. F. I.)

J

JACKS, Rev. L. P. (L. P. J.)

JACKSON, Lieut.-Col. Louis, R.E.; late instructor in Fortification, R.M.A., Woolwich; instructor in Fortification and Military Engineering, School of Military Engineering, Chatham; Assoc. Memb. of Ordnance Committee, etc. (L. J.)

JACOB, Francis, M.I.E.E., F.P.S. Lond.; chief electrician to Messrs Siemens Bros. and Co. (F. Ja.)

JAMES, Edmund Janes, A.M., Ph.D.; President North-Western University; late Professor of Public Administration and Director of the Extension Division, University of Chicago; past Pres. Am. Acad. of Political and Social Science; author of 'Our Legal Tender Decisions,' 'The Education of Business Men,' etc. (E. J. J.)

JAMES, Lionel; Reuter's Special Correspondent in the Chitral Campaign, 1894-95; 'Times' Special Correspondent in South Africa, 1899-1901; author of 'The Relief of Chitral,' and 'Indian Frontier War, 1897-98.' (L. J*.)

JAMIESON, George, C.M.G.; Director of the Pekin Syndicate and Yangtse Valley Company; Consul and Judge of Supreme Court, Shanghai, 1891; Consul-Gen., 1897-99; author of various papers on the Revenue and Statistics of China; prize essay on Bimetallism. (G. J.)

JEBB, Sir Richard Claverhouse, Litt.D., D.C.L., LL.D., M.P.; Regius Professor of Greek, Camb.; Hon. Professor Ancient History, Roy. Acad., since 1898; Fellow and Lecturer of Trinity College, 1863; Public Orator of the University, 1869; Professor of Greek, University of Glasgow, 1875-89; Lecturer at Johns Hopkins University, Baltimore, 1892; Member of Royal Commission on Secondary Education, 1894; of Royal Commission on Irish University Education, 1901; Member of Consulting Committee of Board of Education, 1900; Fellow of London University, 1897; Member of London University Commission, 1898; Bampton Lecturer, 1899; author of 'Aristophanes,' 'Demosthenes,' 'Euripides,' etc., in Ninth Edition of 'Ency. Brit.,' 'Sophocles,' 'Electra' in Catena Classicorum, 'Ajax,' 'Characters of Theophrastus,' 'Attic Orators,' 'Modern Greece,' 1880; 'Bentley,' 'Sophocles,' with Critical Notes, Commentary, and Translation; 'Humanism in Education,' etc. (R. C. J.)

JEFFERSON, Joseph, LL.D.; actor; author of 'Autobiography,' etc. (J. J*.)

JEKELFALUSSY, Józef von Jekel- und Margitfalva, Dr. Juris, the late; Director-General of the Royal Hungarian Statistical Bureau; Member of the Royal Hungarian Academy of Sciences; edited 'The Millennium of Hungary and its People,' etc. (J. Je.)

JENKS, Jeremiah Whipple, Ph.D.; Professor of Political Science, Cornell University; Member of the U.S. Committee to investigate Trusts; author of 'Henry C. Carey,' 'Road Legislation for the American State,' and numerous magazine contributions in Germany, England, and the United States. (J. W. J.)

JENKYNS, Sir Henry, the late, K.C.B.; Parliamentary Counsel to Treasury. (H. Je.)

JERVIS-SMITH, Rev. Frederick J., M.A., F.R.S.; University Lecturer in Mechanics; Millard Lecturer, Trinity College, Oxford; Member of Com. on Explosions, Home Office, 1895-96; received Medal French Exhibition for Dynamometer; silver medal Inventions Exhibitions for Integrator. (F. J. J.-S.)

JEUNE, Rt. Hon. Sir Francis Henry, G.C.B.; appointed a Judge of the High Court, 1891; President of Probate, Divorce, and Admiralty Division; Judge-Advocate-Gen., 1892. (F. H. J.)

JEUNE, The Hon. Lady; contributor to leading reviews and magazines; author of 'Lesser Questions,' etc. (M. J.)

JOHNSTON, Sir Harry Hamilton, G.C.M.G., K.C.B.; Special Commissioner, Commander-in-Chief and Consul-General for Uganda Protectorate; explored Portuguese West Africa and River Congo, 1882-83; commanded scientific Expedition of Royal Society to Mt. Kilimanjaro, 1884; H.M. Vice-Consul in Cameroons, 1885; Acting Consul in Niger Coast Protectorate, 1887; Consul for province of Mozambique, 1888; expedition to Lakes Nyasa and Tanganyika (founding of the British Central Africa Protectorate), 1889; author of 'River Congo,' 'Kilimanjaro,' 'History of a Slave,' 'Life of Livingstone,' 'British Central Africa,' etc. (H. H. J.)

JORDAN, David Starr, Ph.D., LL.D.; President of Leland Stanford Junior University; sometime Assistant to the U.S. Fish Commission, and Professor of Zoology, and President of Indiana University; Commissioner and Expert for the United States to investigate the Fur Seal Question, 1896-97; author of 'Vertebrate Animals of Northern U.S.,' 'Fisheries of North and Middle America,' 'Factors of Organic Evolution,' etc. (D. S. J.)

JORDAN, Richard; Draughts Champion of Scotland, 1896, and of the World since 1896. (R. J.)

JUDSON, Harry Pratt, A.M., LL.D.; Professor of Political Science, and Dean of the Faculties of Arts, Science, and Literature, University of Chicago; author of 'Europe in the Nineteenth Century,' 'Growth of the American Nation,' etc. (H. P. J.)

K

KAN, C. M.; Professor of Geography, University of Amsterdam; author of 'Holland' in Ninth Edition of the 'Ency. Brit.,' 'A History of Discoveries in the Indian Archipelago,' editor 'The International Colonial Review,' etc. (C. M. K.)

KARAGEORGEVITCH, Bojidar, Prince; artist and art critic. (B. K.)

KEANE, Augustus Henry, F.R.G.S.; Emeritus Professor of Hindustani, Univ. Coll. London; late Vice-President Anthrop. Institute; author of 'Kirghiz,' 'Soudan,' 'Somali,' 'Yoruba,' etc., in Ninth Edition of 'Ency. Brit.' Stanford's 'Asia,' 'Africa,' 'Ethnology,' 'Man, Past and Present,' etc. (A. H. K.)

KELSEY, C. H., President of the Title Guaranty and Trust Company, New York. (C. H. K.)

KELTIE, John Scott, F.S.S., F.S.A. (Scot.), LL.D. St Andrews; Secr. Royal Geog. Soc.; Knight of Swedish Order of North Star, 1898; Hon. Memb. Geographical Societies of Paris, Berlin, Rome, Brussels, Amsterdam, Geneva, Lisbon, Buda-Pest, Philadelphia, etc.; for several years sub-editor of 'Nature'; inspector of geographical education, R.G.S., 1884; Librarian R.G.S., 1885; President Geographical Section, Brit. Ass., 1897; author of 'Finland,' 'Sir John Franklin,' etc., in Ninth Edition of 'Ency. Brit.,' 'History of Scottish Highlands and Clans,' 'Applied Geography,' 'The Partition of Africa'; editor of 'Statesman's Year Book' since 1880; editor of the 'Geographical Journal'; joint-editor of 'World's Great Explorers' Series, and 'The Systematic Atlas.' (J. S. K.)

KEMPE, Harry Robert, A.M.I.C.E., M.I.E.E.; principal technical officer, Postal Telegraph Dept., England; author of 'Handbook of Electrical Testing,' 'The Electrical Engineer's Pocket Book,' 'The Engineer's Year Book,' etc. etc. (H. R. K.)

KENNEDY, Sir Charles Malcolm, K.C.M.G., C.B.; Head of Commercial Department, Foreign Office, 1872-93; Lecturer on International Law, Univ. Coll. Bristol; Commissioner in the Levant, 1870-71; at Paris, 1872-86; Plenipotentiary, Treaty of The Hague, 1882; author of 'Kennedy's Ethnological and Linguistic Essays' (editor), 'Diplomacy and International Law.' (C. M. K*.)

KENNEDY, Hon. Sir William Rann; Judge of the King's Bench Division of the High Court of Justice; Fellow, and afterwards Hon. Fellow of Pembroke Coll. Camb. (W. R. K.)

KEYNES, John Neville, M.A., D.Sc.; University Lecturer in Moral Science, Cambridge, 1884; Member of the Council of the Senate of the University of Cambridge; author of 'Studies and Exercises in Formal Logic,' 'Scope and Method of Political Economy.' (J. N. K.)

KHNOPFF, Fernand; Chevalier de l'Ordre de Leopold, de St Michel de Bavière; Vice-Pres. de Cercle Artistique et Littéraire de Bruxelles, etc. (F. K*.)

KIDD, Benjamin; formerly of Inland Revenue Department; author of 'Social Evolution,' 1894 (translations: German, 1895; Swedish, 1895; French, 1896; Russian, 1897; Italian, 1898; Czech, 1900; Danish, 1900); The Control of the Tropics, 1898. (B. K*.)

KIRK, Edward C., D.D.S.; Dean of the Department of Dentistry, and Professor of Clinical Dentistry, University of Pennsylvania; Member of the National Dental Association and the American Academy of Dental Science; editor of 'The American Text-book of Operative Dentistry,' and of 'The Dental Cosmos' Magazine. (E. C. K.)

KNIGHT, Major John G. D., Corps of Engineers, U.S.A., A.M.; Commandant U.S. Engineer School; in charge of U.S. Engineer Depot, 1895-1901, of Torpedo Defence, E. entrance N.Y. Harbour, 1898-1901; on Board of U.S. Torpedo System, 1896-1901. (J. G. D. K.)

KNOTT, Cargill Gilston, D.Sc.; Lecturer on Applied Mathematics, Edinburgh University; Assistant to Professor of Natural Philosophy, Edinburgh University, 1879-83; Prof. of Physics, Imperial University, Japan, 1883-91; conducted Magnetic Survey of Japan, 1887; awarded Keith Prize (Roy. Soc. Edin.) for work on magnetic strains, 1897; author of 'Ice,' 'Pneumatics,' in Ninth Edition of 'Ency. Brit.,' 'Physics,' etc. (C. G. K.)

KNOWLING, Richard John, D.D.; Professor of New Testament Exegesis in King's College, London, 1894; Fellow, 1899; Examiner for Hall-Houghton Prizes at Oxford, 1897, and in Theology at Durham, 1895-96; Select Preacher at Cambridge, 1895; author of 'Witness of the Epistles,' 'Acts of the Apostles,' etc. (R. J. K*.)

KOREN, John; author of 'Economic Aspects of the Liquor Problem, etc. (J. K.)

KRAUS, Professor Dr F. X., the late; Professor of Ecclesiastical History at the University of Freiburg in Breisgau. (F. X. K.)

KROPOTKIN, Prince Peter Alexeivitch; Gold Medal of Russian Geographical Society, 1864; crossed North Manchuria from Transbaikalia to the Amur, 1864; Secretary to Physical Geography Section of Geographical Society; author of 'Lithuanians,' 'Nijni-Novgorod,' 'Nova Zembla,' 'Poland,' 'Siberia,' 'Tomsk,' 'Warsaw,' etc., in Ninth Edition of 'Ency. Brit.,' 'General Sketch of the Orography of East Siberia,' 'In Russian and French Prisons,' 'Recent Science in Nineteenth Century,' 'The State, its Part in History,' 'Memoirs of a Revolutionist.' (P. A. K.)

L

LABBÉ, Alphonse, Docteur ès Sciences; chief of the Laboratory of Zoology, University of Paris; author of 'La Cytologie expérimentale,' 'Recherches zoologiques et biologiques sur les parasites du sang des vertèbres,' etc. (A. L*.)

LAMB, Horace, M.A., LL.D., F.R.S.; Chairman of Convocation, and of the General Board of Studies, Victoria University; Professor of Mathematics, Owens Coll., Victoria Univ., Manchester; member of Council of the Royal Society, 1894-96; President of the Manchester Literary and Philosophical Society, 1899-1901; Fellow and Assistant Tutor, Trinity Coll., Camb., 1872-75; Professor of Mathematics, University of Adelaide, 1875-85; author of 'Motion of Fluids,' 'Hydrodynamics,' 'Infinitesimal Calculus.' (H. Lb.)

LANE-POOLE, Stanley, M.A., Litt.D.; Professor of Arabic at Trin. Coll. Dublin; employed in Coin Department of British Museum, 1874-92; sent by Government on archæological missions to Egypt, 1883, and Russia, 1886; employed by Egyptian Government on archæological research at Cairo, 1895-97; corr. member of the Imperial Russian Archæological Society; lecturer at the Royal Institution, 1900; author of 'Catalogue of the Oriental and Indian Coins in the British Museum,' 'Lord Stratford de Redcliffe,' 'E. W. Lane,' 'Saladin,' 'Histories of the Moors in Spain,' 'Turkey,' 'The Barbary Corsairs,' 'The Mahommedan Dynasties,' 'The Mogul Emperors,' 'Egypt in the Middle Ages,' 'Egypt,' 'The Art of the Saracens of Egypt,' 'Cairo,' etc., edited 'Lane's Arabic Lexicon,' 'Arabian Society in the Middle Ages,' 'Life of General Chesney.' (S. L.-P.)

LANESSAN, J. M. A. de; Agr. de la faculté de Médicine; French Minister of Marine; formerly Governor-General of Indo-China; author of 'La Tunisie,' 'L'expansion coloniale de la France,' 'L'Indo-Chine française,' 'Du Protoplasme végétal,' 'La Matière, la Vie et les êtres vivants.' (J. M. A. de L.)

LANG, Andrew, M.A., LL.D.; Hon. Fellow of Merton Coll., Oxford; author of 'Apparitions,' 'Ballad,' 'Family,' 'Molière,' in Ninth Edition of 'Ency. Brit.,' 'Oxford,' 'Helen of Troy,' 'Custom and Myth,' 'Myth, Ritual and Religion,' 'Life, Letters, and Diaries of Sir Stafford Northcote,' 'Pickle the Spy,' 'The Book of Dreams and Ghosts,' Translations of 'Odyssey' (with Professor Butcher), and 'Iliad' (with Myers and Walter Leaf); 'The World's Desire' (with Rider Haggard), 'The Making of Religion,' 'The Companions of Pickle,' 'A History of Scotland from the Roman Occupation,' 'Prince Charles Edward,' 'Magic and Religion,' 'The Mystery of Mary Stuart,' etc. (A. L.)

LANG, W. H., M.B., D.Sc.; lecturer in botany, Queen Margaret's Coll., Glasgow; author of 'Memoirs on Morphology,' 'The Development of the Higher Cryptogams,' etc. (W. H. L.)

LANKESTER, Edwin Ray, M.A., LL.D., F.R.S.; Hon. Fellow of Exeter Coll., Oxford; Correspondent of the Institute of France; Director of the Natural History Department of the British Museum; Fullerian Professor of Physiology and Comparative Anatomy in the Royal Institution of London, 1898-1900; Fellow and Lecturer, Exeter Coll., 1872; Professor of Zoology and Compar. Anat. Univ. Coll., London, 1874-90; Regius Professor Natural History, Edinburgh, 1882; Linacre Professor of Comparative Anatomy, Oxford, 1891-1898; Royal Medallist Royal Society, 1885; Vice-President Royal Society, 1896; Founder (1884), President (1892) Marine Biological Association (Plymouth Laboratory); Correspondent of the Institute of France; Corr. Mem. Imp. Acad. Sciences, St Petersburg; For. Mem. Royal Bohemian Society of Sciences, of the New York Academy of Sciences, of the Academy of the Lincei of Rome, of the Royal Belgian Academy, and of the Academy of Sciences of Philadelphia; editor since 1869 of 'Quarterly Journal of Microscopical Science'; author of 'Hydrozoa,' 'Mollusca,' 'Mussel,' 'Polyzoa,' 'Protozoa,' 'Vertebrata,' 'Zoology,' in Ninth Edition of 'Ency. Brit.,' 'A Monograph of Cephalaspidian Fishes,' 'Comparative Longevity,' 'Developmental History of the Mollusca,' 'Degeneration,' 'The Advancement of Science,' 'Zoological Articles'; joint-editor of 'Scientific Memoirs of Thomas Henry Huxley.' (E. R. L.)

LARMOR, Joseph, M.A., D.Sc., Sec. R.S.; Fellow of St John's Coll., Camb.; University Lecturer in Mathematics; Professor of Natural Philosophy, Queen's Coll., Galway, and in the Queen's University in Ireland, 1880-1885, and formerly Fellow of the Royal University; Examiner in Mathematics and Natural Philosophy in the Univ. of London; lately President of the Cambridge Philosophical Society; Treasurer of the London Mathematical Society; author of 'Æther and Matter,' and various Memoirs on Mathematics and Physics. (J. L*.)

LAUGHTON, John Knox, M.A.; Professor of Modern History, King's Coll., London; Secretary of the Navy Records Society; served in Baltic during the Russian War, 1854-55; in China, 1856-59; afterwards in Mediterranean and Channel; Mathematical and Naval Instructor, Royal Naval College, Portsmouth, 1866-73; also at Greenwich, and lecturer on Meteorology, 1873-85; Pres. R. Met. Soc. 1882-1884; Honorary Fellow, Caius College, Cambridge, 1895; author of 'Farragut,' 'Fitzroy,' in Ninth Edition of 'Ency. Brit.,' 'Physical Geography in its Relation to the Prevailing Winds and Currents,' 'Studies in Naval History,' 'Nelson and his Companions in Arms,' 'Life of Henry Reeve,' 'Sea Fights and Adventures,' 'Letters and Despatches of Lord Nelson,' 'Defeat of the Spanish Armada.' (J. K. L.)

LAWRENCE, Rt. Rev. William, D.D., S.T.D.; Bishop of Massachusetts; sometime Professor of Homiletics and Pastoral Theology, and Dean Episcopal Theological School, Cambridge, U.S.A.; author of 'Life of Amos A. Lawrence,' 'Proportional Representation in the House of Clerical and Lay Delegates,' 'Visions and Service.' (W. L.)

LAYARD, George S.; English art writer; author of 'Charles Keene,' 'Mrs Lynn Linton,' 'Portraits of Cruikshank by Himself,' 'Tennyson and his Pre-Raphaelite Illustrators,' etc. (G. S. L.)

LECLÈRE, Léon; Professor of Universal History and History of Philosophy, University of Brussels. (L. L.)

LEE-WARNER, Sir William, K.C.S.I., M.A.; Secretary in the Political and Secret Departments of the India Office; Fellow of the University of Bombay; entered Indian Civil Service, 1869; political agent at Kolhapur; Under-Secretary in Foreign Office of India; Secretary to the Government of Bombay in Political and Judicial Departments; Chief Commissioner of Coorg and Resident in Mysore; additional member of the Viceroy's Council; served on Education Commission, the Financial Commission, etc.; author of 'The Protected Princes of India,' 'The Citizen of India. (W. L.-W.)

LEGGE, J. G.; Chief Inspector of Reformatory and Industrial Schools, Home Office. (J. G. L.)

LEGGE, Robin H.; editor of 'Music in the Nineteenth Century.' (R. H. L.)

LEONARD, Rt. Rev. Abiel, A.M., S.T.D.; Bishop of the Diocese of Salt Lake. (A. Le.)

LEVEY, George Collins, C.M.G.; London Correspondent of 'Melbourne Age'; editor and proprietor of 'Melbourne Herald,' 1863-68; editor and contributor to 'Melbourne Age,' 1869-81; Secretary to Commissioners for Victoria at the Exhibitions in London, Paris, Vienna, Philadelphia, Melbourne, 1873, 1876, 1878, 1880-81; Executive Commissioner, Amsterdam, 1883; Secretary Royal Commission, Hobart Exhibition, 1894-95; Secretary Colonial Adelaide Exhibition, 1887; Committee of Royal Commission to Paris Exhibition, 1900; member of Board of Advice to Agent-General of Victoria; author of 'Handbook to Australasia,' 'Australian Encyclopædia.' (G. C. L.)

LEWES, Vivian B., F.I.C., F.C.S.; Professor of Chemistry, Royal Naval College; Chief Superintending Gas Examiner to the Corporation of the City of London. (V. B. L.)

LEWIS, Charlton T., Ph.D.; President N.Y. Prison Association, N.J. State Charities Aid Association; Chairman of Commission to revise Penal Laws of New Jersey; Lecturer on Life Insurance, Harvard and Columbia Universities, and on Principles of Insurance, Cornell University; author of 'History of Germany,' Essays, Addresses, etc. (C. T. L.)

LEYLAND, John; writer on naval questions. (J. Ld.)

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LOCH, Charles Stewart, B.A.; Secretary to the Council of the London Charity Organization Society since 1875; Member Royal Commission on Aged Poor, 1893-95; Dunkin Trust Lecturer, Manchester College, Oxford, 1896; Vice-President Royal Statistical Society, 1894, 1895, 1897, 1901; author of 'Charity Organization,' 'Old Age Pensions and Pauperism.' (C. S. L.)

LOCOCK, Col. Herbert, C.B.; retired Colonel of Royal Engineers; Assist. Director of Works at Headquarters, 1881-86; Depy. Inspector-General of Fortifications at Headquarters, 1887-96. (H. Lo.)

LODGE, Sir Oliver Joseph, F.R.S., D.Sc., LL.D.; Principal of the University of Birmingham; Professor of Physics, University Coll., Liverpool, 1881-1900; author of 'Elementary Mechanics,' 'Modern Views of Electricity,' 'Pioneers of Science,' 'Signalling without Wires,' etc. (O. J. L.)

LORD, J. K., Professor of the Latin Language and Literature, Dartmouth College, N.H.; author of 'New Hampshire' in Ninth Edition of 'Ency. Brit.' (J. K. L*.)

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LOUIS, Paul; French statistician; staff of the 'Revue Blanche.' (P. L.)

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LOW, A. P.; of the Geological Survey of Canada; author of 'Report on the Exploration in the Labrador Peninsula,' etc. (A. P. Lo.)

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LOW, Sidney James, M.A., L.C.C.; Lecturer on History, King's College, 1883-86; editor of the 'St James's Gazette,' 1888-97; co-editor of the 'Dictionary of English History'; author of contributions to 'Nineteenth Century,' 'Fortnightly Review,' 'National Review,' etc. (S. J. L.)

LOWE, Major F. M., R.A.; Junior Experimental Officer, Shoeburyness, 1884; Asst. Proof Officer, Royal Gun Factory, 1885; Asst.-Inspector, Army Inspection Dept., 1888; Gunnery Instructor, Brit. N. America, 1893; Gunnery Instructor, Coast Defence School, Isle of Wight, 1894; and Assistant Superintendent of Experiments at Shoeburyness from 1898. (F. M. L*.)

LUGARD, Brig.-Gen. Sir Frederick John Dealtry, K.C.M.G., C.B., D.S.O.; High Commissioner of Northern Nigeria; served Afghan War, 1879-1880; Soudan Campaign, 1885; Burma Campaign, 1886-1887; commanded expedition against slave traders on Lake Nyassa, 1888; employed by British East African Company; in command of Exploration of the Sabakhi, and Administrator of Uganda, 1889-92; employed by Royal Niger Company, 1894-95; West Charterland, 1896-97; H.M. Commissioner Hinterland of Nigeria and Lagos, 1897-99; Commandant of West African Frontier Force, 1897-99; author of 'Our East African Empire.' (F. D. L.)

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LYDEKKER, Richard, B.A., F.R.S., F.G.S., F.Z.S.; Geological Survey of India, 1874-82; author of 'Geology of Kashmir,' 'Catalogues of Fossil Mammals, Reptiles, and Birds in British Museum,' 'Phases of Animal Life,' 'Royal Natural History,' 'A Manual of Palæontology' (with late Professor A. Nicholson), 'The Great and Small Game of Europe, N. and W. Asia, and America,' 'Descriptions of South American Fossil Animals.' (R. L*.)

LYNES, G. B., A.M.; sub-editor of the New Volumes of 'Ency. Brit.'; formerly literary editor of the 'Baltimore News,' and instructor in History and Acting Librarian, Union College, Schenectady, N.Y.; author of 'A Course in Modern European History,' etc. (G. B. L.)

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MACGREGOR, Sir William, K.C.M.G., C.B., M.D. Aberdeen, B.Sc. Camb., LL.D. Aberdeen; Governor of Lagos; Resident Surgeon and Resident Physician Glasgow Royal Infirmary, and Royal Lunatic Asylum, Aberdeen; Assistant Government Medical Officer, Seychelles, 1873; Surgeon Civil Hospital, Port Louis, Mauritius, 1874; Chief Medical Officer, Fiji, 1875; late Receiver-General and Administrator of the Government, and Acting High Commissioner and Consul-General for the Western Pacific; Administrator of British New Guinea, 1888; Lieut.-Governor, 1895. (W. M'G.)

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MACKAY, T., LL.D.; author of 'A History of the English Poor Law,' 'The Public Relief of the Poor,' 'Methods of Social Reform,' 'The State and Charity,' 'The English Poor'; editor of 'A Policy of Free Exchange,' 'A Plea for Liberty,' &c. (T. M*.)

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MACMORRAN, Alexander, K.C., A.M.I.C.E.; became editor of 'Justice of the Peace,' 1879, and has so continued; author of editions of 'Lumley's Public Health,' works on 'The Public Health (London) Act, 1891,' the 'Local Government Act, 1888,' the 'Local Government Act, 1894,' the 'London Government Act, 1899,' 'Poor Law Orders,' 'Poor Law Statutes,' etc. (A. M'M.)

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MAITLAND, Frederic William, LL.D., D.C.L. (Oxford, Glasgow, Cracow); Professor of English Law, Cambridge; Reader of English Law at Cambridge, 1884; Corresponding Member of Roy. Prussian Academy; author of 'Justice and Police,' 'Bracton's Note-Book,' 'History of English Law' (with Sir F. Pollock), 'Domesday Book and Beyond,' 'Township and Borough,' 'Canon Law in England,' etc. (F. W. M.)

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MARKHAM, Sir Clements Robert, K.C.B., F.R.S.; President of the Royal Geographical Society, of the International Geographical Congress, 1894-99, and of the Hakluyt Society, and of the Geographical, Elizabethan, and Royal Society Clubs; entered the Navy in 1844; served in the Arctic Expedition of 1850-51; geographer to the Abyssinian Expedition; Assistant Secretary in the India Office, 1867-77; author of 'Geography' (historical), 'Peru,' 'Polar Regions,' in Ninth Edition of 'Ency. Brit.'; 'Life of the Great Lord Fairfax,' 'The Fighting Veres,' 'History of Peru,' 'History of Persia,' 'History of the Abyssinian Expedition,' Lives of Columbus, John Davis, and Major Rennell, 'The Paladins of Edwin the Great'; edited volumes for the Hakluyt Society, the Navy Records Society, the Roxburghe Club, etc. (C. R. M.)

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MERCATELLI, Luigi, late war correspondent in Abyssinia of 'La Tribuna.' (L. Me.)

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MIDDLETON, R. E., M.I.C.E., M.I.M.E.; Fellow of the Sanitary Inst., Fellow of Surveyors' Inst., etc.; late Engineer-in-Charge of Surveying of Forth Bridge; Instructor in Surveying, Central Tech. Coll., S. Kensington; Lecturer on Waterworks, Engineering and Sewage, Univ. Coll., London; part author of 'A Treatise on Surveying,' etc. (R. E. M.)

MIJATOVICH, Chedomille; Senator of the kingdom of Servia since 1875; Envoy Extraordinary and Minister Plenipotentiary of the King of Servia to the Court of St James, 1895-1900; transferred to Constantinople. 1900; Minister of Finance and Commerce of Servia, 1873; Minister of Foreign Affairs and Finance, 1880; Servian Minister to the Court of St James, 1884; Servian Plenipotentiary for the conclusion of peace with Bulgaria, 1886; Member of Royal Servian Academy of Science; corresponding member of South Slavonic Academy; hon. member of Royal Hist. Soc. London; author of several publications in Servian on Political Economy, Finances, History of Commerce, and History of Servia in Fifteenth Century; novels—'Rayko of Rassina,' 'Ikoniya, the Mother of the Vezier,' etc., 'Constantine the last Emperor of the Greeks,' 'Ancestors of the House of Orange.' (C. Mi.)

MILL, Hugh Robert, D.Sc. (Edin.), LL.D. (St Andrews), F.R.S.G.S., F.R.G.S., F.R.Met.Soc.; Director of British Rainfall Organization, and editor of 'Symons' Meteorological Magazine' since 1901; Hon. Corresponding Member of the Geographical Societies of Paris, Berlin, Amsterdam, Budapest, Brisbane, and Philadelphia; Recorder of Section E, British Association, 1893-99; President, Section E, 1901; British Delegate to International Conference on the Exploration of the Sea, at Christiania, 1901; author of 'Rainband,' 'Rain-gauge,' 'Thermometer,' 'Whirlpool,' in Ninth Edition of 'Ency. Brit.,' 'Realm of Nature,' 'The Clyde Sea Area,' 'The English Lakes,' 'Hints on the Choice of Geographical Books,' 'New Lands,' 'The International Geography,' etc. (H. R. M.)

MILLAR, Alexander; author of 'Carpets.' (A. Mi.)

MILLINGEN, Alexander Van, M.A.; Robert College, Constantinople; author of 'Byzantine Constantinople,' etc. (A. van M.)

MILMAN, Sir Archibald John Scott, K.C.B., the late; Clerk of the House of Commons 1900, retired 1902; entered service of House of Commons in 1857; promoted Second Clerk Assistant, 1870; Clerk Assistant, 1886-1900. (A. J. S. M.)

MILNE, John, F.R.S., F.G.S.; twenty years employed by Japanese Govt. as geologist and mining engineer; established the Seismic Survey of Japan; designer of seismographs and instruments to record vibrations on railways, etc.; author of 'Earthquakes,' 'Seismology,' 'Crystallography,' etc. (J. Mi.)

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MITCHELL, Hugh; of Gibraltar; Barrister-at-Law, Inner Temple. (H. M*.)

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MONCKTON, Lionel; composer, and musical critic to the 'Daily Telegraph.' (L. M.)

MONCRIEFF, Sir Colin Campbell Scott, K.C.M.G., C.S.I., LL.D.; Under-Secretary for Scotland; Irrigation Depart. N.W. Provinces; Chief Engineer, Burma; Under-Secretary of State Public Works, Memshy, Cairo, 1883-92; author of 'Irrigation in Southern Europe.' (C. S. M.)

MONKHOUSE, William Cosmo, the late; Assistant Secretary (Finance) Board of Trade; served on several Departmental Committees and Committee on the Mercantile Marine Fund, 1894-96; author of 'The Christ upon the Hill,' 'A Question of Honour,' 'The Earlier English Water-Colour Painters,' 'The Italian Pre-Raphaelites,' 'British Contemporary Artists,' etc. (C. Mo.)

MONTAGU, Sir Samuel; head of the banking firm of Samuel Montagu and Co., London; member of Gold and Silver Commission, 1887-90; author of magazine articles on Finance, Decimal Currency, Weights and Measures, etc. (S. M.)

MOORE, A. W., M.A.; Speaker of the House of Keys, Isle of Man. (A. W. M.)

MOORE, Hon. John Bassett, LL.D.; Professor International Law and Diplomacy, Columbia University, New York; author 'Extradition and Inter-State Rendition,' 'International Arbitrations,' etc. (J. B. M*.)

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MORTON, Hon. Julius Sterling (the late); sometime U.S. Secretary of Agriculture and President of Nebraska State Historical Society. (J. S. M*.)

MOSCA, Gaetano; Professor of Constitutional Law, Turin, Italy. (G. Mo.)

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MOTT, Frederick Walker, M.D., B.S. Lond., F.R.C.P., F.R.S.; Physician to Out-Patients, Charing Cross Hospital; Pathologist to the London County Asylums; Croonian Lecturer, Royal College of Physicians, 1900. (F. W. Mo.)

MUIR, John, A.M., LL.D.; U.S. Explorer and Naturalist; discoverer of the Muir glacier, Alaska; author of 'Our National Parks,' 'The Mountains of California' and of numerous articles on the natural history of the Pacific Coast, Alaska, etc.; Editor 'Picturesque California.' (J. Mu*.)

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MURRAY, Sir George Herbert, K.C.B.; Secretary to the Post Office since 1899; entered Foreign Office, 1873; transferred to Treasury, 1880; private secretary to Mr Gladstone and Earl of Rosebery when Prime Minister; Chairman Board of Inland Revenue, 1897-1899. (G. H. M.)

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NASH, James Okey, M.A., of the Community of the Resurrection. (J. O. N.)

NATHAN, Major F. L., R.A.; Superintendent of the Royal Gunpowder Factory, Waltham Abbey. (F. L. N.)

NATHAN, Major Sir Matthew, K.C.M.G., R.E.; Governor of Gold Coast; served in Nile Expedition, 1885; Lushai Expedition, 1889; Sec. Col. Defence Com. 1895-1900; administered Government Sierra Leone, 1899. (M. N.)

NELSON, William Rockhill, Editor-in-Chief of the 'Kansas City Star,' Kansas City, Mo. (W. R. N.)

NEWCOMB, Prof. Simon, Ph.D., LL.D., D.Sc., D. Nat. Phil.; Superintendent U.S. Nautical Almanac; Foreign Mem. Royal Society, London; Assoc. Institute of France, etc.; author of 'Moon' in Ninth Edition of 'Ency. Brit.,' 'Popular Astronomy,' etc.; editor of 'American Journal of Mathematics.' (S. N.)

NEWELL, Frederick Haynes; Hydrographer of the U.S. Geol. Survey; author of 'Agriculture by Irrigation,' 'Hydrography of the United States,' etc. (F. H. N.)

NEWSOM, George Ernest, M.A.; Vice-Principal of King's College, London. (G. E. N.)

NEWTON, Henry G., M.A., LL.B.; Referee in Bankruptcy, New Haven, Conn. (H. G. N.)

NISBET, C. (C. N.)

NORTON, Charles Eliot, LL.D.; Professor of the History of Art, Harvard; Dante scholar and translator; author of 'Church Buildings in the Middle Ages'; editor of 'Letters of James Russell Lowell,' 'Correspondence of Carlyle and Emerson,' 'Writings of George William Curtis,' etc. (C. E. N.)

NORTON, Richard, A.B.; Director of the American School of Classical Studies in Rome; formerly Professor of History of Art and Archæology of Bryn Mawr College, Pennsylvania. (R. N.)

NOTTER, Col. J. Lane, M.A., M.D., R.A.M.C., F.C.S.; late Prof. of Military Hygiene, Netley; author of 'The Theory and Practice of Hygiene,' etc. (J. L. N.)

O

O'DONOGHUE, Freeman M., F.S.A.; Assistant Keeper of Prints, British Museum; author of 'Catalogue of the Collection of Playing Cards bequeathed to the British Museum by Lady Charlotte Schneber,' 'A Descriptive and Classified Catalogue of the Portraits of Queen Elizabeth,' etc. (F. M. O'D.)

OELSNER, Herman, M.A. (Cantab.), Ph.D. (Berlin); recognized Intercollegiate Lecturer in Romance in the University of Cambridge; Examiner in Romance for the Mediæval and Modern Languages Tripos; Italian Examiner in the Royal University of Ireland, and in the University of London; author of 'The Influence of Dante on Modern Thought' (Cambridge University Le Bas Prize Essay, 1894), 'Dante in France'; editor of the 'Commedia' in the 'Temple Classics,' etc.; is writing a 'History of Provençal Literature' for Mr Gosse's 'Literatures of the World' Series, etc. (H. O.)

OLDFIELD, Josiah, D.C.L., M.R.C.S. (J. O.)

O'NEILL, Æneas; Assistant Correspondent of 'The Times,' Vienna. (Æ. O'N.)

ORDE-BROWNE, Capt. C., the late; author of 'Armour and its Attack by Artillery,' 'Short Notes on Field Batteries,' 'Ammunition for Rifled Ordnance,' etc. (C. O.-B.)

OWEN, Capt. C. R. B., R.A.; late Professor of Artillery, Ordnance College; Assist. Superintendent, Roy. Carriage Dept., Woolwich Arsenal. (C. R. B. O.)

OWEN, Edmund, M.B. Lond., F.R.C.S.; Senior Surgeon to St Mary's Hospital, London, and Consulting Surgeon to the Children's Hospital, Great Ormond Street; Member of the Council, and late Member of the Court of Examiners of Royal College of Surgeons; Examiner in Surgery at the Universities of Cambridge and of London; Knight of Grace of the Order of St John of Jerusalem; Corresponding Member of the Imperial Medical Military Academy of St Petersburg, and of the Canadian Medical Association, and of the Association of American Orthopædic Surgeons; Hon. Surgeon to the Royal Society of Musicians; late President of the Medical Society of London; author of 'A Manual of Anatomy for Senior Students,' 'The Surgical Diseases of Children.' (E. O*.)

P

PAGET, Sir John R., Bart., LL.B., K.C.; Gilbart Lecturer on Banking. (J. R. P*.)

PAGET, Stephen, F.R.C.S.; Surgeon to West London Hospital; Surgeon to Throat and Ear Department, Middlesex Hospital; author of 'The Surgery of the Chest,' 'John Hunter,' 'Ambroise Paré and his Times,' Experiments on Animals,' 'Memoirs and Letters of Sir James Paget.' (S. P.)

PALGRAVE, Robert Harry Inglis, F.R.S.; editor of 'Economist,' 1877-83; author of 'The Local Taxation of Great Britain and Ireland,' 'Notes on Banking in Great Britain and Ireland, Sweden, Denmark, and Hamburg,' 'An Analysis of the Transactions of the Bank of England for the years 1844-72,' 'Bank Rate in England, France, and Germany, 1844-1878'; editor of 'Dictionary of Political Economy.' (R. H. I. P.)

PAPILLON, Rev. Thomas Leslie, M.A.; late Fellow of Merton Coll. and of New Coll., Oxford; author of 'A Manual of Comparative Philology'; editor Dean Bradley's 'Aids to Writing Latin Prose,' etc. (T. L. P.)

PARKIN, George Robert, LL.D., C.M.G.; Principal of Upper Canada College, Toronto, Canada; author of 'Imperial Federation,' 'Round the Empire,' 'The Great Dominion,' 'Life and Letters of Edward Thring.' (G. R. P.)

PARSONS, William Barclay: Chief Engineer of the Underground Railway, New York City. (W. B. P.)

PASCO, Hon. Samuel; Member of the Nicaragua Canal Commission, United States Senator from the State of Florida, 1887-99. (S. Pa.)

PATON, Diarmid Noël, M.D., B.Sc., F.R.C.P. Ed.; Superintendent of Research Laboratory of Royal College of Physicians, Edinburgh, 1889; Lecturer on Physiology, School of Medicine of Royal Colleges, Edinburgh, 1886; Biological Fellow of Edinburgh University, 1884; Member of the Royal Commission on Salmon Fisheries; author of many papers on Physiological subjects. (D. N. P.)

PAUL, Alfred Wallis, C.I.E., B.A.; late Scholar of Wadham College, Oxford; Indian Civil Service (retired): Political Officer Sikkim Expedition; British Commissioner under Anglo-Chinese Convention of 1890; Deputy Commissioner of Darjeeling. (A. W. P.)

PEACH, Capt. E., Indian Staff Corps; author of 'Tactics—Savage Warfare,' etc. (E. P.)

PEARSON, Karl, M.A., LL.B., F.R.S.; Professor of Applied Mathematics and Mechanics, University College, London; Gresham Professor of Geometry, 1892-94; Darwin Medal Royal Society, 1898; author of 'Grammar of Science,' 'Enlarged Grammar of Science,' 'The Chances of Death, and other Studies in Evolution,' 'The Ethic of Freethought,' 'Die Fronica, a History of the Mediæval Portraits of Christ,' etc. (K. P.)

PELSENEER, PAUL, D.Sc. (Brussels); cor. member of the Royal Belgian Academy of Science; member of the Belgian Committee of Mariculture; Professor in the Normal School, Ghent; lecturer, Brussels University; author of 'Introduction à l'Étude des Mollusques,' '"Challenger" Report on the Pteropoda,' 'The Anatomy of the Deep-Sea Mollusca,' etc. (P. P.)

PEMBREY, Marcus Seymour, M.A., M.D.; Lecturer in Physiology, Guy's Hospital Medical School. (M. S. P.)

PENDEREL-BRODHURST, James George Joseph; editor of 'Land,' 1881-83, assistant editor of 'St James's Gazette,' 1888-1893, editor of 'St James's Budget,' 1889-98; author of 'The Life and Times of King Edward VII.,' part author of 'The Royal River and Abbeys and Churches of England and Wales.' (J. G. J. P.-B.)

PENNELL, Joseph, artist; author of 'A Canterbury Pilgrimage,' 'An Italian Pilgrimage,' 'Two Pilgrims' Progress,' 'Our Sentimental Journey through France and Italy,' 'Pen Drawing and Pen Draughtsmen,' 'Our Journey to the Hebrides,' 'The Stream of Pleasure,' 'The Jew at Home,' 'Play in Provence, 'Modern Illustration,' 'The Illustration of Books, 'The Work of Charles Keene,' 'Lithography and Lithographers.' (J. P*.)

PERSHING, James H., A.B.; Lecturer on International Law in the University of Denver, and Professor of Medical Jurisprudence in Gross Medical College, Denver. (J. H. Pe.)

PETERSON, Frederick, Ph.D., M.D.; Head of the New York State Commission of Lunacy; President New York Neurological Society and President of the Board of Managers of Craig Colony for Epileptics; Chief of Clinic, Department of Neurology, Columbia University. (F. P*.)

PETRIE, William Matthew Flinders, D.C.L., Litt.D., LL.D., Ph.D.; Edwards Professor of Egyptology, University Coll. London; surveying British remains, 1875-80; excavating in Egypt, 1880-1901; author of 'Pyramid,' 'Weights and Measures,' in Ninth Edition of 'Ency. Brit.,' 'Stonehenge, 'Pyramids and Temples of Gizeh,' 'Season in Egypt,' 'Racial Portraits,' 'Historical Scarabs,' 'Ten Years' Digging,' 'History of Egypt,' 'Tel el Amarna,' 'Egyptian Tales,' 'Decorative Art,' 'Six Temples at Thebes,' 'Religion and Conscience in Ancient Egypt,' 'Syria and Egypt,' 'Royal Tombs of the First Dynasty,' 'Royal Tombs of the Earliest Dynasties,' etc. (W. M. F. P.)

PFEIL, Count Joachim Von, one of the founders of German East Africa; sometime resident in Bismarck Archipelago; author of 'The Founding of the Boer States,' 'Studies and Observations in the South Seas,' etc. (J. von P.)

PHELAN, Hon. James Duval; Mayor of San Francisco, 1896-1901. (J. D. P.)

PHILLIMORE, George Grenville, M.A., B.C.L.; Barrister-at-Law of the Middle Temple. (G. G. P*.)

PHILLIMORE, Sir Walter George Frank, Bt., D.C.L., LL.D.; Judge of the King's Bench Div.; author of 'Book of Church Law,' 2nd ed. of 'Phillimore's Ecclesiastical Law, 3rd ed. of vol. iv. of 'Phillimore's International Law.' (W. G. F. P.)

PHILLIPS, R. W., M.A., D.Sc., F.L.S.; Professor of Botany in the University Coll. of North Wales; author of 'Memoirs on the Physiology of Plants,' 'Morphology of the Algæ,' etc. (R. W. P.)

PHILLPOTTS, Lieut.-Col. A. H. C., R.A. (A. H. C. P.)

PINCHOT, Gifford, B.A.; Forester of the U.S. Department of Agriculture, Special Lecturer in the Forest School, Yale Univ.; author of 'The White Pine.' (G. P.)

PITMAN, Charles Murray; Stroke of the Oxford Eight, 1893-95; author of articles on Rowing. (C. M. P.)

PITT, Walter, M.I.C.E., M.I.M.E.; Member of the Committee of International Maritime Conference (London), etc. (W. P*.)

POLLEN, John Hungerford, M.A.; Examiner for Art, South Kensington; Fellow of Merton Coll., Oxford; Professor of Fine Arts in Catholic University of Dublin; Cantor Lecturer, Society of Arts, 1885; author of 'Carving,' 'Filigree,' 'Furniture,' in Ninth Edition of 'Ency. Brit.,' 'Ancient and Modern Furniture and Woodwork,' 'Ancient and Modern Gold- and Silver-smiths' Work,' 'The Trojan Column,' etc. (J. H. P.)

POLLOCK, Sir Frederick, Bt., LL.D., D.C.L.; Corpus Professor of Jurisprudence, Oxford; editor of the Law Reports from 1895; Fellow Trin. Coll., Camb. 1868; Corresponding member Institute of France, 1894; Professor of Jurisprudence, University Coll., London, 1882-1883; Professor of Common Law in the Inns of Court, 1884-90; member Royal Labour Commission, 1891-94; author of 'Sword,' 'Tort' in Ninth Edition of 'Ency. Brit.,' 'Principles of Contract,' 'The Law of Torts,' 'Digest of the Law of Partnership,' 'The Land Laws,' 'History of English Law,' 'Spinoza, Life and Philosophy,' 'A First Book of Jurisprudence,' 'The Etchingham Letters,' 1899 (with E. Fuller Maitland). (F. Po.)

POORE, George Vivian, M.D.; Professor of Medicine and Clinical Medicine, University College, London; medical attendant to late Prince Leopold, Duke of Albany, 1870-71; and Prince of Wales, 1872; received Dannebrog for professional services to the Princess Thyra, Duchess of Cumberland, 1872; Physician University Coll. Hospital, 1876; Secretary-General of Sanitary Congress, 1891, etc.; author of 'Essays on Rural Hygiene,' 'A Treatise on Medical Jurisprudence.' (G. V. P.)

PORTER, W. Haldane, B.A.; Barrister, Middle Temple; Chancellor's English Essay, Oxford, 1893. (W. H. Po.)

POST, George B.; Architect; Member of the Am. Society of Civil Engineers. (G. B. P.)

POTTER, Rt. Rev. Henry Codman, D.D., LL.D.; Bishop of the Diocese of New York; author of 'The Church and Her Children,' 'The Scholar and the State,' etc. (H. C. P.)

POULTON, Edward Bagnall, M.A., D.Sc.; Hon. LL.D. Princeton, F.R.S.; Hope Professor of Zoology, Oxford; Fellow of Jesus Coll., Oxford; Member of Council of Royal Society, 1897-99; Member of Hebdomadal Council of Oxford; Demonstrator in Anatomical Department of University Museum, 1877-79; Lecturer in Natural Science, and tutor of Keble College, Oxford, 1880-89: Lecturer in Natural Science, Jesus College, Oxford, 1880-88; author of 'The Colours of Animals,' 'Charles Darwin and the Theory of Natural Selection,' many memoirs on Zoological Subjects in the Proceedings and Transactions of the Royal, Linnæan, Zoological, Entomological, and other learned Societies. (E. B. P.)

POWELL, F. York, M.A.; Regius Professor of Modern History, Oxford; Student of Ch. Ch., Oxford; author of 'Icelandic Language,' etc., in Ninth Edition of 'Ency. Brit.,' 'Alfred the Great and William the Conqueror,' 'History of England to 1509.' (F. Y. P.)

POWELL, Harry J., B.A., F.C.S.; of James Powell and Sons (the Whitefriars Glass Works); Juror for Glass of all kinds, Paris Exhibition of 1889; member of the Art-Workers' Guild, of the Arts and Crafts Society, etc.; part-author of 'The Principles of Glass-Making.' (H. J. P.)

POYNTING, John Henry, D.Sc., F.R.S.; late Fellow of Trin. Coll., Camb.; Professor of Physics and Dean of the Faculty of Science, Birmingham University; author of the Adams Prize Essay (1891) on the 'Mean Density of the Earth,' 'A Text-Book of Physics' (with Professor J. J. Thomson), and various physical papers. (J. H. P*.)

PRINCE, Hon. L. Bradford, LL.D.; President of the Bureau of Immigration of the territory of New Mexico, Santa Fé, New Mexico; ex-Governor of the State of New Mexico; President of the New Mex. Hist. Soc.; author of 'New Mexico' in Ninth Edition of 'Ency. Brit.' (L. B. Pr.)

PROCTER, Hon. John Robert, President U.S. Civil Service Commission, Washington, D.C.; Geologist State of Kentucky, 1880-1893; author of 'Kentucky' in Ninth Edition of 'Ency. Brit.' (J. R. P.)

PROUT, Col. Henry Goslee, C.E., M.A.; editor of 'The Railroad Gazette,' New York; sometime Governor of the Provinces of the Equator, Africa, and Colonel of Engineers, Army of the Khedive. (H. G. P.)

PROWSE, Daniel Wodley, K.C., LL.D., D.C.L.; retired Judge Central District Court of Newfoundland; appointed Judge Central District Court, 1869; Commissioner for the Consolidation of Colonial laws; Chairman Board of Health, 1893-96; author of 'History of Newfoundland,' 'Manual for Magistrates in Newfoundland,' numerous pamphlets and newspaper articles. (D. W. P.)

PULLAN, Rev. Leighton, Fellow of St John's Coll., Oxford; author of 'History of Early Christianity,' 'Lectures on Religion,' etc. (L. P.)

PURSER, F., M.A., M.R.I.A.; Fellow of Trinity Coll., Dublin, and Professor of Natural Philosophy, University of Dublin. (F. Pu.)

PURSER, J., M.A., D.Sc., LL.D., M.R.I.A.; emeritus Professor of Mathematics, Queen's Coll., Belfast. (J. Pu.)

PUTNAM, George Haven, A.M., Litt.D.; Head of the publishing House of G. P. Putnam's Sons, N.Y.; led in reorganizing, 1887, the American Copyright League, and was its secretary during the movement for International Copyright which resulted in the Copyright Bill of 1891; received Cross of the Legion of Honour from France, 1891; author of 'Question of Copyright,' 'Books and their Makers in the Middle Ages,' etc. (G. H. P*.)

PUTNAM, Hon. Herbert, Librarian of Congress, Washington, D.C. (H. P.)

PYLE, Joseph Gilpin; editor of the 'Post-Intelligencer,' Seattle, Washington; author of 'Minnesota' in Ninth Edition of 'Ency. Brit.' (J. G. P.)

Q

QUILLER-COUCH, Arthur Thomas, B.A.; Lecturer Classics Trin. Coll., Oxford, 1886-87; author of 'Dead Man's Rock,' 'Troy Town,' 'The Splendid Spur,' 'Noughts and Crosses,' 'The Delectable Duchy,' 'Adventures in Criticism,' 'The Oxford Book of English Verse,' 'The Laird's Luck,' finished R. L. Stevenson's uncompleted novel 'St Ives,' etc. (A. T. Q.-C.)

R

RADAU, R.; Membre de l'Académie des Sciences et du Bureau des Longitudes, Paris; writer on Astronomy, etc., part author of 'Géologie d'Ethiopie,' etc. (R. Ra.)

RAIKES, His Honour Judge Francis William, LL.D., K.C.; Judge of County Court (Hull); three years in merchant service, then passed into Royal Navy first; called to the Bar, 1873; author of 'The New Practice' (with Mr Justice Kennedy); 'Jurisdiction and Practice of County Courts in Admiralty' (with Mr Kilburn); 'Both to Blame,' paper read at Brussels International Law Conference, 1895; and various papers on maritime law, translations and editions of the Maritime Codes of Europe, etc. (F. W. Ra.)

RAMBAUT, Arthur Alcock, M.A. (Dub. and Oxon.); D.Sc., F.R.S., F.R.A.S.; Radcliffe Observer, Oxford; Assistant Astronomer Trinity College, Dublin, at Dunsink, 1882-92; Andrews Professor of Astronomy in the University of Dublin and Royal Astronomer of Ireland, 1892-97; author of various memoirs and papers on astronomical subjects. (A. A. R*.)

RANDALL, John; Secretary of the London Association of Correctors of the Press; Press Reader of the 'Athenæum.' (J. R*.)

RASHDALL, Rev. Hastings, M.A., D.C.L.; Fellow and Tutor of New College, Oxford; Lecturer in St David's College, Lampeter, 1883; Tutor in the Univ. of Durham, 1884-88; Fellow and Lecturer of Hertford Coll., Oxford, 1888-95; Chaplain and Theological Tutor of Balliol Coll., 1894-95; author of 'The Universities of Europe in the Middle Ages,' 'Doctrine and Development' (with R. S. Rait), 'New College.' (H. Rl.)

RÁTH, Dr Zoltán; Professor at the Royal Academy of Law, Kassa, Hungary; late of the Royal Hungarian Statistical Bureau; author of 'Evitzedünk egyenesadó-reform-jairól.' (Z. R.)

RAVENSTEIN, Ernest George; War Office, Topographical (now Intelligence) Department, 1855-75; Council Royal Statistical Society, 1877-92; President, Section E, Brit. Assoc., 1891; Professor of Geography, Bedford Coll., 1882-83; author of 'The Russians on the Amur,' 'Geographie und Statistik des Britischen Reiches,' 'Vasco da Gama's First Voyage,' 'Map, Equatorial Africa,' 'Systematic Atlas.' (E. G. R.)

RAYLEIGH, Lord, 3rd Baron, D.C.L. (Hon. Oxon.), LL.D., D.Sc. (Camb. and Dublin), F.R.S.; member of the Order of Merit; Professor of Natural Philosophy, Royal Institution; Scientific Adviser to Trinity House; Cavendish Professor of Experimental Physics, Cambridge, 1879-84; Secretary of Royal Society, 1887-96; author of 'Optics,' 'Wave Theory,' in Ninth Edition of 'Ency. Brit.,' 'Theory of Sound,' numerous scientific papers. (R.)

REDWOOD, Boverton, F.R.S.Ed., A.M.I.C.E., M.I.M.E.; Fellow of Inst. of Chem.; V.P. and Mem. of Council and Publication Com., Soc. Chem. Ind.; Fellow of Chem. Geol. and R. Geog. Soc.; D.Sc. Ohio Normal University; Mem. of Am. Chem. Soc., and Am. Philosophical Soc. (honorary); Hon. Corres. Mem. Imperial Russian Technical Soc.; Chevalier of the Order of Leopold; Consulting Chemist, with special experience in the technology of petroleum; Adviser on Petroleum to the Home Office; Consulting Adviser to the Corporation of London under the Petroleum Acts; Chemical Adviser to the Oil Trade Section of the London Chamber of Commerce; member of several juries at International Inventions and Health Exhibitions, president of International Jury for lighting appliances and materials at Brussels Exhibition, 1897, and member of Jury, Paris Exhibition, 1900; author of 'Cantor Lectures on Petroleum and its Products,' 'Petroleum: its Production and Use,' 'Report (with Sir Frederick Abel) on Accidents with Mineral Oil Lamps,' 'Report (with Sir Frederick Abel) on the Transport of Petroleum through the Suez Canal,' 'The Transport of Petroleum in Bulk,' articles on the Petroleum Industry, and Lamps in Chemical Technology, 'A Treatise on Petroleum,' 'The Detection and Estimation of Inflammable Gases and Vapours in the Air' (with Professor Clowes), 'Handbook on Petroleum' (with Capt. J. H. Thomson). (B. R.)

REEVES, Hon. William Pember, Agent-General for New Zealand; Member of Senate of University of London; edited the 'Canterbury Times,' and the 'Lyttelton Times'; Member of N.Z. Parliament, 1887-96; Minister of Education, Labour, and Justice, 1891-96; resigned position to become Agent-General for colony; author of 'The Long White Cloud, a History of New Zealand,' 'An Introduction to the History of Communism and Socialism,' also volume of New Zealand verse. (W. P. R.)

REICH, Emil, Dr. Juris, F.R.Hist.S.; author of 'History of Hungarian Literature,' 'History of Civilization,' 'Græco-Roman Institutions,' 'Historical Atlas of English History,' 'Historical Atlas of Modern History,' etc. (E. Re*.)

REID, Clement, F.R.S., F.L.S., F.G.S.; geologist on survey of England and Wales; formerly secretary and recorder to the Geological Section of British Association; author of 'Pliocene Deposits of Britain,' 'Origin of the British Flora,' many contributions to geological journals. (C. R.)

REID, Sir George, LL.D.,; President Royal Scottish Academy; author of 'Lithography,' 'Painting,' 'Turner,' in Ninth Edition of 'Ency. Brit.' (G. Re.)

REID, Hon. Whitelaw, A.M., LL.D.; editor of the New York Tribune; Ex-U.S. Minister to France; author of 'Greeley,' 'Newspapers,' in Ninth Edition of 'Ency. Brit.' (W. R.)

RENTON, A. Wood, LL.B.; Puisne Judge, Mauritius; author of 'Thurlow' in Ninth Edition of 'Ency. Brit.' (A. W. R.)

RENWICK, I. P. A., M.A., LL.B.; assistant editor of the 'Statesman's Year Book.' (I. P. A. R.)

REYNOLDS, Osborne, M.A., LL.D. Glasgow, F.R.S., M.I.C.E., Hon. Fellow Queens' Coll., Cambridge; Professor of Engineering, Owens College, Victoria University, Manchester; Fellow of Queens' College, Cambridge, 1877; President, Section G, British Association, 1887; author of upwards of sixty papers on original researches in 'Mechanics and Physics,' in the Philosophical Transactions and Proceedings of the Royal Society, etc. (O. R.)

RHODES, Hon. Bradford; editor of 'The Banker's Magazine,' New York. (B. R*.)

RHODES, James Ford, LL.D.; author of 'History of the United States from the Compromise to 1850.' (J. F. R.)

RICHARDS, Robert Hallowell, Sc.B.; Professor of Mining, Engineering, and Metallurgy, Massachusetts Institute of Technology. (R. H. R.)

RICHARDSON, Charles Francis, A.M., Ph.D.; Professor of English, Dartmouth College, N.H.; author of 'History of American Literature,' 'The Choice of Books,' etc., etc. (C. F. R.)

RICHARDSON, Professor Rufus B.; Director of American School of Classical Studies, Athens. (R. B. R.)

RICHMOND, Sir William Blake, R.A., M.A., K.C.B.; Slade Professor at Oxford, 1878-1883; President of Society of Miniature Painters, 1899. (W. B. Ri.)

RICKETTS, Charles, English printer, artist, and wood-engraver; one of the founders of the Vale Press; decorated 'Early Poems of John Milton,' 'The Poems of Keats,' etc. (C. Ri.)

RILEY, John Athelstan Laurie, M.A.; travelled in Persia, 1881; Turkey in Europe, 1883; Persia and Kurdistan, 1884, 1886, 1888; member of the House of Laymen of the Province of Canterbury; member London School Board, 1891-97; author of 'Athos, or the Mountain of the Monks,' various pamphlets and articles, subjects connected with education, Eastern Christians, and foreign travel. (J. A. L. R.)

RIPON, Bishop of, Rt. Rev. William Boyd Carpenter, Hon. D.D. Glasgow, Hon. D.C.L. Oxon.; Knight of the Order of the Royal Crown, Prussia; Hulsean Lecturer, Cambridge, 1878; Bampton Lecturer, Oxford, 1887; Pastoral Lecturer on Theology, Cambridge, 1895; Canon of Windsor, 1882-1884; Hon. Chaplain to the Queen, 1879-83; Chaplain-in-Ordinary, 1883-84; author of 'Commentary on Revelation,' 'Witness of Heart to Christ' (Huslean Lectures), 'Permanent Elements of Religion' (Bampton Lectures), 'Lectures on Preaching,' 'Christian Reunion,' 'The Great Charter of Christ,' 'A Popular History of the Church of England.' (W. B. R.)

RISTORI, Emanuel Joseph, B.S., F.R.S.A., F.R.M.S., Assoc.M.Inst.C.E.; Managing Director of the Aluminium Company; has designed and erected several factories connected with the aluminium industry. (E. J. R.)

ROBERTS, W.; author of 'Christie's,' 'The Book-hunter in London,' etc. (W. R*.)

ROBERTS-AUSTEN, Sir William Chandler, K.C.B., D.C.L. (Durham), F.R.S.; Chevalier de la Légion d'Honneur; chemist and assayer to Royal Mint since 1870; Professor of Metallurgy, Royal School of Mines since 1880; President of Iron and Steel Institute; author of 'Gold,' etc., in Ninth Edition of 'Ency. Brit.,' 'An Introduction to the Study of Metallurgy.' (W. C. R.-A.)

ROBERTSON, Sir George Scott, K.C.S.I., D.C.L.; entered Indian Medical Service, 1878; British Agent in Gilgit; conducted a political mission to Chitral, 1893; besieged in Chitral, during March and April 1895; installed the present ruler of Chitral, September 1895; author of 'The Kafirs of the Hindu Kush,' 'Chitral: The Story of a Minor Siege.' (G. S. R.)

ROBERTSON, James W.; Commissioner of Agriculture and Dairying, Ottawa, Canada. (J. W. R.)

ROBERTSON, John G.; Lecturer on the English Language, University of Strasburg. (J. G. R.)

ROBINSON, A. Mary F. (Mme. Duclaux; formerly Mme. Darmesteter), author of 'Emily Brontë,' 'The End of the Middle Ages,' 'Margaret of Angoulême, Queen of Navarre,' 'Retrospect, and other Poems,' 'Life of Renan,' 'Collected Poems,' 'Marguerites du Temps Passé,' 'Froissart,' 'Grands Ecrivains d'outre Manche,' etc. (A. M. F. D.)

ROBINSON, Rev. Charles Henry, M.A.; Hon. Canon of Ripon; Lecturer in Hausa in the University of Cambridge, 1896; travelled in Armenia in order to report to Archbishop of Canterbury on the condition of Armenian Church, 1892; conducted pioneer expedition to Kano, 1893-95; author of 'Hausaland, or Fifteen Hundred Miles through the Central Soudan,' 'Specimens of Hausa Literature,' 'Grammar of the Hausa Language,' 'Dictionary of the Hausa Language,' 'Studies in the Character of Christ,' 'Nigeria, Our Latest Protectorate,' 'Human Nature a Revelation of the Divine.' (C. H. R.)

ROBINSON, Gerald Philip; President of the Society of Mezzotint Engravers; late Mezzotint Engraver to Queen Victoria, and appointed same to the King, 1901. (G. P. R.)

ROBINSON, Rev. Joseph Armitage, D.D., Ph.D.; Canon of Westminster; Norrisian Professor of Divinity, Cambridge University, 1893-99; author of 'A Collation of the Athos Codex of the Shepherd of Hermas,' 'Appendix to The Apology of Aristides,' 'The Passion of St Perpetua,' 'The Philocalia of Origen,' 'Euthaliana,' 'Unity in Christ.' (J. A. R.)

ROCKHILL, Hon. William Woodville; Head of the Bureau of American Republics; sometime First Assistant Secretary of State; U.S. Commissioner to China, etc.; author of 'Land of the Llamas.' (W. W. R.)

ROCKWELL, General Alfred P., author of 'Fire,' 'Fire Extinction,' in Ninth Edition of 'Ency. Brit.' (A. P. R.)

ROGERS, Henry Wade, LL.D.; Lecturer at Yale University; sometime President of North-Western University, Evanston, Ill.; Chairman of the World's Congress on Jurisprudence and Law Reform, World's Columbian Exposition; author of 'Expert Testimony, etc. (H. W. R.)

ROLLS, Hon. C. S., M.A.; pioneer in motor-car travelling. (C. S. R.)

ROSCOE, Sir Henry Enfield, Ph.D., LL.D., D.C.L., M.D., F.R.S.; Vice-Chancellor, University of London; Emeritus Professor, Owens College, Victoria University; Member of Royal Commissions on Noxious Vapours, Technical Instruction, Scottish Universities, Secondary Education, and Exhibition of 1851; President of the British Association (Manchester, 1887); President Society of Chemical Industry, 1881; President Chemical Society, 1882; author of 'Lessons in Elementary Chemistry,' 'Treatise on Chemistry,' 'Primer of Chemistry,' 'John Dalton,' 'New View of the Genesis of the Atomic Theory of Chemistry' (with Dr Harden). (H. E. R.)

ROSEWATER, Victor, A.M., Ph.D.; managing editor of the Omaha Bee, Omaha, Nebraska; Member Omaha Public Library Bd., Am. Economic Assn., Am. Library Assn., Neb. Historical Society; author of 'Special Assessments: a Study in Municipal Finance.' (V. R.)

ROSS, H. M., B.A.; formerly exhibitioner of Lincoln Coll., Oxford; writer on engineering and scientific subjects; associate editor of the new volumes of the 'Encyclopædia Britannica.' (H. M. R.)

ROSSETTI, William Michael; Professional Assistant to Board of Inland Rev. for Estate duty on Pictures and Drawings; author of 'Canova,' 'Correggio,' 'Fiesole,' 'Ghirlandajo,' 'Lippi,' 'Murillo,' 'Perugino,' 'Reni,' 'Rosa,' 'Shelley,' 'Titian,' 'Veronese,' etc., in Ninth Edition of 'Ency. Brit.'; 'Fine Art, chiefly contemporary,' 'Lives of Famous Poets,' 'Life of Keats,' 'Dante G. Rossetti as Designer and Writer,' 'Memoir of Dante G. Rossetti'; editor of 'The Germ,' 1850, of 'Shelley's Poems,' of 'Wm. Blake's Poems,' of 'Poems by Dante and Christina Rossetti,' of 'Ruskin,' 'Rossetti,' 'Præraphaelitism,' of 'Præraphaelite Diaries and Letters,' etc. (W. M. R.)

ROWLAND, Henry Augustus, Ph.D., LL.D., F.R.S., the late; Professor of Physics, Johns Hopkins University; recipient of Rumford, Draper, and Matteucci medals for scientific discoveries; Hon. Member Inst. of France, etc.; author of 'Screw' in Ninth Edition of 'Ency. Brit.' (H. A. R.)

RUFFINI, Arthur; Royal Naval Academy, Leghorn. (A. R*.)

RUGE, Dr Sophus; Professor of Geography, University of Dresden; author of 'Map' in Ninth Edition of 'Ency. Brit.,' 'Geschichte des Zeitalters der Entdeckungen,' 'Abhandlungen und Vorträge zur Geschichte der Erdkunde,' 'Christopher Columbus,' etc. (S. R.)

RUSSELL, Hon. Bertrand Arthur William, M.A.; Fellow of Trinity College, Cambridge; author of 'German Social Democracy,' 'Essay on the Foundations of Geometry,' 'Philosophy of Leibnitz.' (B. A. W. R.)

RUSSELL, George William Erskine, LL.D.; Parliamentary Secretary to the Local Government Board, 1883-85; Under-Secretary of State for India, 1892-94; for the Home Department, 1894-95; author of 'A Monograph on the Rt. Hon. W. E. Gladstone,' 'Letters of Matthew Arnold,' 'Collections and Recollections, 1898.' (G. W. E. R.)

S

SACHS, Edwin O., A.M.I.C.E.; Chairman of British Fire Prevention Committee; Fellow of the Royal Statistical Society; Associate of the Institution of Naval Architects, etc.; in 1898 he applied electrical power to the working of the stage at Drury Lane; in 1899 he was appointed technical adviser to the Royal Opera, Covent Garden; founded in 1897 the British Fire Prevention Committee, and in 1899 the first independent fire-testing station established in Europe; author of 'Modern Opera Houses and Theatres,' 'Stage Construction,' 'Fires and Public Entertainments.' (E. O. S.)

ST. JOHN, Molyneux; Ottawa, Canada. (M. St. J.)

SAMPSON, Rear-Admiral William Thomas, LL.D., the late; in command of U.S. North Atlantic Squadron, battle of Santiago; afterwards Commandant U.S. Navy Yard, Boston, Mass.; Member of International Prime Meridian and Time Conference; U.S. Delegate to International Maritime Conference; Chief of U.S. Bureau of Ordnance, 1893-97. (W. T. S.)

SAUNDERS, George, B.A.; Berlin Correspondent of 'The Times'; late Berlin Correspondent of the 'Morning Post,' etc. (G. Su.)

SAYCE, Rev. Archibald Henry, M.A., LL.D., D.D.; Fellow of Queen's College, Oxford; Professor of Assyriology, Oxford; Member of O.T. Revision Company, 1874-84; Deputy Professor of Comparative Philology, Oxford, 1876-1890; Hibbert Lect., 1887; Gifford Lect., 1900-1; author of 'Babylonia,' 'Cyrus,' 'Darius,' 'Grammar,' 'Humboldt,' 'Inscriptions' (Cuneiform and Semitic), 'Lydia,' in Ninth Edition of 'Ency. Brit.,' 'Assyrian Grammar for Comparative Purposes,' 'Translations in Records of the Past,' 1st series; 'Lectures on the Assyrian Language and Syllabary,' 'Babylonian Literature,' 'Introduction to the Science of Language,' 'The Monuments of the Hittites,' 'Fresh Light from the Monuments,' 'The Ancient Empires of the East,' 'Hibbert Lectures on Babylonian Religion,' 'The Hittites,' 'The Races of the Old Testament,' 'The Higher Criticism and the Verdict of the Monuments,' 'The Egypt of the Hebrews and Herodotus,' 'Early History of the Hebrews.' (A. H. S.)

SCHIDROWITZ, Philip, Ph.D. Berne; F.C.S. (Great Britain and Germany); Member of Societies of Chemical Industry and of Public Analysts; author (joint) of various papers on Acids, Wine, Analyses, etc. (P. S.)

SCHILLER, F. C. S., M.A.; Fellow and Tutor of C.C.C. Oxford. (F. C. S. S.)

SCHLICH, William, C.I.E., Ph.D., F.R.S.; Professor of Forestry, Cooper's Hill Coll.; appointed to the Indian Forest Department, 1866; Conservator of Forests, 1871; Inspector-General of Forests to the Government of India, 1881; organized the first School of Forestry in England at Cooper's Hill, 1885; author of 'A Manual of Forestry.' (W. Sch.)

SCHLOSS, David, M.A.; author of works on labour questions. (D. Sch.)

SCHOULER, James, LL.D.; Professor School of Law, Boston University, and Lecturer at Johns Hopkins University, Baltimore; author of 'History of the United States under the Constitution' and numerous works on Jurisprudence. (J. Sch.)

SCHRADER, Franz; Prix Gay de l'Académie des Sciences; editor of 'L'Année Cartographique,' 'Le Tour du Monde'; author of 'Aperçu de la Structure Géologique des Pyrénées,' etc. (F. Sch.)

SCHURMAN, Jacob Gould, D.Sc., LL.D.; President and sometime Professor of Philosophy, Cornell University; Chairman of the U.S. Philippine Commission, 1899; author of 'Kantian Ethics,' 'Ethics of Evolution,' 'Agnosticism and Religion,' etc. (J. G. S*.)

SCHURZ, Hon. Carl, LL.D.; Secretary of the Interior under President Hayes; author of 'Life of Henry Clay,' 'Abraham Lincoln,' 'Speeches.' (C. S.)

SCOTT, Austin, Ph.D., LL.D.; President Rutgers College and Rutgers Scientific School, New Jersey. (A. Sc.)

SCOTT, Dukinfield Henry, M.A., Ph.D., F.R.S.; Honorary Keeper Jodrell Laboratory, Royal Gardens, Kew; Assistant Professor of Botany, Univ. Coll., London, 1882-85; Royal Coll. of Science, London, 1885-92; a General Secretary of the British Association; cooperated with the late Professor W. C. Williamson in his 'Researches on Fossil Plants'; one of the editors of the 'Annals of Botany'; author of 'An Introduction to Structural Botany,' 'Studies in Fossil Botany'; author and joint-author of many botanical papers. (D. H. S.)

SCOTT, Harold Spencer; Barrister-at-Law, Lincoln's Inn. (H. S. S.)

SCOTT, Sir James George, G.C.I.E.; Deputy Commissioner, Burma; War Correspondent in Perak, 1875-76; Burma, 1879; Hong Kong, 1883-85; joined Burma Commission in 1886; member of Anglo-Siamese Boundary Commission, 1889-90; Superintendent Northern Shan States, 1891; Chargé d'Affaires in Bangkok, 1893-94; British Commissioner, Mekong Commission, 1894-96; British Commissioner Burma-China Boundary Commission, 1898-1900; author of 'The Burman, His Life and Notions,' 'France and Tongking,' 'Burma,' 'The Upper Burma Gazetteer.' (J. G. Sc.)

SCOTT, Hon. Sir John, M.A., D.C.L., K.C.M.G.; Deputy Judge-Advocate-General to His Majesty's Forces; Judge, afterwards Vice-President, International Court of Appeal in Egypt, 1874-82, Judge of High Court, Bombay, 1882-90; Judicial Adviser to the Khedive of Egypt, 1890-98; Vice-President International Law Association; Grand Cordon of the Medjidieh; Grand Cordon of the Osmanieh. (Jno. S.)

SCOTT, Leslie Frederic, M.A.; Barrister-at-Law, Inner Temple. (L. F. S.)

SCOTT, Walter S.; foreign sub-editor of 'The Times.' (W. S. S*.)

SCRUTTON, T. E., M.A., K.C.; Barrister, Inner Temple; author of 'Law of Copyright,' etc. (T. E. S.)

SCUDDER, Horace Elisha, Litt.D., the late; editor of 'The Atlantic Monthly,' 1890-98; author of 'History of the United States,' 'Book of Fables,' 'The Life of James Russell Lowell,' etc. (H. E. S*.)

SECCOMBE, Thomas, M.A.; assistant editor, 'Dictionary of National Biography'; author of 'The Age of Johnson,' etc. etc. (T. Se.)

SEDGWICK, Adam, M.A., F.R.S.; Fellow and Tutor of Trin. Coll. Cambridge; Reader in Animal Morphology in the University. (A. Se*.)

SETON-KARR, Henry, M.A., M.P.; travelled and shot big game in Western America, British Columbia, and Norway; writer on sport and allied subjects. (H. S.-K.)

SEWARD, Albert Charles, M.A., F.R.S., F.L.S., F.R.G.S.; University Lecturer in Botany, Cambridge; late Fellow of St John's College; Fellow and Tutor in Natural Science at Emmanuel College, Cambridge; author of 'Fossil Plants as Tests of Climate,' 'The Wealden Flora,' 'Fossil Plants for Students of Botany and Geology,' 'The Jurassic Flora,' also various Botanical papers contributed to scientific journals. (A. C. Se.)

SHADWELL, A., M.A., M.D., M.R.C.P. (Lond.); Member of Council of Epidemiological Society; author of 'The London Water Supply,' 'Plague at Oporto,' 'Diphtheria at Darenth Asylum,' etc. (A. Sl.)

SHADWELL, L. L., M.A.; Barrister-at-Law, Lincoln's Inn; revising barrister, Middlesex, 1885-1902. (L. L. S.)

SHARP, David, M.A., M.B., C.M., F.R.S.; Past President of Entomological Society of London; author of 'Aquatic Carnivorous Coleoptera,' 'Insects.' (D. S*.)

SHARP, Robert Farquharson, B.A.; Assistant Librarian, British Museum; edited 'Lytton's Plays,' author of 'Dictionary of English Authors,' Wagner's drama, 'Der Ring des Nibelungen,' 'Translation of Victor Hugo's "Hernani,"' 'Makers of Music,' 'Architects of English Literature.' (R. F. S.)

SHAW, Albert, Ph.D.; editor of the American 'Monthly Review of Reviews'; author of 'Local Government in Illinois,' 'Municipal Government in Great Britain,' 'Municipal Government in Continental Europe,' etc. (A. Sw.)

SHAW, Flora L. (Lady Lugard); Special Correspondent for 'The Times' to South Africa and Australia, Canada and Klondike; author of articles on British colonial questions. (F. L. S.)

SHAW, Herbert, B.A.; Secretary of the Tyneside Geographical Society. (H. Sh.)

SHAW, Hon. Leslie Mortier, LL.D.; Secretary of the U.S. Treasury; formerly Governor of the State of Iowa. (L. M. S.)

SHAYLOR, J.; manager to Simpkin, Marshall, and Co. (J. Sh*.)

SHEARMAN, Montague; past President O.U.A.C.: joint-author of 'Football: Its History for Five Centuries,' author of 'Athletics and Football.' (M. S.)

SHEARMAN, Thomas Gaskell, the late; joint-author of 'Shearman and Redfield on Negligence'; author of 'Natural Taxation,' 'Crooked Taxation,' 'Distribution of Wealth,' 'The Single Tax,' etc. (T. G. S.)

SHERRINGTON, Charles S., M.A., M.D., F.R.S.; Professor of Physiology, Univ. Coll. Liverpool; Member of Council of Royal Society; late Brown Professor of Pathology, University of London; Lecturer on Physiology, St Thomas's Hospital, London; Croonian Lecturer, Royal Society; Member of the Commission on Asiatic Cholera, 1886; Anglo-American Secretary, International Congresses of Physiology, Liége 1892, Berne 1895, Cambridge 1898, Turin 1901; author of numerous scientific papers to the Royal and other scientific societies, especially on the brain and nervous system. (C. S. S.)

SHERWELL, Arthur; author of works on Temperance questions. (A. Sh.)

SHIPLEY, Arthur Everett, M.A., F.Z.S.; Fellow, Tutor, and Lecturer at Christ's College, Cambridge; Lecturer on Advanced Morphology of the Invertebrata in the University; Demonstrator of Comparative Anatomy in the University, 1885-94; Fellow of Christ's College, 1887; Member of the Council of the Senate, 1896; author of 'Zoology of the Invertebrata'; author of 'Vine Disease,' 'Wasps,' 'Wheat Pests,' in Ninth Edition of 'Ency. Brit.'; joint-editor and part-author of the 'Cambridge Natural History'; editor of the 'Pitt Press Natural Science Manuals,' Biological Series; part-author of 'A Text-Book on Zoology,' etc. (A. E. S.)

SHORTER, Clement King; editor of 'The Sphere'; late editor of the 'Illustrated London News,' the 'Sketch,' and the 'English Illustrated Magazine'; author of 'Charlotte Brontë and Her Circle,' 'Sixty Years of Victorian Literature,' etc. etc. (C. K. S.)

SIBREE, Rev. James; for over twenty years a missionary in Madagascar; author of 'Madagascar' in the Ninth Edition of the 'Ency. Brit.,' 'Madagascar and its People,' 'The Great African Island,' 'Madagascar before the Conquest,' etc. (J. Si*.)

SIMPSON, Alexander Russell, M.D.; Professor of Midwifery and the Diseases of Women and Children, University of Edinburgh; editor of Sir James Y. Simpson's 'Lectures on Diseases of Women'; author of 'Contributions to Obstetrics and Gynæcology,' and of an 'Atlas of the Frozen Section of a Cadaver in the Genu-pectoral Position' (along with Dr Berry Hart), and many Memoirs. (A. R. S.)

SIMPSON, Rev. James Gilliland, M.A.; Principal of Leeds Clergy School; lately Rector of St Paul's, Dundee. (J. G. Si.)

SIMPSON, Lieut.-Col. W. A.; Assistant Adjutant-General U.S. War Department; Instructor U.S. Military Academy, West Point, 1883-87. (W. A. S.)

SINCLAIR, F. G., M.A., F.L.S.; author of many biological papers in scientific journals, etc. (F. G. S*.)

SKINNER, Frank C.; Principal Examiner and Chief of Classification Division, U.S. Patent Office. (F. C. S.)

SLOANE, Thomas O'Conor, Ph.D., A.M.; late Professor Nat. Sc., Seton Hall Coll., South Orange, N.J. (T. O'C. S.)

SLOANE, William Milligan, Ph.D., L.H.D., LL.D.; Professor of History, Columbia University, New York; sometime Professor of History in Princeton University, and editor of the 'Princeton Review'; Secretary to George Bancroft in Berlin, 1873-75; author of 'The French War and the Revolution,' 'Napoleon Bonaparte,' etc. (W. M. S.)

SLOCUM, William F., LL.D.; President Colorado College. (W. F. S.)

SMITH, Benjamin Eli, A.M., L.H.D.; assistant editor of the 'Century Dictionary'; editor of the 'Century Cyclopædia of Names' and of the 'Century Atlas.' (B. E. S.)

SMITH, Hon. Charles Emory; Postmaster-General, Washington, D.C.; formerly United States Minister to Russia; editor of the 'Philadelphia Press' since 1880. (C. E. S.)

SMITH, George Barnett, F.R.G.S.; author of 'Mrs Browning,' in Ninth Edition of 'Ency. Brit.,' 'Shelley,' 'Life of Mr Gladstone,' 'Victor Hugo,' 'The Life of Mr Bright,' 'The Prime Ministers of Queen Victoria,' 'Life and Enterprises of Ferdinand de Lesseps,' 'The Life of Queen Victoria,' etc. (G. B. S.)

SMITH, Hubert Llewellyn, M.A., B.Sc.; Deputy Controller-General and Labour Commissioner, Labour Department, Board of Trade; Cobden Prize, Oxford, 1886. (H. L. S.)

SMITH, Dr Hugh M.; in charge of Division of Inquiry respecting Food Fishes, U.S. Commission of Fish and Fisheries. (H. M. S*.)

SMITH, John, C.B.; Inspector-General in Bankruptcy. (J. Sm*.)

SMYTH, Herbert Warrington, M.A., LL.M., F.G.S., F.R.G.S.; Sec. Mining Dept., Transvaal; Order of the White Elephant, Siam; Sec. Siamese Legation, 1898-1901; author of 'Journey on the Upper Mekong,' 'Five Years in Siam,' etc. (H. W. Sm.)

SNOW, Francis Huntingdon, LL.D.; Chancellor of the University of Kansas. (F. H. S.)

SNOW, Marshall Solomon, A.M.; Professor of History and Dean of the College, Washington University, St Louis, Missouri; author of 'Missouri' in Ninth Edition of 'Ency. Brit.,' 'The City Government of St Louis.' (M. S. S.)

SÖDERBERG, Dr E.; of the Central Statistical Bureau, Sweden; author of 'Samuel Johan Hedborn,' etc. (E. So.)

SOULE, R. H., B.A., M.E.; sometime General Manager of the Erie R.R. (R. H. So.)

SPIELMANN, Marion H.; editor of the 'Magazine of Art' since 1887; art critic to 'Daily Graphic' until, in 1891, art editor and part-founder of 'Black and White'; author of 'Works of G. F. Watts, R.A.,' 'Henriette Ronner,' 'History of "Punch,"' 'Millais and his Works,' 'The Unidentified Contributions of Thackeray to "Punch,"' 'John Ruskin,' 'Notes on the Wallace Collection in Hertford House,' 'The Portraits of Geoffrey Chaucer,' 'British Sculpture and Sculptors of To-day.' (M. H. S.)

SPIERS, R. Phené, F.S.A., F.R.I.B.A.; Master of the Architectural School and Surveyor of Royal Academy; Associate and Hon. Fellow of King's Coll. London; Past President of Architectural Association; Member of Council Royal Institute of British Architects; Hon. and Corres. Member of the Société Centrale des Architectes, Paris; Sociedad de los Arquitectos, Madrid; edited 'Pugin's Normandy,' 'Fergusson's History of Architecture'; author of 'Architectural Drawing,' 'Architectural Essays on Pierrefonds,' 'Domed Churches in Perigord,' 'Mosque at Damascus,' etc. (R. P. S.)

SPRING-RICE, Stephen Edward, C.B., the late; Principal Clerk H.M. Treasury; Auditor of the Civil List; private secretary to successive Financial Secretaries to the Treasury, 1881-1888, and to Chancellor of the Exchequer, 1886. (S. E. S.-R.)

SQUIRE, William Barclay, M.A., F.S.A., F.R.G.S.; Assist. Brit. Museum; Hon. Sec. Purcell Soc.; Joint Hon. Sec. Eng. Com. International Music Society; late musical critic of 'Westminster Gazette,' 'Saturday Review,' and 'Globe' (London); author of various articles on music; and editor of 'Byrd's Masses,' 'The Fitzwilliam Virginal Book,' etc. (W. B. S*.)

STANTON, Rev. Vincent Henry, D.D., M.A.; Ely Professor of Divinity, Cambridge, and Canon of Ely; Hulsean Lecturer, 1879; author of 'The Jewish and the Christian Messiah,' 'The Place of Authority in Matters of Religious Belief.' (V. H. S.)

STATHAM, H. H.; editor of 'The Builder'; author of 'Architecture for General Readers,' 'Architecture among the Poets.' (H. H. S.)

STEBBING, Rev. Thomas Roscoe Rede, M.A., F.R.S., F.L.S., F.Z.S.; Fellow of King's College, London; Fellow of Worcester Coll. Oxford; prepared Report on the Amphipoda of the 'Challenger' Expedition; Chairman of Conference of Delegates, corresponding societies of British Association, 1899; author of 'Translation of Longinus On the Sublime,' 'Essays on Darwinism,' '"Challenger" Reports,' 'Zoology,' 'A History of Crustacea,' etc. (T. R. R. S.)

STEDMAN, Edmund Clarence, L.H.D., LL.D.; poet and critic; author of 'Poems,' 'Victorian Poets,' 'Poets of America,' 'The Nature and Elements of Poetry'; editor of 'Library of American Literature,' 'Victorian Anthology,' etc. (E. C. S.)

STEED, H. WICKHAM; Correspondent of 'The Times' at Rome. (H. W. S.)

STEPHEN, Sir Herbert, Bart., LL.M.; Clerk of Assize for the Northern Circuit; author of 'The Law Relating to Malicious Prosecutions,' 'Prisoners on Oath,' etc. (H. S*.)

STEPHEN, Sir Leslie, K.C.B., Litt.D., M.A.; Hon. Fellow of Trin. Hall, Camb.; President of Ethical Society; formerly Fellow and Assistant Tutor, Trin. Hall Coll., and Clark Lecturer in English Literature; editor of Cornhill Magazine, 1871-82; Dictionary of National Biography, 1882-91; author of 'Hours in a Library,' 'History of English Thought in the Eighteenth Century,' 'Essays on Freethinking and Plain Speaking,' 'The Science of Ethics,' 'Life of Henry Fawcett,' 'An Agnostic's Apology,' 'Life of Sir James Fitz-James Stephen,' 'Studies of a Biographer,' 'The English Utilitarians'; edited 'Letters of John Richard Green.' (L. S.)

STEPHENS, F. G.; one of the Pre-Raphaelite Brotherhood; late art critic of the 'Athenæum'; author of 'Landseer' in Ninth Edition of 'Ency. Brit.,' 'Catalogue of Satires' (Brit. Mus.), 'Artists at Home,' 'George Cruikshank,' 'Memorials of W. Mulready,' 'French and Flemish Pictures,' 'Sir E. Landseer,' 'T. C. Hook, R.A.,' etc. (F. G. S.)

STERLAND, Miss M. B.; writer on Ecclesiastical History. (M. B. S.)

STERLING, Maj.-Gen. John B.; Egypt, 1882; Sudan and Cyprus, 1885. (J. B. S.)

STEWART, John Alexander, M.A., LL.D.; Tutor of Christ Church; White's Professor of Moral Philosophy, Oxford; author of 'The English MSS. of the Nicomachean Ethics,' 'Notes on the Nicomachean Ethics.' (J. A. St.)

STOCK, Eugene; Editorial Secretary of the Church Missionary Society. (E. St.)

STOCKMAN, Ralph, M.D., F.R.C.P.Ed., F.R.S.Ed.; Professor of Materia Medica and Therapeutics, University of Glasgow; assistant in the University of Edinburgh for six years, and afterwards Lecturer on Materia Medica in the School of Medicine. (R. S*.)

STRANGE, Edward Fairbrother; Assistant Keeper, National Art Library; Assistant, South Kensington Museum, 1889; National Art Library, 1891; author of 'Alphabets: a Handbook of Lettering,' 'Japanese Illustration,' 'Worcester, the Cathedral and City,' and numerous essays on art subjects. (E. F. S.)

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SWINBURNE, Algernon Charles; author of 'Beaumont and Fletcher,' 'Congreve,' 'Keats,' 'Landor,' 'Marlowe,' 'Mary' (of Scotland), 'Tourneur,' 'John Webster,' in Ninth Edition of 'Ency. Brit., 'The Queen-Mother, and Rosamond,' 'Atalanta in Calydon,' 'Chastelard,' 'Poems and Ballads,' 'William Blake,' 'Songs before Sunrise,' 'Bothwell,' 'Songs of Two Nations,' 'George Chapman,' 'Poems and Ballads' (2nd series), 'A Study of Shakespeare,' 'Mary Stuart,' 'Tristram of Lyonesse, and other Poems,' 'Miscellanies,' 'A Study of Victor Hugo,' 'Locrine,' 'Poems and Ballads' (3rd series), 'Study of Ben Jonson,' 'Studies in Prose and Poetry,' 'Rosamund, Queen of the Lombards,' etc. (A. C. S.)

SYMONS, Arthur; author of 'An Introduction to the Study of Browning,' 'Days and Nights,' 'Silhouettes,' 'London Nights,' 'Studies in Two Literatures,' 'The Symbolist Movement in Literature,' 'Images of Good and Evil,' 'Collected Poems.' (A. Sy.)

SYMONS, Henry, B.A.; late Scholar of Wadham College, Oxford, and University Scholar in Classics of the University of London; formerly Lecturer in Greek and Roman History at Bedford College, London; Assistant Librarian, British Museum. (H. Sy.)

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TAIT, Peter Guthrie, M.A., D.Sc., the late; Professor of Natural Philosophy, Edin.; Sec. Royal Soc., Edin.; Hon. Fellow St Peter's Coll., Cambridge; Professor of Mathematics, Queen's Coll., Belfast, 1854; author of 'Light,' 'Sir W. Rowan Hamilton,' etc., in Ninth Edition of 'Ency. Brit.,' 'Dynamics of a Particle,' 'Quaternions,' 'Thermo-Dynamics,' 'Heat,' 'Light,' etc. (P. G. T.)

TANSLEY, A. G., M.A., F.L.S.; Asst. Professor of Botany, University Coll., London; author of 'Memoirs on the Anatomy of Plants'; editor of 'The New Phytologist,' etc. (A. G. T.)

TAUSSIG, Frank William, Ph.D., LL.D.; Professor of Political Economy, Harvard University, and editor of the 'Quarterly Journal of Economics'; author of 'Tariff History of the United States,' 'Wages and Labour,' etc. (F. W. T.)

TAYLOR, Charles, M.A., D.D., Hon. LL.D. (Harvard); Master of St John's Coll., Cambridge; author of 'Geometrical Conics,' 'The Gospel in the Law,' 'The Teaching of the Twelve Apostles,' etc. (C. T*.)

TAYLOR, Hon. Hannis, LL.D.; U.S. Minister to Spain, 1893-97; author of 'The Origin and Growth of the English Constitution.' (H. T*.)

TCHERTKOFF, V.; author of 'Christian Martyrdom in Russia'; agent for Count Tolstoy in England. (V. T.)

TEDDER, Henry Richard, F.S.A.; Secretary and Librarian of the Athenæum Club; librarian to Lord Acton, 1873-74; one of the organisers and joint-sec. of 1st International Conference of Librarians, 1877; joint hon. sec. of Library Association, 1878-80; hon. treas. of the same, 1889-97, and 1898-1901; President, 1897-98; treas. and sec. Metropolitan Free Libraries' Committee, 1878-80; hon. treas. second International Conference of Librarians, 1897; joint-editor of first three volumes of Transactions of Library Association, and of Reports of 1st and 2nd International Library Conference; author of 'Libraries,' etc., in Ninth Edition of 'Ency. Brit.,' and of many papers in publications of Library Association, some printed separately, articles in reviews, etc. (H. R. T.)

TELBIN, William; English scenic artist; author of 'Scenery,' 'Act Drops,' etc., in 'Magazine of Art,' etc. (W. Te.)

TEMPLE, Lieut.-Col. Sir Richard Carnac, Bt., C.I.E.; Knight of Grace; Chief Commissioner, Andaman and Nicobar Islands, and Superintendent, Penal Settlement at Port Blair; served Afghan Campaign, 1878-79; Burmah War, 1887-89; Cantonment Magistrate, Panjab; Assistant Commissioner, Burmah, and Cantonment Magistrate, Mandalay, 1887; Deputy-Commissioner, 1888; to special duty with Government of India, 1890; Official President, Rangoon Municipality, and Port-Commissioner, Rangoon, 1891; has been member of the Council R. Asiatic Soc.; Asiatic Soc., Beng.; Cor. Member American Philosophical Socy.; Smithsonian Institute; Numismatic Socy. of Philadelphia; edited 'Fallon's Dict. of Hindustani Proverbs,' 'Burnell's Devil-Worship of the Tuluvas'; has been editor and proprietor of the 'Indian Antiquary,' since 1884; founded and edited the 'Panjab (Indian) Notes and Queries,' 1883-87. (R. C. T.)

THAYER, William Roscoe, A.M.; editor of 'The Harvard Graduates' Magazine'; author of 'The Dawn of Italian Independence,' 'Poems New and Old,' 'Throne Makers,' etc. (W. R. T.)

THEOBALD, F. V., M.A.; Foreign Member of Association of Economic Entomologists, U.S.; Zoologist to the South-Eastern Agricultural College; Lecturer in Economic Entomology to the Horticultural College, Swanley; author of 'A Text-book of Agricultural Zoology,' 'The Parasitic Diseases of Poultry,' 'British Flies,' 'Insect Life,' etc. (F. V. T.)

THOMPSON, Sir Edward Maunde, K.C.B., D.C.L., LL.D., V.P.S.A.; corresponding member of the Institute of France and of the Royal Prussian Academy of Sciences; Director and Principal Librarian, Brit. Museum; Assis. Brit. Mus., 1861; Keeper of the MSS. and Egerton Librarian, 1878; Sandars Reader in Bibliography, Cambridge, 1895-96; editor of 'Chronicon Angliae'; author of 'Miniature,' 'Paleography,' etc., in Ninth Edition of 'Ency. Brit.,' 'Letters of Humphrey Prideaux,' 'Correspondence of the Family of Hatton,' 'Chronicon Adae de Usk, 1377-1404,' 'Diary of Richard Cocks in Japan, 1615-22,' 'Chronicon Galfridi le Baker de Swynebroke, 1303-1356,' 'Adae Murimuth Continuatio Chronicorum, 1303-1347,' 'Robertus de Avesbury de gestis mirabilibus Regis Edwardi Tertii': joint-editor of publications of the Palæographical Society, and of the Facsimile of the Laurentian Sophocles, 'Handbook of Greek and Latin Palæography.' (E. M. T.)

THOMPSON, Sir Henry, Bt., F.R.C.S., M.B., London; Surgeon Extraordinary to King of the Belgians; Com. Order of Leopold; Consulting Surgeon to University Coll. Hospital, London, and emeritus Professor of Clinical Surgery; surgeon to University Coll. Hospital, 1863; Professor of Pathology and Surgery, Royal College of Surgeons, 1884; President of the Cremation Society of England; author of 'Practical Lithotrity and Lithotomy,' 'Cremation, or Treatment of the Body after Death,' 'Modern Cremation,' 'Charley Kingston's Aunt,' 'All But,' 'On Food and Feeding,' 'Diet in Relation to Age and Activity,' etc. etc. (H. Th.)

THOMSON, Basil H.; Governor of Dartmouth Convict Prison; late of the Colonial Service; acted as Prime Minister of Tonga, etc.; author of 'Diversions of a Prime Minister,' 'South Sea Yarns,' etc. (B. H. T.)

THOMSON, David Croal; editor of 'The Art Journal'; author of 'The Life and Work of Thomas Bewick,' 'The Life and Work of H. K. Browne ("Phiz"),' 'The Barbizon School of Painters,' 'Corot,' 'Luke Fildes, R.A.,' 'The Tate Gallery,' 'Fifty Years of Art,' 'The Paris Exhibition, 1900.' (D. C. T.)

THOMSON, Prof. Elihu; Electrician for the General Electric Company; inventor of electric welding and other important electrical appliances. (E. T.)

THOMSON, John Arthur, M.A.; formerly Lecturer on Zoology and Biology, School of Medicine, Edinburgh; Regius Professor of Natural History, Aberdeen University; part-author of 'Evolution of Sex'; author of 'The Study of Animal Life,' 'Outlines of Zoology,' 'The Natural History of the Year,' 'The Science of Life,' etc. (J. A. T.)

THOMSON, Joseph John, D.Sc., LL.D. Glasgow and Princeton, Ph.D. Cracow, F.R.S.; Cavendish Professor of Experimental Physics, Cambridge; Fellow of Trinity College; Lecturer Trinity College; Roy. Socs. Upsala and Turin; President of Cambridge Philosophical Society, 1894; President of Section A, British Association, 1896; author of 'A Treatise on the Motion of Vortex Rings,' 'Application of Dynamics to Physics and Chemistry,' 'Recent Researches in Electricity and Magnetism,' 'Elements of the Mathematical Theory of Electricity and Magnetism,' etc. (J. J. T.)

THORODDSEN, Dr Theodor H.; Icelandic expert and explorer; author of 'History of Icelandic Geography,' etc. (Th. T.)

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THURSTON, Prof. Robert Henry, A.M., C.E., LL.D.; Director of Sibley College, and Professor of Mechanical Engineering, Cornell University; sometime President Am. Society Mechanical Engineers; inventor of Testing Machines, etc.; author of 'Manual of the Steam Boiler,' 'History of the Steam Engine,' 'Materials of Engineering,' etc. (R. H. T.)

THWING, Charles Franklin, D.D., LL.D.; President Western Reserve University and Adelbert College; author of 'American Colleges,' 'The Reading of Books,' 'Within College Walls,' 'American College in American Life,' etc. (C. F. T.)

TIEDEMANN, H.; Anglo-Dutch journalist; ex-President of the Foreign Press Association. (H. Ti.)

TODD (J.), Spencer Brydges, C.M.G.; Secretary Dept. of Agent-General for Cape of Good Hope in London; Executive Commissioner, Paris, for Universal Exhibition, 1878; appointed by H.R.H. Prince of Wales a member of the International Jury; author of 'The Resident Magistrate at the Cape of Good Hope,' 'Handy Guide to Laws and Regulations at the Cape of Good Hope.' (S. B. T.)

TREBLE, Rev. Edmund John, A.K.C.L.; Eng. Chap., Wiesbaden; author of 'Plain Teaching about the Church of England,' etc. (E. J. T.)

TRENT, William Peterfield, A.M., LL.D.; Prof. of English, Columbia University, New York; formerly editor of the 'Sewanee Review'; author of 'English Culture in Virginia,' 'Southern Statesmen of the Old Régime,' 'Life of William Gilmore Simms,' 'Robert E. Lee,' etc. (W. P. T.)

TRIPP, Hon. Bartlett; late U.S. Minister to Austria; Chief-Justice of the Supreme Court of Dakota Territory, 1885-89. (B. T.)

TROTTER, Lieut.-Colonel Henry, C.B.; British Delegate on the European Commission of the Danube, and H.B.M. Consul-General for Roumania; served 1863-75 on great Trigonometrical Survey of India; accompanied mission to Yarkand and Kashgar, 1873-74; special service in China, 1876; additional military attaché at Constantinople during Turko-Russian War, 1877-78; Consul for Kurdistan, 1878-82; military attaché, Constantinople, 1882-89; Consul-General in Syria, 1890-94; has acted as H.M. Chargé d'Affaires at Bucharest; author of various papers contributed to the Royal Geog. Soc. (H. Tr.)

TROUP, Charles Edward, M.A., C.B.; Principal Clerk in the Home Office since 1896; chairman of Committee on Identification of Habitual Criminals; editor of 'Judicial Statistics of England and Wales'; author of 'The Future of Free Trade.' (C. E. T.)

TUKE, Sir John Batty, M.D., D.Sc., F.R.C.P.Ed., F.R.S.Ed., M.P.; Medical Superintendent, Saughton Hall Asylum, Edinburgh; Member of General Medical Council of Registration and Education; Medical Superintendent of Fife and Kinross Asylum, 1865-73; author of 'Aphasia,' 'Hippocrates,' 'Hysteria,' 'Insanity,' in Ninth Edition of 'Ency. Brit.,' 'Morrison Lectures,' 'Insanity of Over-exertion of the Brain.' (J. B. T.)

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U

UKITA, Goji; Chancellor of the Japanese Legation, London. (G. U.)

UNWIN, William Cawthorne, F.R.S., M.I.C.E.; Hon. Life M.I.M.E.; Hon. Mem. Am. Soc. M.E.; Hon. Assoc. R. I. Brit. Architects; Professor of Civil and Mechanical Engineering, Central Technical College, City and Guilds of London Institute; instructor at Royal School of Naval Architecture and Marine Engineering, Kensington, 1868-72; Professor of Hydraulic Engineering, Royal Indian Engineering College, Cooper's Hill, 1872-85; Professor of Engineering, Central Technical College of the Guilds of London, Kensington, since 1885; President, Section G, British Association, 1892; on the Council of Royal Society, 1894; on the Council Inst. Civil Engineers, 1900; on the Senate London University, 1900; author of 'Hydraulics,' etc., in Ninth Edition of 'Ency. Brit.,' 'Wrought Iron Bridges and Roofs,' 'Machine Design,' 'The Testing of Materials of Construction,' 'The Development and Transmission of Power from Central Stations,' etc. (W. C. U.)

V

VAN DER WAALS, J. D.; Doctor of Math. and Physics, Leyden; Professor of Physics, Amsterdam; Gen. Sec. Royal Academy of Sciences, Amsterdam; Cor. Member de l'Académie des Sciences de Paris, etc.; author of 'The Continuity of the Gaseous and Liquid States of Matter,' etc. (J. D. v. d. W.)

VAN DYKE, Prof. Henry, D.D., LL.D.; Professor of English Literature, Princeton University; author of 'The Poetry of Tennyson,' 'Little Rivers,' 'The Gospel for an Age of Doubt,' 'The Toiling of Felix, and other Poems,' etc. (H. van D.)

VAN DYKE, John Charles, L.H.D.; author of 'History of Painting,' 'Old Dutch and Flemish Masters,' etc. (J. C. Van D.)

VASCONCELLOS, Captain Ernesto de; Secretary of the Committee of Colonial Cartography, Department of Marine and Fisheries, Portugal; Secretary of the Lisbon Geographical Society; author of 'As Colonias Portuguesas,' etc. (E. de V.)

VAUGHAN, H.E. Herbert, Cardinal, D.D., Priest of the Title of SS. Andrew and Gregory on the Coelian Hill; Archbishop of Westminster; Bishop of Salford, 1872-92; author of a large number of pamphlets and letters concerning educational, social, and religious questions, etc. (✠H. E. V.)

VERDINOIS, Frederigo; Italian man of letters; translated 'Cantico di Natale' and 'La Piccola Dorrit' from Dickens, Shakespeare's 'Midsummer Night's Dream,' etc. (F. V.)

VERNON-HARCOURT, Leveson Francis, M.A., M.I.C.E.; Professor of Civil Engineering at Univ. Coll. London; proceeded to India, 1896, to inspect the river Húgli, reporting to Calcutta Port Commissioners; British Member of Jury for Civil Engineering, Paris Exhibition, 1900; author of 'River Engineering,' 'Water Supply,' in Ninth Edition 'Ency. Brit.,' 'Rivers and Canals,' 'Harbours and Docks,' 'Achievements in Engineering,' 'Civil Engineering as applied in Construction,' etc. (L. F. V.-H.)

VERWORN, Max, M.D., Ph.D.; Professor of Physiology, Jena, author of 'Allgemeine Physiologie,' 'Psycho-physiologische Protisten-Studien,' etc. (M. V.)

VETCH, Col. Robert Hamilton, R.E., C.B., employed on defences of Bermuda, Bristol Channel, Plymouth Harbour, and Malta, 1861-1876; Secretary of R.E. Institute, Chatham, 1877-1883; commanded R.E. Submarine Mining Batt., 1884; Assistant Inspector-General of Fortifications at War Office, 1884-89; Deputy Inspector-General of Fortifications and Secretary of the Defence Committee, and of the Joint Naval and Military Committee on Defence, War Office, 1889-94; Chief Engineer in Ireland and Colonel on Staff, 1894-98; author of 'Gordon's Campaign in China,' 'Life of Lieut.-Gen. Sir Gerald Graham'; edited 'The Professional Papers of the Corps of R.E.'; also the 'R.E. Journal,' 1877-84. (R. H. V.)

VILLARS, Paul; Knight of the Legion of Honour; and London Correspondent of 'Le Journal des Débats,' 'Le Figaro,' etc.; author of 'Sketches of England,' 'Scotland and Ireland,' etc. (P. V*.)

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VINES, Sydney Howard, D.Sc. London, M.A., D.Sc. Camb., F.R.S.; President of the Linnean Society of London; Sherardian Professor of Botany, Oxford; Fellow of Magdalen College; Fellow and Lecturer of Christ's Coll. Cambridge, 1876; Reader in Botany, Cambridge, 1883; Hon. Fellow of Christ's Coll. Cambridge, 1897; author of 'Reproduction,' etc., in Ninth Edition of 'Ency. Brit.,' 'Lectures on the Physiology of Plants,' 'A Student's Text-Book of Botany,' papers in various scientific journals, etc. (S. H. V*.)

VITTORE, E. (E. Vi.)

W

WADSWORTH, S., M.A.; Barrister-at-Law, of the Inner Temple and of Lincoln's Inn; joint-editor of the 17th edition of Davidson's 'Concise Precedents in Conveyancing.' (S. Wa.)

WAGER, Harold W. T., F.L.S.; formerly Lecturer in Biology, Yorkshire Coll. Leeds; H.M. Inspector of Science Schools; author of 'Memoirs on Cytology and Reproduction of the Lower Organisms,' etc. (H. W*.)

WAGLE, N. B., B.A.; formerly Lecturer on Sanskrit at the Robert Money Institution, Bombay, and Travelling Fellow of the Bombay University; deputed by the University of Bombay and staff of the Native States to carry on research work in Europe in connexion with Indian industries; Vice-President of the London Indian Society; author of 'Industrial Development of India,' 'Experiences of Factory Life in England,' etc. (N. B. W.)

WAGNER, Dr Hermann; Professor of Geography in Göttingen University; author of 'Germany (Geography)' in Ninth Edition of 'Ency. Brit.,' 'Lehrbuch der Geographie,' editor 'Geographisches Jahrbuch,' etc. (H. Wa.)

WALDSTEIN, Charles, Litt.D., Ph.D., L.H.D.; Knight Commander of the Order of the Redeemer; and Ernestine Saxon Order; Fellow of King's College, Cambridge, 1894; member of Council of British Archæological School, Athens, etc.; Lecturer in Classical Archæology in Univ. of Camb., 1880; Director of Fitzwilliam Museum, Camb., 1883-89; Director of American Archæological School, Athens (retaining Readership at Camb.), 1889-1893, retaining Professorship there till 1896; Slade Professor of Fine Art, 1895-1901; author of 'Balance of Emotion and Intellect,' 1878, 'Essays on the Art of Phidias,' 1885, 'The Work of John Ruskin,' 1894, 'The Study of Art in Universities,' 1895, 'The Expansion of Western Ideals' and the 'World's Peace,' 1899, 'The

Jewish Question' and the 'Mission of the Jews,' 1899, and numerous reports of excavations and archæological memoirs. (C. W*.)

WALKER, James, D.Sc., F.R.S.; Professor of Chemistry, University College, Dundee. (J. Wal.)

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WALLACE, Sir Donald Mackenzie, K.C.I.E., K.C.V.O.; Private Secretary to Marquesses of Dufferin and of Lansdowne as Viceroys of India, 1884-89; attached to the Czarewitch as political officer during his tour in India and Ceylon, 1890-91; Director of the Foreign Department of 'The Times,' 1891-99; Assist. Private Secy. to H.R.H. the Duke of Cornwall and York during his colonial tour, 1901; member of Institut de Droit International and Officier de l'Instruction Publique of France; joint-editor of New Volumes of "Encyclopædia Britannica"; author of 'Russia,' 'Egypt and the Egyptian Question,' 'The Web of Empire,' etc. (D. M. W.)

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WALLIS, John Edward Power, M.A.; Advocate-General of Madras; Inns of Court Reader in Constitutional Law, 1892-97; author of 'State Trials' for the State Trials Committee, and numerous articles on constitutional law and history. (J. E. P. W.)

WALPOLE, Sir Spencer, K.C.B., Hon. LL.D. Edin.; Inspector of Fisheries, 1867; Lieut.-Governor of the Isle of Man, 1882; Secretary to the Post Office, 1893-99; author of 'History of England from 1815,' 'Life of Rt. Hon. Spencer Perceval,' 'Life of Lord John Russell,' 'The Electorate and the Legislature,' 'Foreign Relations,' 'The Land of Home Rule.' (S. W.)

WALTON, Hon. Sir Joseph, K.C.; Judge of the King's Bench Div.; chairman of the General Council of the Bar, 1899; Recorder of Wigan, 1895-1901; author of 'Practice and Procedure of Court of Common Pleas at Lancaster.' (W.)

WARD, H. Marshall, D.Sc., F.R.S., F.L.S., F.R.Hort.S.; Professor of Botany, Cambridge; Fellow of Sidney Sussex College, Cambridge; Hon. Fellow of Christ's College, Cambridge; President of the British Mycological Society; corresponding Member Cryptogamic Society of Scotland; Cryptogamic Botanist to Ceylon Government, 1880-82; Berkeley Fellow, Owens Coll., 1882; Fellow of Christ's Coll., 1883; Professor of Botany in Forest School, Cooper's Hill, 1885-95; author of 'Schizomycetes' in Ninth Edition of 'Ency. Brit.,' 'Timber and some of its Diseases,' 'The Oak,' 'Sachs' Lectures on the Physiology of Plants,' 'Laslett's Timber and Timber Trees,' 'Diseases of Plants,' 'Grasses,' 'Disease in Plants.' (H. M. W.)

WARD, James, M.A., LL.D., D.Sc.; Fellow of Trin. Coll. Camb. and Professor of Mental Philosophy, Cambridge; Gifford Lecturer, University of Aberdeen, 1895-97; author of 'Herbart,' 'Psychology,' in Ninth Edition of 'Ency. Brit.,' 'Naturalism and Agnosticism.' (J. W*.)

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WATERHOUSE, Major-Gen. James; Unemployed Supernumerary List, Indian Staff Corps; Vice-President Roy. Phot. Soc.; Hon. Mem. Vienna Phot. Soc. 1901; Indian Ordnance Dept. 1866; Assist. Surveyor-Gen. in charge of photographic operations in the Surveyor-General's Office, Calcutta, 1866-97; took part in the observation of total eclipses, 1871 and 1875, and of transit of Venus, 1874; President of the Asiatic Society of Bengal, 1888-90; awarded Roy. Phot. Soc. Progress Medal, 1890, also Vienna Phot. Soc. Voigtländer Medal, 1895; author of 'The Preparation of Drawings for Photographic Reproduction,' and numerous papers in the 'Bengal Asiatic Society's Journal' and various photographic journals and publications. (J. Wa*.)

WATSON, Alfred Edward Thomas ('Rapier'); editor of the 'Badminton Library' and 'Badminton Magazine'; musical and dramatic critic of the 'Standard'; edited the 'Illustrated Sporting and Dramatic News,' writing under the signature 'Rapier,' 1880-95; author of 'Sketches in the Hunting Field,' 'Race Course and Covert Side,' 'Types of the Turf,' 'Steeplechasing,' chapters in the Badminton volumes on Hunting, Riding and Driving, Racing and Chasing, 'The Turf,' etc. (A. E. T. W.)

WATSON, Colonel Charles Moore, C.M.G., C.B., M.A., late R.E.; Deputy Inspector-General of Fortifications, War Office; served in Sudan under the late Gen. C. G. Gordon, C.B., 1874-1875; A.D.C. to Field-Marshal Sir Lintorn Simmons, G.C.B., 1878-80; employed in India Office, 1880-82; special service, Egyptian War, 1882; employed in Egyptian Army, 1882-86, with rank of Pasha (3rd class Osmanieh); Assistant Inspector-General of Fortifications, 1891-96; Deputy Inspector-General, 1896. (C. M. W.)

WATTS, Philip, F.R.S.; Director of Naval Construction; formerly Naval Architect and Director of War Shipbuilding Department of Sir W. G. Armstrong, Whitworth and Co. (P. Wa.)

WATTS-DUNTON, Theodore; poet, novelist, and critic; author of 'Poetry,' 'Rossetti,' 'Sonnet,' 'Vanbrugh,' 'Wycherley,' etc., in Ninth Edition of 'Ency. Brit.,' 'The Coming of Love,' 'Aylwin'; edited 'Lavengro,' etc. (T. W. D.)

WAUGH, Arthur; London Correspondent to the 'New York Critic,' 1893-97; literary adviser to Kegan Paul and Co. Ltd.; author of 'Gordon in Africa,' 'Alfred, Lord Tennyson'; edited 'Johnson's Lives of the Poets'; edited the 'Pamphlet Library,' 'Legends of the Wheel,' 'Robert Browning.' (A. Wa.)

WEBB, Gen. Alexander Stewart; President of the College of the City of New York; Brig.-Gen. of Volunteers in the Civil War; author of 'The Peninsula,' 'McClellan's Campaign of 1862,' etc. (A. S. W*.)

WEBBER, Maj.-Gen. C. E., C.B., M.I.C.E., M.I.E.E.; Indian Mutiny, 1857-60; instructor in topography, R.M.A.; with Prussian Army in 1866; Paris Exhibition, 1867; Egyptian expedition, 1882; Nile expeditions, 1884-85; founder (with late Sir Francis Bolton) and past President of the Institution of Electrical Engineers; author of various articles on military subjects, Telegraphy, Telephony, and Electrical Engineering. (C. E. W.)

WEBER, Gustavus A., LL.B.; Statistical Expert, U.S. Dept. of Labour, Washington, D.C. (G. A. W.)

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WELCH, Lewis S., A.B.; editor of the 'Yale Alumni Weekly.' (L. S. W.)

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WETHERELL, W.; assistant editor, 'Liverpool Daily Post.' (W. We.)

WHATES, H.; assistant editor of the 'Standard'; editor of the 'Politician's Handbook.' (H. Wh.)

WHEATLEY, Henry Benjamin; Asst. Secretary, Society of Arts, Assistant Sec. Brit. Royal Commission, Section of Chicago Exhibition, 1893; Hon. Sec. Early English Text Society, 1864-72; Treasurer, 1872-1901; author of 'Index,' etc., in Ninth Edition of 'Ency. Brit.,' 'Anagrams,' 'Round about Piccadilly and Pall Mall,' 'What is an Index?' 'Samuel Pepys and the World he lived in,' 'How to form a Library,' 'How to Catalogue a Library,' 'London Past and Present,' 'New Edit. Pepys' Diary,' 'Historical Portraits,' 'Prices of Books,' 'Pepysiana,' etc. (H. B. W*.)

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WHITAKER, Edgar; editor of the 'Constantinople Messenger'; author of 'The Outlook in Asiatic Turkey'; translated Giacometti's 'Russia's Work in Turkey,' etc. (E. W*.)

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WHYTE, Frederic W.; author and dramatic critic; author of 'Actors of the Century'; translator of A. Filon's 'English Stage,' etc. (F. W. W.)

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WILKINSON, Henry Spenser, M.A., on staff of the 'Morning Post'; author of 'Citizen Soldiers,' 'Essays on the War Game,' 'Exercises in Strategy and Tactics' (from the German), 'The Command of Artillery in the Army Corps and the Infantry Division' (from the German), 'The Brain of an Army,' 'The Volunteers and the National Defence,' 'Imperial Defence' (in collaboration with Sir Charles Dilke), 'The Great Alternative, a Plea for a National Policy,' 'The Command of the Sea,' 'The Brain of the Navy,' 'British Policy in South Africa,' 'Lessons of the War,' 'War and Policy.' (H. S. W.)

WILLCOX, Walter F., LL.B., Ph.D.; Chief Statistician, U.S. Census Bureau; Professor of Social Science and Statistics, Cornell University; Member of the American Social Science Association, and Secretary of the American Economical Association; author of 'The Divorce Problem: A Study in Statistics,' 'Social Statistics of the United States,' etc. (W. F. W.)

WILLEY, Arthur, Hon. M.A. Camb., D.Sc., F.R.S.; Curator of the Colombo Museum; late Balfour Student of Cambridge University; formerly Tutor of Columbia University, New York; author of numerous zoological memoirs, and of 'Amphioseus and the Ancestry of the Vertebrates.' (A. W*.)

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WILLIAMS, Major Arthur Blount Cuthbert; Indian Staff Corps. (A. B. W.)

WILLIAMS, E. H., M.D.; formerly Associate Professor of Pathology, State University of Iowa; and Assistant Physician at the Hospital for the Insane, Matteawan, N.Y., and at the Manhattan State Hospital, N.Y. (E. H. W.)

WILLIAMS, Sir E. Leader; consulting engineer Manchester Ship Canal; engaged as engineer since 1846 on the works of the Great Northern Railway, Shoreham and Dover Harbours, River Weaver and Bridgwater Canal Navigations; chief engineer of the Manchester Ship Canal during its construction; Member of Council of Institution of Civil Engineers; author of papers printed in 'Proceedings of Institution of Civil Engineers.' (E. L. W.)

WILLIAMS, Henry Smith, M.D., B.Sc.; former lecturer in the Hartford School of Sociology, U.S.A.; editor of forthcoming 'History of the World' in 25 volumes; author of 'The Story of Nineteenth Century Science,' 'The History of the Art of Writing,' 'The Lesson of Heredity,' etc. (H. S. W*.)

WILLIAMS, R. Vaughan, B.A.; Mus. Doc., Trinity College, Cambridge. (R. V. W.)

WILLIAMS, Talcott; editor of the 'Philadelphia Press.' (T. W*.)

WILLIAMSON, George C., Litt.D., F.R.S.L.; author of 'Portrait Miniatures,' 'Richard Cosway, R.A., and his Companions,' 'George Engleheart,' 'Andrew and Nathaniel Plimer,' 'Pietro Perugino,' 'Bernardino Luini,' etc. (G. C. W.)

WILLSON, Beckles; staff of 'Boston Globe,' U.S.A., 1887; correspondent in Cuba, 1888; editor, 'Press of Atlanta,' Georgia, 1889; staff of 'New York Herald,' 1890; staff of 'London Daily Mail,' 1896-98; author of 'Harold: an Experiment,' 1891, 'Drift,' 1893, 'The Tenth Island,' 1897, 'The Great Company,' 1899. (B. W*.)

WILSON, Maj.-Gen. Sir Charles William, R.E., K.C.B., K.C.M.G., D.C.L., LL.D., F.R.S.; secretary to North American Boundary Commission, 1858-62; surveys of Jerusalem and Palestine, 1864-66; Ordnance Survey of Scotland, 1866-68; survey of Sinai, 1868-69; director Topographical Department W.O., and A.Q.M.G. Intelligence Department, 1869-76; Ordnance Survey of Ireland, 1876-78; Royal Commission on Registration of Deeds and Insurances in Ireland, 1878; British Commissioner Servian Boundary Commission, 1878-79; Consul-Gen. Anatolia, 1879-82; special mission to Eastern Rumelia, 1880; and to Consulates in Asiatic Turkey, 1881; special service in Egypt and attached to Lord Dufferin's mission, 1882-1883; D.A.G. (Intelligence Department) Nile Expedition, 1884-85; Ordnance Survey of Ireland, 1885-86; Director-Gen. Ordnance Survey, 1886-94; Director-Gen. of Military Education, 1895-98; president Geographical Section British Association, Belfast, 1874; Bath, 1888; Vice-President Royal Geographical Society, 1897-1901; author of 'Notes to Ordnance Survey of Jerusalem,' 'Notes to Ordnance Survey of Sinai' (part), 'Picturesque Palestine' (Jerusalem vol.), 'From Korti to Khartûm,' 'Life of Lord Clive,' Murray's Handbooks to 'Constantinople' and 'Asia Minor.' (C. W. W.)

WILSON, W. J.; of the Canadian Geological Survey. (W. J. W.)

WINTER, Miss E. G.; contributor to 'The Times' Gazetteer. (E. G. W.)

WOLCOTT, Hon. Roger, the late; Governor of Massachusetts, 1897-99. (R. Wo.)

WOLF, Lucien; sub-editor and leader-writer, 'Jewish World,' 1874-93; staff of 'Daily Graphic'; London correspondent, 'Le Journal,' Paris; Fellow of Inst. of Journalists; first President and now Vice-President of Jewish Historical Society of England; author of 'Sir Moses Montefiore'; joint-editor with Joseph Jacobs of 'Bibliotheca Anglo-Judaica'; 'Menasseh B. Israel's Mission to Oliver Cromwell'; many essays on foreign and colonial politics in 'Fortnightly Review,' 'Nineteenth Century,' and other magazines. (L. W.)

WOLFF, Rt. Hon. Sir Henry Drummond, G.C.B., G.C.M.G.; Ambassador-Extraordinary and Plenipotentiary at Madrid, 1892-1900; author of a 'Life of Napoleon at Elba'; 'Memnon Letters on the Suez Canal,' 'Some Notes of the Past' (H. D. W.)

WOOD, General Sir Evelyn, G.C.B., G.C.M.G., V.C.; commanding 2nd Army Corps; entered Navy, 1852; served in Crimea with Naval Brigade, 1 Oct. 1854 to 18 June 1855; Knight of Legion of Honour, Medjidieh, Turkish medal; Ashantee, Kaffir, Zulu, and Transvaal Wars, 1879-81; commanded Chatham District, 1882-83; 2nd Brigade (2nd Division) Expedition to Egypt, 1882; raised the Egyptian Army, 1883; served in Nile Expedition, 1894-95; commanded Eastern District, 1886-88; Aldershot Division, 1889-93; Quartermaster-Gen. to the Forces, 1893-97; Adjutant-General to Forces, 1897-1901; author of 'The Crimea in 1854-94,' 'Cavalry at Waterloo,' 'Achievements of Cavalry.' (E. Wo.)

WOODBERRY, George Edward, A.B.; Professor of English Literature, Columbia University, New York; author of 'The North Shore Watch,' 'Life of E. A. Poe,' 'Heart of Man,' 'Studies in Letters and Life,' 'Makers of Literature,' etc. (G. E. W.)

WOODHEAD, German Sims, M.A. M.D. Edin., F.R.C.P.Ed., F.R.S.Ed.; Fellow of Trinity Hall, Cambridge; Prof. of Pathology, Cambridge Univ., since 1899; formerly Director of the Laboratories of the Conjoint Board of the Royal Colleges of Physicians (London) and Surgeons (England); President Royal Medical Society; acted as Assistant Commissioner to the Royal Commission on Tuberculosis, 1892-95; Surgeon-Capt. Volunteer Medical Staff Corps; author of 'Practical Pathology,' 'Pathological Mycology' (with Arthur W. Hare, M.B.), 'Bacteria and their Products,' 'Report to the Royal Commission on Tuberculosis,' 'Report on Diphtheria' to the Metropolitan Asylums Board; editor of the 'Journal of Pathology and Bacteriology.' (G. S. W.)

WOODWARD, Arthur Smith, F.R.S., Hon. LL.D. (Glasgow); Asst. Keeper of Geology, British Museum; author of 'Cat. of Fossil Fishes in the British Museum,' 'Outlines of Vertebrate Palæontology,' etc. (A. S. Wo.)

WOOLSEY, Theo. S., LL.D.; Professor of International Law, Yale University; editor of 'Woolsey's International Law' (6th ed.), and of 'Pomeroy's International Law'; author of 'America's Foreign Policy. (T. S. W.)

WORCESTER, Dean Conant; Assistant Professor of Zoology, University of Michigan; Member of the First and Second U.S. Philippines Commission; author of 'The Philippine Islands and their People.' (D. C. W.)

WRIGHT, Hon. Carroll Davidson; U.S. Commissioner of Labour; author of 'Factory System of the United States,' 'Strikes and Lock-outs,' 'Cost of Production of Iron, Steel, etc.,' 'Industrial Evolution of the United States,' 'Outline of Practical Sociology,' etc. (C. D. W.)

WRIGHT, Charles Theodore Hagberg, B.A., LL.D.; Secretary and Librarian, London Library; Assistant Librarian, National Library of Ireland, 1890-93. (C. T. H. W.)

WRIGHT, Lewis; author of 'The New Book of Poultry,' 'The Practical Poultry Keeper,' 'The Poultry Club Standards'; editor of 'Fulton's Book of Pigeons,' etc. (L. Wr.)

WYATT, J. W., A.M.I.C.E.; Fellow Roy. Indian Engineering Coll., Cooper's Hill; author of 'The Art of Making Paper,' etc. (J. W. W.)

X

X (Anonymous). Signatory initial used after certain articles, where the real initials are omitted for special or personal reasons. (X.)

Y

YORKE, Lieut.-Col. H. A., R.E. (retired); Chief Inspecting Officer of Railways, Board of Trade. (H. A. Y.)

YOUNG, Alexander Bell Filson; assistant editor of the 'Pilot' since 1901; special war correspondent of the 'Manchester Guardian,' S.A.; author of various songs and instrumental works, 'The Relief of Mafeking,' 'Five Lyrics,' 'A Volunteer Brigade,' 'Mastersingers,' etc. (A. B. F. Y.)

YOUNG, Rev. William; for many years Minister at the English Presbyterian Church, Kersal, Manchester; Joint Secretary of the Religious Tract Society. (W. Y.)

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ZIMMERN, Miss Alice; author of 'The Renaissance of Girls: Education in England,' 'Methods of Education,' etc (A. Z.)

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